

AN OVERVIEW OF TRANSPORTATION R&D

HEARINGS

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION

COMMITTEE ON SCIENCE AND

TECHNOLOGY

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

FEBRUARY 12, 2009

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AN OVERVIEW OF TRANSPORTATION R&D: PRIORITIES FOR REAUTHORIZATION

THURSDAY, FEBRUARY 12, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. David Wu [Chair of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
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Subcommittee on Technology and Innovation's

Hearing on

***AN OVERVIEW OF TRANSPORTATION R&D:
PRIORITIES FOR REAUTHORIZATION***

Thursday, February 12, 2009
10:00a.m. – 12:00p.m.
2318 Rayburn House Office Building

Witness List

The Honorable Paul Brubaker
*Former Administrator of the Research and Innovative Technology Administration of the
U.S. Department of Transportation*

Dr. Elizabeth Deakin
*Director of the University of California Transportation Center at the University of
California, Berkeley*

Mr. Amadeo Saenz, Jr. PE
Executive Director of Texas Department of Transportation

Mr. Robert Skinner
Executive Director of the Transportation Research Board

Mr. David Wise
*Acting Director of Physical Infrastructure Issues at the Government Accountability
Office*

**SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

**An Overview of
Transportation R&D:
Priorities for Reauthorization**

THURSDAY, FEBRUARY 12, 2009
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

I. Purpose

On Thursday, February 12, 2009, the Subcommittee on Technology and Innovation will convene a hearing to review the research, development, and deployment activities of the Department of Transportation. The hearing will focus on issues related to the funding, planning, and execution of current research initiatives and how these efforts fulfill the strategic goals of both federal and State Departments of Transportation, metropolitan transportation organizations, and industry. With the expiration of SAFETEA-LU in FY 2009, this hearing will also examine possible ways to improve the current federal transportation effort.

II. Witnesses

The Honorable Paul Brubaker is a former Administrator of the Research and Innovative Technology Administration of the U.S. Department of Transportation.

Dr. Elizabeth Deakin is the Director of the University of California Transportation Center at the University of California, Berkeley.

Mr. Robert E. Skinner, Jr. is the Executive Director of the Transportation Research Board.

Mr. David Wise is the Acting Director of Physical Infrastructure Issues at the Government Accountability Office.

Mr. Amadeo Saenz, Jr. is the Executive Director of Texas Department of Transportation.

III. Overview

Signed in 2005, the *Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) (P.L. 109-59) authorized a total of \$2.227 billion through FY 2009 for research and related programs under Title V of the bill. This Title authorizes surface transportation research by the Federal Highway Administration (FHWA), training and education programs, the Bureau of Transportation Statistics, the University Transportation Centers (UTCs), and Intelligent Transportation Systems (ITS) Research. The Science and Technology Committee's jurisdiction over surface transportation research and development is based on House rules which grant the Committee jurisdiction over, "Scientific research, development, and demonstration, and projects therefore" and legislative precedent. Jurisdiction over these programs is shared with the Transportation and Infrastructure Committee. The Science and Technology Committee has a long referral history regarding surface transportation research and development (R&D) bills, including H.R. 860 in the 105th Congress and H.R. 242, and H.R. 243 in the 109th Congress. Elements of each of these bills were incorporated in the highway reauthorization bills for the respective Congresses.

IV. Issues and Concerns

Planning, Coordination, and Evaluation of Research, Development, and Technology (RD&T)

Despite the creation of a specific RD&T coordinating agency within Department of Transportation (DOT) by the *Mineta Act of 2004* (P.L. 108-426), and requirements in the *Transportation Equity Act for the 21st Century* (TEA-21) (P.L. 105-178) and SAFETEA-LU that DOT evaluate and coordinate its research programs, efforts in this regard continue to fall short. In 2003, the Government Accountability Office (GAO) evaluated the coordination and review efforts by the Research and Special Programs Administration (RSPA).¹ RSPA had been created by the Secretary of Transportation to coordinate and review RD&T activity across the modal agencies. It was dissolved when the Mineta Act created the Research and Innovative Technology Administration (RITA) to fulfill largely the same functions. In the 2003 report, GAO found that efforts to locate duplicative programs and opportunities for cross-collaboration between the modal agencies were hampered by a lack of information on the RD&T activities being pursued across the modal agencies. GAO also found that DOT did not have a systematic method for measuring the results of federal transportation research activities, or a method to show how their research impacted the performance of surface transportation in the U.S. RSPA cited a lack of resources to perform these types of evaluations, and they also stated that each modal agency undertook its own evaluation of its research programs. GAO recommended that RSPA define metrics to evaluate the outcomes of its DOT-wide RD&T coordination efforts. In 2006, GAO did a follow-up evaluation of RD&T coordination and evaluation.² They again offered similar recommendations, noting the continuing lack of common performance measures for DOT RD&T activities. However, at the time of that evaluation, RITA had just recently been established. GAO commended the initiative in RITA's FY 2007 budget request to devote \$2.5 million to RD&T coordinating activities (an increase of nearly \$2 million over the \$536,000 spent by RSPA in FY06 on coordination).

In November of 2006, RITA submitted the *Transportation Research, Development and Technology Strategic Plan for 2006-2010* to Congress. The Transportation Research Board (TRB), of the National Research Council, evaluated this plan and noted, "The strategic RD&T plan for 2006-2010 is a reasonable first effort. It offers useful descriptions of the many RD&T programs within the Department. At the same time, it is more a compendium of individual RD&T activities than a strategic plan that articulates department wide priorities and justifications for RD&T programs and budgets."³ According to TRB, the plan lacked stakeholder input and also failed to identify how stakeholder input would be sought for strategic planning in research topic areas. It further failed to articulate the role and value of DOT's RD&T activities; describe the process used for selecting research topics to ensure their relevance, quality, or performance; describe the expected outcomes from RD&T; and describe the process for monitoring performance. In TRB's view, the plan, at a minimum should have explained the extent to which quantifiable goals, timetables, and performance measures would be part of RD&T programs.

The major surface transportation RD&T program of the FHWA has received similar criticisms regarding coordination and evaluation as DOT's overall RD&T program. The program is highly decentralized, with research activities taking place in five out of the thirteen offices within the agency. In 2002, GAO reviewed FHWA's R&D approach and urged that the agency "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."⁴ FHWA subsequently developed its *Corporate Master Plan for Research and Deployment of Technology and Innovation*, released in 2003. This document contains many overarching principles, such as measuring the performance of RD&T activities, but does not provide specific mechanisms through which FHWA will implement all of them. It is also unclear from FHWA's RD&T Performance Plan for 2006/2007 if the many research projects listed have been evaluated for their use by the transportation com-

¹ GAO-03-500, *Transportation Research: Actions Needed to Improve Coordination and Evaluation of Research*.

² GAO-06-917, *Transportation Research: Opportunities for Improving the Oversight of DOT's Research Programs and User Satisfaction with Transportation Statistics*.

³ RITA, *Transportation Research, Development and Technology Strategic Plan: 2006-2010*, Nov. 2006, Appendix A.

⁴ GAO-02-573, *Highway Research: Systematic Selection and Evaluation Processes Needed for Research Program*, pg. 19.

munity. Without such analysis, the information portrayed in these documents establishes outputs, but does not offer any outcomes.

Tech-Transfer

There is general agreement that the transfer of technology and new ideas from the R&D stage to deployment and adoption is slow. In testimony before this committee in September of 2007, FHWA identified some of the contributing factors that slow the State and local adoption of new transportation technology, including insufficient information on the benefits versus the costs of new technologies; lack of confidence in new technologies or a lack of performance data; and a lack of incentive mechanisms to encourage the deployment of new technology.⁵ TRB Special Report 295, *The Federal Investment in Highway Research, 2006–2009: Strengths and Weaknesses*, notes the important role FHWA plays in educating State DOTs about new technologies and encouraging their adoption, noting such efforts as FHWA's activities to identify, market, and track the deployment of market-ready technologies and incorporate a strategic plan for the deployment of pavement research activities. However, the funding for technology transfer activities at FHWA has suffered in recent years, falling from \$100 million to \$40 million after the passage of TEA–21. The report further notes, "The missing element among all of FHWA's deployment activities appears to be the resources within the agency with explicit expertise in technology transfer and deployment that could provide guidance to the various efforts agency wide [sic]." ⁶

The Intelligent Transportation Systems program is a well studied example of transfer and deployment of R&D efforts. In 2005, GAO identified broad issues with DOT's deployment goals for traffic management ITS, finding that the goals did not take into account the level of ITS needed to accomplish local objectives and priorities; did not reflect whether localities were operating the ITS as intended; and did not adequately capture the cost-effectiveness of ITS.⁷ Additional studies of ITS deployment have found that local officials are aware of ITS technologies but feel that the benefits are not adequately described.⁸

Recommendations from TRB

With support from FHWA, TRB's Research and Technology Coordinating Committee (RTCC) has periodically assessed the state of highway research and made recommendations to policy-makers. In its recent report, TRB Special Report 295, *The Federal Investment in Highway Research, 2006–2009: Strengths and Weaknesses*, the RTCC evaluated the investments in highway R&D made under SAFETEA–LU. According to the report, transportation R&D is significantly underfunded when compared with the R&D investments made in other industrial sectors. Also, the report recommended that the matching requirement for UTCs be adjusted from 50 percent to 20 percent. According to the RTCC, if UTCs relied less on State DOTs and others for matching funds, they would be free to pursue longer-term advanced research topics and move away from applied research that could be handled elsewhere. The RTCC recommended that FHWA's Exploratory Advanced Research Program continue as well, and that a larger percentage of the agency's research budget go toward advanced research. Additionally, the report states that all research grants, including those to UTCs, should be made on a competitive, merit-reviewed basis. The RTCC recommended that FHWA be given more resources to engage stakeholders and carry out technology transfer activities. FHWA should be given the resources to take the lead in establishing an ongoing process whereby the highway community can set these priorities. Finally, the RTCC noted that the Strategic Highway Research Program 2 (SHRP 2) was funded significantly less than stakeholders had requested, and recommended that it continue to receive funding for another two years. TRB states many recommendations but does not provide specific mechanisms to accomplish them.

⁵ House Science and Technology Committee, *Bridge Safety: Next Steps to Protect the Nation's Critical Infrastructure*, September 19, 2007.

⁶ TRB Special Report 295, page 68.

⁷ GAO–05–943, *Highway Congestion: Intelligent Transportation Systems' Promise for Managing Congestion Falls Short, and DOT Could Better Facilitate Their Strategic Use*.

⁸ Deakin, B. *Mainstreaming Intelligent Transportation Systems: Findings from a Survey of California Leaders*, 2004.

V. Background

Federal Highway Administration (FHWA)

The Federal Highway Administration oversees surface transportation infrastructure planning, construction, and maintenance; develops educational and training programs for transportation workers; and funds research efforts in surface transportation fields. Within FHWA, the Office of Research, Development, and Technology directs the Administration's transportation research efforts.

Office of Research, Development, and Technology

The Office of Research, Development, and Technology funds research into pavements, structures, safety initiatives, highway operations, and environmental interests. The Office of Research, Development, and Technology directs most of the research funds for DOT and operates the Turner-Fairbank Highway Research Center.

- **Turner-Fairbank Highway Research Center (TFHRC)**
TFHRC operates as the hub for highway research by developing research plans in support of FHWA strategic goals; managing policy, budget, and administrative services for its research customers; and initiating strategic marketing plans to ensure the utilization of highway research.
- **Exploratory Advanced Research Program (EARP)**
EARP manages longer-term, higher-risk research aimed at addressing mission-oriented technology and knowledge gaps as mandated in SAFETEA-LU. Intending to react to the call for more long-term research, this program seeks out projects not directed to solve specific current problems, but to enable approaches to future transportation questions.

Research and Innovative Technology Administration (RITA)

RITA is mandated to coordinate, facilitate and review the DOT's research and development activities, including those funded through FHWA.

- **Intelligent Transportation Systems Joint Program Office (ITS JPO)**
ITS JPO was created in the *Mineta Act of 2004* to take over coordination of the Intelligent Transportation Systems program. ITS JPO focuses on developing transportation infrastructure and vehicles with integrated communication systems intended to deliver up-to-date information to both drivers and decision-makers. This information could be used to coordinate State department of transportation emergency efforts, relieve congestion through metropolitan signal coordination and enable on-the-go planning of efficient driving routes with up-to-date traffic information.
- **University Transportation Research**
University Transportation Center (UTC) programs support almost 60 university-based centers that conduct transportation research in all disciplines and support educational activities for the next generation of transportation professionals. The centers are funded on a 50/50 matching funds agreement. Generally, the states provide the matching funds, and while the UTCs are intended to jointly operate as a multi-modal system focused on the DOT's strategic objectives, these matching funds often provide opportunities for State departments of transportation to channel efforts towards specific regional transportation issues.
- **Bureau of Transportation Statistics (BTS)**
BTS is a component of the Research and Innovative Technology Administration (RITA) that collects, compiles, analyzes, and publishes transportation statistics in freight, travel and aviation; transportation economics; and geospatial issues. BTS is utilized by Federal, State, and local governments; universities; and the private sector. Data sets made available to customers can include air carrier traffic, border crossing, and national freight movement.
- **John A. Volpe National Transportation Systems Center**
A fee-for-service organization, the Volpe Center is a center designed to respond to issues brought forth to them by Federal, State, and local governments; industry; and academia. The Center assists these clients in a number of areas including human factors research; system design, implementation, and assessment; environmental preservation; and organizational effectiveness. DOT makes up about two-thirds of the Volpe Center's contracted funding.

- **Transportation Safety Institute (TSI)**

TSI is also a fee-for-service organization utilized by Federal, State, and local governments; industry; and the international community; that develops and conducts worldwide safety, security, and environmental training. TSI focuses on education programs developed in collaboration with the client organizations to meet specific situation needs. Training and educational information is disseminated through publications, websites, seminars, and classes.

The Transportation Research Board

TRB is one of five major divisions of the National Research Council; the principal operating agency of the National Research Council. TRB receives federal funding to manage cooperative research efforts and issue published analyses of transportation policy and research strategy. Two of the research efforts managed by TRB are the National Cooperative Highway Research Program and the Strategic Highway Research Program 2.

- **National Cooperative Highway Research Program (NCHRP)**

NCHRP is a program aimed providing solutions to near-term problems in the transportation industry by tackling an annual list of research topics developed by State departments of transportation. NCHRP is administered by TRB and sponsored by the State departments of transportation in the American Association of State Highway and Transportation Officials.

- **Strategic Highway Research Program 2**

SHRP 2 is a highway research program designed to advance highway performance and safety for the U.S. highway system. This program focuses on four areas of research that were identified by a TRB-established committee of leaders from the highway community: safety, infrastructure renewal, reliability, and transportation capacity. Funding is transferred through FHWA for execution by TRB with an expected program completion date of FY 2009.

Funding for Surface Transportation Research and Development (\$ millions)		
	FY2007	FY2008
<i>Federal Highway Administration</i>	38731.0	41216.0
Office of Research, Development, and Technology	111.3	124.9
Turner-Fairbank Highway Research Center	100.2	114.4
Exploratory Advanced Research Project	11.1	10.5
	FY2007	FY2008
Research and Innovative Technology Administration	198.9	199.0
Operating Costs	6.0	6.0
Intelligent Transportation Systems	101.3	101.6
University Transportation Research	64.1	64.4
Bureau of Transportation Statistics	27.5	27.0
	FY2007	FY2008
<i>Transportation Research Board**</i>	-	-
<i>National Cooperative Highway Research Program</i>	30.0	30.0
Strategic Highway Research Program II	40.5	38.5

* - italicized lines are not under the House Subcommittee on Technology and Innovation's jurisdiction

** - historical numbers are not available, FY2009 funds are \$89.5 million

Chair WU. Good morning. This hearing will come to order. Welcome to today's hearing entitled *An Overview of Transportation Research and Development: Priorities for Reauthorization*.

I want to welcome everyone to the Technology and Innovation Subcommittee's first hearing of the 111th Congress. This subcommittee was very productive in the 110th, moving the Small Business Innovative Research Program Reauthorization, Green Transportation Legislation, the 10,000 Trained by 2010, Health Information Technology Education Reauthorization—I am sorry—Legislation, and the U.S. Fire Administration Reauthorization and the National Institute of Standards and Technology portions of the COMPETES Act. I am certain that we can maintain this quick pace in the 111th Congress, and it is my intention to do so on a basis where both sides of the aisle will be participating vigorously in these processes.

And first up on our agenda and the subject of this first hearing is Surface Transportation Research and Development in preparation for the Surface Transportation Reauthorization Bill. I can think of a no more appropriate topic for this subcommittee to begin with as Congress concludes debate on an economic stimulus package that includes multi-billions of dollars for surface transportation projects.

As we start these and other major infrastructure initiatives, we all agree that we should deploy the most recent, efficient, proven surface transportation technologies to ensure that we are building the highways of the past—I am sorry—the highways of the future and not of the past. Today's hearing is an overview, an assessment of our current R&D investments, their coordination, and their focus. This will be the first in a series of hearings as this subcommittee develops a surface transportation title that will later be incorporated into the comprehensive Surface Transportation Bill.

In reviewing some of the Transportation Research Board's recent assessments of our surface transportation investments, I am somewhat concerned that the recommendations focus on increased funding as the sole means to overcome the challenges identified, including slow technology transfer and a lack of clear national priorities in DOT's (Department of Transportation's) R&D spending. More money is sometimes necessary. It is difficult in our current environment, and sometimes it is not a solution to a lack of coordination or a lack of focus.

What I hope to learn today, and in this series of hearings, is how to make our federal investments in surface transportation research and development as effective and as efficient as possible in overcoming the challenges of congestion mitigation and its impact on our lives and on the external environment.

I want to thank our panel of witnesses for taking the time from their busy schedules to be with us today.

Now I would like to recognize my colleague from Nebraska, Representative Smith, for his opening statement.

[The prepared statement of Chair Wu follows:]

PREPARED STATEMENT OF CHAIR DAVID WU

Welcome to today's hearing entitled "*An Overview of Transportation R&D: Priorities for Reauthorization*."

I want to welcome everyone to the Technology and Innovation Subcommittee's first hearing of the 111th Congress. This subcommittee was very productive in the 110th, moving the Small Business Innovation Research program reauthorization, green transportation legislation, the 10,000 Trained by 2010 health information technology education legislation, the U.S. Fire Administration reauthorization, and the National Institute of Standards and Technology portion of the COMPETES Act. I am certain we can maintain this pace in the 111th Congress.

Our first hearing focuses on surface transportation research and development programs, in preparation for the surface transportation reauthorization bill. I can think of no more appropriate topic for this subcommittee to begin with, as Congress debates an economic stimulus package that contains \$30 billion for surface transportation projects. As we commence this major infrastructure initiative, we all agree that we should deploy the most recent and proven surface transportation technologies to ensure we're building the highways of the future, not the highways of the past.

Today's hearing is an overview and assessment of our current R&D investments. This will be the first in a series of hearings as the Subcommittee develops a surface transportation title that will later be incorporated into the comprehensive surface transportation bill.

In reviewing some of the Transportation Research Board's recent assessments of our surface transportation investments, I have been disappointed by their recommendations that focus on increased funding as the means to overcome the challenges they identify, including slow technology transfer and a lack of clear national priorities in DOT's R&D spending. I don't think more money is a practical or realistic recommendation in our current economic environment.

What I hope to learn today, and in this series of hearings, is how to make our federal investments in surface transportation R&D as effective and efficient as possible in overcoming the challenges of congestion mitigation and its impact on the environment.

I want to thank our panel of witnesses for taking the time from their busy schedules to appear for us today.

And now I would like to recognize Representative Smith for his opening statement.

Mr. SMITH. Thank you, Mr. Chair. It is a pleasure to return to business today, and I look forward to a productive and collaborative 111th Congress on this subcommittee.

The economic challenges facing our nation are of utmost importance to us all. We must ensure our nation's citizens have the opportunity to create and innovate. We must support entrepreneurship and see that businesses are allowed to become more nimble, more efficient, and more competitive. I believe the Subcommittee on Technology and Innovation will take an active role in shaping our economic recovery and certainly competitiveness.

I look forward to working closely with you, Mr. Chair, and the rest of my colleagues on the Subcommittee in accomplishing this task.

The agencies we oversee on this subcommittee are vital to the Nation's health and well-being. The National Institute of Standards and Technology performs cutting-edge research which supports the next generation of computers and electronics, the next generation of fuel-efficient vehicles, and the next generation of health care technologies. The Department of Homeland Security continues to perform lifesaving work to ensure our safety and security, and the Department of Transportation supports the highways and railways vital to our commerce and way of life.

Chair Wu, we have a lot of work ahead of us certainly, and all of these agencies may see funding increases due to a stimulus plan and all will need to have close oversight to ensure we are spending taxpayer dollars wisely. I am happy our first hearing of the year

addresses one of the major challenges facing our nation in Congress this year; infrastructure research and development.

We are currently contemplating spending billions of dollars on highway and railway infrastructure improvements. We will need to ask important questions in order to address the issues facing our nation's aging infrastructure. How will these projects incorporate science and technology to extend the life of and improve the quality of our transportation networks? How have our R&D programs performed over the past several years, and what can we do to improve them?

We expect most R&D to be relevant to the problems at hand and expect research agencies to focus on the real-world outcomes of such research. The witnesses before us today all have expertise in translating results from the lab to the road. I would like to thank you all for coming today and sharing your thoughts on how to improve our transportation networks and our research activities. I look forward to starting a dialogue with you during the question and answer portion of today's hearing and hope you will continue to work with us as we craft a new highway bill.

Thank you, Mr. Chair. Again, it is a pleasure to serve as Ranking Member of this subcommittee, and I look forward to continuing this bipartisan and productive relationship. I yield back.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF REPRESENTATIVE ADRIAN SMITH

It is a pleasure to return to business today and I look forward to a productive and collaborative 111th Congress on this subcommittee. The economic challenges facing our nation are of utmost importance to us all. We must ensure our nation's citizens have the opportunity to create and innovate. We must support entrepreneurship and help our businesses become more nimble, more efficient, and more competitive. I believe the Subcommittee on Technology and Innovation will take an active role in shaping our economic recovery and competitiveness. I look forward to working closely with you, Chairman Wu, and the rest of my colleagues on the Subcommittee in accomplishing this task.

The agencies we oversee on this subcommittee are vital to the Nation's health and well-being. The National Institute of Standards and Technology performs cutting edge research which supports the next generation of computers and electronics, the next generation of fuel-efficient cars, and the next generation of health care technologies. The Department of Homeland Security continues to perform life-saving work to ensure our safety and security. And the Department of Transportation supports the highways and railways vital to our commerce and way of life. Chairman Wu, we have a lot of work ahead of us. All of these agencies may see funding increases due to a stimulus plan and all will need close oversight to ensure we are spending taxpayer dollars wisely.

I am happy our first hearing of the year addresses one of the major challenges facing our nation and Congress this year—infrastructure research and development. We are currently contemplating spending billions of dollars on highway and railway infrastructure improvements. We will need to ask important questions in order to address the issues facing our nation's aging infrastructure. How will these projects incorporate science and technology to extend the life of and improve the quality of our transportation networks? How have our R&D programs performed over the past several years and what can we do to improve them? We expect most R&D to be relevant to the problems at hand and expect research agencies to focus on the real-world outcomes of such research.

The witnesses before us today all have expertise in translating results from the lab to the road. I'd like to thank you all for coming today and sharing your thoughts on how to improve our transportation networks and our research activities. I look forward to starting a dialogue with you during the question and answer portion of today's hearing and hope you will continue to work with us as we craft a new highway bill.

Thank you Mr. Chairman. Again, it is a pleasure to serve as Ranking Member of this subcommittee and I look forward to continuing this bipartisan and productive relationship. I yield back the balance of my time.

Chair WU. Thank you very much, Mr. Smith. If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

Today we will discuss surface transportation research and development funding, planning, and execution.

Surface transportation research and development is critical as the population continues to grow and congestion continues to increase.

Take Arizona, for example, which is one of the fastest growing states in the Nation. Since 1970, our population has more than tripled. The Phoenix metropolitan area, long the largest in our state, is now one of the largest in the Nation.

Not surprisingly, all this growth has created an urgent need for new transportation infrastructure and congestion mitigation efforts.

The Arizona Department of Transportation (ADOT) has been a leader in transportation research and technology and has engaged in several research efforts to improve infrastructure problems such as monitoring and managing congestion and experimenting with pavement materials.

I look forward to hearing from our witnesses about how we can encourage the development of new technologies and materials.

I yield back.

Chair WU. It is now my pleasure to introduce our witnesses. Mr. Paul Brubaker is the Former Administrator of the Research and Innovative Technology Administration of the U.S. Department of Transportation. Dr. Elizabeth Deakin is the Director of the University of California Transportation Center at the University of California, Berkeley. Mr. Amadeo Saenz is the Executive Director of the Texas Department of Transportation. Mr. Robert Skinner is the Executive Director of the Transportation Research Board. And our final witness is Mr. David Wise, the Acting Director of Physical Infrastructure Issues at the Government Accountability Office.

You will each have five minutes for your spoken testimony. Your written testimony will be included in the record for this hearing, and when you complete all of your testimony, we will begin with questions, and each Member will have five minutes to question the panel. We will go as many rounds as there are questions or we have time for, whichever arrives first.

Mr. Brubaker, please begin.

**STATEMENT OF THE HONORABLE PAUL R. BRUBAKER,
FORMER ADMINISTRATOR, RESEARCH AND INNOVATIVE
TECHNOLOGY ADMINISTRATION, U.S. DEPARTMENT OF
TRANSPORTATION**

Mr. BRUBAKER. Thank you, Mr. Chair, Ranking Member Smith, Vice Chair Luján, distinguished Members of the Subcommittee. My name is Paul Brubaker, and I had the honor of serving as the Administrator of the Research and Innovative Technology Administration (RITA) at the U.S. Department of Transportation (DOT) from August, 2007, until January 20 of this year.

Oh, I am sorry.

I am pleased to be here today to testify on what I think is the real tipping point in the transportation infrastructure; how we le-

verage research going forward to transform our transportation infrastructure.

I have submitted written testimony as you know for the record, but I would like to highlight some key points in my oral testimony.

During my tenure at RITA we attempted to establish a process by which research funding decisions were made, executed, and evaluated, as well as develop a construct to actually manage research, in portfolios based on multi-modal communities of interest. We weren't entirely successful.

However, we did make significant progress in at least establishing a degree of transparency into the research spent which hadn't been reached before. The transparency is only the beginning. Decisions where to spend the 1.2 billion in research dollars must be based on strategic research objectives established in a holistic, multi-modal, and focused national transportation research agenda that covers all aspects of the transportation picture and drives innovation into the system.

For all research funded by the Department or through the Highway Trust Fund, outcome expectations and performance measures should be agreed upon in advance, progress should be monitored, and performance should be measured after the projects are complete. The Surface Transportation Authorization provides us an opportunity to redefine how we approach and conduct transportation research in a way that better serves our nation.

Before asking for additional transportation research dollars, I strongly believe we must ensure that current dollars are being spent wisely. As it stands right now nobody, and I mean nobody, can say with reasonable assurance or authority that funds are being spent wisely or in a manner that best reflects the overall national transportation priorities. We have an opportunity to fix this optimal situation by creating a new transportation research paradigm.

One good place to start is to ensure that RITA, and you might naturally expect me to say this, is both sufficiently resourced and allowed to perform its role that was created under the Mineta Act to coordinate the research spend for the Department, but more importantly, to develop that holistic process where the Secretary can select, control, and evaluate research in a strategic context based on a to-be-developed national transportation research agenda that reflects a broad group of stakeholders, ranging from states and localities to personal and commercial uses of our national transportation system, to accident victims, police and first responders, even economic development officials from states and localities.

I have made other recommendations including the establishment of the Transportation Advanced Research Projects Agency, the consolidation of research functions under RITA, and funds set aside for innovative research projects that can be carried out by a variety of institutions and individuals. Those are included in my written testimony.

I look forward to a constructive discussion today on ways to improve our transportation research to better leverage our existing investments and better serve the American public.

Thank you, Mr. Chair.

[The prepared statement of Mr. Brubaker follows:]

PREPARED STATEMENT OF PAUL R. BRUBAKER

Chairman Wu, Ranking Member Smith, Vice Chairman Luján, distinguished Members of the Subcommittee. My name is Paul Brubaker and I had the honor of serving as the Administrator of the Research and Innovative Technology Administration (RITA) at the U.S. Department of Transportation from August 2007 until January 20th of this year and I am pleased to be before you this morning to discuss lessons learned during my tenure; suggestions on how to improve transportation research; ways in which we can deploy the results of that research; and some thinking as it relates to the new surface transportation legislation.

Based on my recent experience, I believe we have a tremendous opportunity to shape a National Transportation Research program that has the potential to transform how we move people and goods across the Nation and indeed re-establish our global position as leaders of a new, innovative and efficient transportation paradigm. In order to achieve this lofty goal, we will need to rethink our approach to transportation research; build on a couple of innovations that I attempted to implement during my brief term; and establish structural improvements that can ensure the level of innovation that is often promised but rarely realized.

In your invitation you laid out a series of questions that I will attempt to answer in my testimony but with some additional information that I hope will provide a more complete narrative.

The current transportation research and development investment structure is improving—but what it really needs is a complete overhaul.

Early in my tenure it was clear that the fundamental legislative requirements of the Mineta Act, which created my office and called on RITA to coordinate the Department's transportation research, were not being met. While the Department established a Research Planning Council and a Research Planning Team—it could best be described as a loose governance process that was only meant to “rubber stamp” the Department's \$1.2 billion in transportation research money was spent—with no enterprise level coordination as the law—as I read it—required.

After conducting a pretty quick assessment of the situation I asked RITA's RD&T staff to establish a framework by which we could prioritize transportation research investments to better reflect and align to the strategic goals of the Department and the Administration. I further requested that this framework be based on the Capital Planning and Investment Control (CPIC) processes mandated by OMB circular A-11 for the government's capital investments because there were a number of similarities and the GAO had established a nice corresponding maturity model for organizations to use in developing and using CPIC for technology investments.

The framework that was initially conceived, originally known as Research Planning and Investment Control (RPIC), cannot only prioritize investments, but was designed to monitor and track research outcomes over the life of the project and manage the research in portfolios. However, due to cultural resistance to change, the word “control” in RPIC was changed to “coordination,” the investment prioritization activities, the research monitoring plans, and the concept of portfolio management were all scrapped. The RPIC project was relegated to a “pilot” program and today is essentially a data base of existing research programs that can be viewed by multimodal communities of interest (e.g., human factors; materials; safety systems) and across the modes. While this transparency is good and desirable, RPIC was originally conceived to do considerably more—it was to serve as a decision support, program management and program evaluation tool so that we could select, evaluate and control the underlying research spending in a manner consistent with research investment criteria.

The current incarnation of the RPIC process “buckets” existing spending to communities of interest but the actual decisions to invest in particular research activity are made almost exclusively by the modes. Consequently, the current spending of the Department's research resources is not subject to a systematic Department-wide prioritization. This spending is most often aligned with the wishes of a number of key stakeholders in each of the modes, or in some cases is the result of a Congressional earmark but the Department's portfolio of transportation research does not represent a comprehensive, holistic program that supports an overall National Transportation Research Agenda.

The University Transportation Centers represent approximately \$70M of research spending each year. It is the one program where RITA has complete visibility over the research spending and reviews the strategic plans for consistency with the Department's overall strategic plan. Given the mission of the UTC program—to train the next generation of transportation leadership—there is strong evidence that the program is meeting that goal.

Clearly, we need to improve the current transportation R&D investment structure. My suggestion would be to start over. Begin with the development of a National Transportation Research Agenda. This agenda should take a comprehensive, holistic, multi-modal view of our transportation system and receive input from the Congress, Administration, transportation system user communities and all stakeholders—not just the ones with the deepest pockets—and establish and outline the key objectives and desired outcomes of our transportation system. It should then clearly map research programs and spending to the outcomes and goals outlined in the plan and clearly describe how these projects will help us achieve our goals and achieve our desired outcomes.

Once that agenda is established, a governance process—much like that originally conceived for the RPIC—explicitly supported by the Secretary and managed on behalf of the Secretary by RITA, should examine all of the research programs and proposals that receive any direct or indirect federal dollars, and only those that are consistent with the goals of the National Transportation Research Agenda should be funded. Those that are funded should be monitored and evaluated. A dedicated office of technology transfer, perhaps within RITA, could help ensure that the relevant, valuable knowledge (for both successful and unsuccessful projects) is shared and when appropriate, that successful innovations are commercialized and/or generate new levels of research.

The Department, through RITA, should also act as a facilitator of knowledge through the use of advanced collaboration capabilities that would allow researchers to self-organize around communities of interest. During my tenure, we attempted the creation of such an environment—think Facebook for the transportation research community—that would make knowledge sharing and technology transfer much more convenient and effective as collaboration and reporting could be accomplished virtually. Those not wishing to share results until the research projects are completed could create password protected work spaces that would restrict access only to those working on the project. While at RITA, we built the first generation of this collaborative capability at www.transportationresearch.gov. It is only the beginning of what could become an interesting new paradigm in research collaboration and ironically may bring the Internet back to its roots.

Our ability in the transportation research community to successfully transfer, commercialize and deploy new methods, innovations, and technology must be refocused. Currently, there is no systematic or focused program, process or set of activities that are driving innovations out of the laboratory and onto our Nation's roads, rails, runways or waterways. Most in the community believe that effective technology transfer only involves having researchers share their research by publishing peer reviewed articles in transportation research journals or presenting papers at conferences. Researchers communicating with other researchers is a valuable way to share knowledge—it is also a sure fire way to ensure that these advances or ideas rarely get commercialized.

We must focus on a new model and process to achieve technology transfer that leads to commercialization and deployment of new transportation-related technologies. Unfortunately, we may miss a prime opportunity to drive innovation into the transportation infrastructure through the stimulus spending but it may be an order too difficult to fill in short order.

Only a new approach to technology transfer and commercialization that is focused on transparency, openness, and a systematic way to communicate with a broader set of industry, entrepreneurs, investors and other interested parties will succeed in fostering innovation and ensuring wider-spread deployment of these innovations. For years, this has largely been an “inside game” managed by a relatively small group—an example of that President Eisenhower foresaw in his farewell speech in January, 1961—which virtually ensures that an innovator tinkering in the garage has no chance of getting his or her ideas vetted.

We need to look beyond the universe of traditional gatekeepers and work to facilitate the timely testing and standards development that would allow rapid prototyping, piloting and deployment of these new technologies. In short, we must move closer to technology development times versus industrial age development cycles. I have witnessed a great number of good ideas that are available today—but may not be deployed for decades to come because of a variety of cultural, structural and systemic obstacles—mostly related to intolerance of risk and processes that have the effect of stifling innovation. This can change. But it will require a collective commitment and leadership that is willing to deploy a systematic way of improving technology transfer and commercialization.

As the Congress begins drafting the next surface transportation legislation, it will have a unique opportunity to change the focus from strictly “highways” and direct spending and programs that better reflect the way we actually travel. While high-

ways are indeed an integral part of this equation, the view must be significantly expanded to include or at least accommodate alternative modes for people and freight to include rail, high speed passenger rail and transit, and water transportation. We even must integrate air as we consider this holistic picture.

The next surface transportation authorization must ensure that the transportation research budget and that of the Bureau of Transportation Statistics is directly aligned with the National Transportation Research Agenda which should be updated and published every two years by the Research and Innovative Technology Administration in coordination with the Administration, the Departmental leadership, the users of the systems and key stakeholders.

The budget should be aligned and adjusted based on changing priorities and the portfolio of projects should be balanced according to the priorities reflected in the agenda. This portfolio should be transparent both within and outside of the department and the final annual budget and program plan should be public. This way, citizens from anywhere in the county can examine the portfolio and its anticipated outcomes and compare actual results to anticipated results. Such increased transparency may actually improve achieve deployment of these technologies and methods as more people and entrepreneurs will have access to the new ideas being explored by the Department and its research community.

There is also a clear role for the Bureau of Transportation Statistics but it should be much focused and adequately resourced to monitor the performance of the Nation's transportation system. It must also expand its role and develop forecasting models and simulations that can help us drive research proposals as it will help us better understand the potential impact of alternative investments and research results as well as ensure that it has the capability to further our understanding of external events that impact our transportation system. For example, with this capability BTS could have been able to model the impact of fluctuating fuel prices on our national logistics system and passenger movement system.

Perhaps not surprisingly, I believe that RITA should remain the Department's focal point for transportation research—but it must be significantly strengthened—but it will require a significant and substantial investment in people and money. RITA's first order of business should be to coordinate the formulation of the National Transportation Research Agenda—one that represents a cross-modal and holistic view of our national transportation system. This can only be developed with significant input from the user community and from stakeholders. The research agenda must also be multi- or intermodal in nature and not be primarily or disproportionately focused on highways to the exclusion of other modes—the only way to accomplish this is to provide direct funding.

Then, RITA should establish and manage a governance process that can align and direct transportation research resources in a manner that is consistent with the National Transportation Research Agenda. RITA could build on the RPIC process to achieve this goal but most importantly, the research portfolio should be managed and evaluated for its outcomes, results and effectiveness by developing transparent program and project evaluations and lessons learned that can be used to determine appropriate follow on research and serve as a basis for technology transfer and commercialization of the promising research.

RITA should also continue to play an active role in overseeing the University Transportation Research as well as house appropriate multi-modal research activity—such as the Intelligent Transportation System and Alternative Fuels program—and should expand its oversight role to include the approval and oversight of any Department or indirect federal dollars going to any University or not-for-profit research entity for transportation-related research. This includes the coordination, review and approval of any projects directly or indirectly receiving federal funds that are managed by the Transportation Research Board of the National Academies.

Although controversial, the Committee should examine the feasibility of consolidating all of the research laboratories within the Department. These could be centrally managed by RITA or at a minimum be subject to strict oversight by RITA to ensure that their activities are consistent with and achieving the objectives of the National Transportation Research agenda. Currently, a number of the modes have research labs dedicated toward performing transportation research. For example, the Turner-Fairbank Highway Research Center in Virginia currently performs a great deal of highway related materials and systems research. In many cases, similar if not identical research is also being conducted at a number of universities—some of which is funded by the Federal Highway Administration. While it may be appropriate in some cases to validate research results, I believe the resistance to visibility and oversight as well as the failure of the Department to drive toward better management of the research portfolio continues to encourage research redundancy and waste.

Finally, I would like to suggest that a certain portion of the Department's Transportation Research funding—at least half—go toward advanced systems research—and directed by RITA consistent with the National Transportation Research Agenda. I would propose that the majority of the funding be used to establish a Transportation Advanced Research Projects Agency. The balance of the funds should be used for worthy projects proposed by the Volpe National Transportation Systems Center, Turner-Fairbank, The Transportation Research Board, Universities and other potential worthy and qualified grantees including those who tinker in their garages.

Thank you for the opportunity to present the ideas to you this morning and I look forward to answering any questions you may have.

BIOGRAPHY FOR PAUL R. BRUBAKER

Paul Brubaker recently joined Cisco Systems, Inc. as leader of its North American public sector team in the Internet Business Solutions Group (IBSG).

Paul has an unusual blend of public and private sector experience. He has served in both the legislative and executive branches of the U.S. Federal Government. During his service in legislative branch, Paul worked for the General Accounting Office and eventually became Minority Staff Director of the Senate Subcommittee on Oversight of Government Management where he worked on a number of reform efforts including leading the effort that resulted in passage of the *Information Technology Management Reform Act* linking federal investment in technology to measurable improvements in mission performance and establishing CIO positions in major federal agencies.

In 1998, Paul was appointed by President Clinton to serve as Deputy Assistant Secretary of Defense and Deputy Chief Information Officer and in 2007 he was appointed by President Bush and confirmed by the Senate to serve as the Administrator for Research, Innovation and Technology at the U.S. Department of Transportation.

In the private sector, Paul founded two successful small businesses and has worked in a number of senior strategy positions with government contractors including: Litton PRC; Commerce One; and SI International. At SI international, he served as Executive Vice President and led the government and investor relations activities while serving as Chief Marketing Officer where he also re-engineered and automated a number of sales and proposal processes. While at Commerce One, Paul led a management buy-out of the firm's public sector professional services unit which he took private.

In his spare time, he has served as the Chairman of the Virginia Innovative Technology Authority, Chairman of the Technology Committee of the International Armed Forces Communications and Electronics Association, and as a board member of the Churchill Centre.

For his work in government Paul has received numerous awards including the Department of Defense Distinguished Public Service Medal (with palm device); The Gold Medal from the Department of Transportation; the Association for Federal Information Resource Management Federal Executive of the Year in 2000; and was a two-time winner of the Federal 100 Award from *Federal Computer Week*.

Chair WU. Thank you, Mr. Brubaker.

Next, Dr. Deakin, please proceed.

STATEMENT OF DR. ELIZABETH DEAKIN, PROFESSOR OF CITY AND REGIONAL PLANNING; DIRECTOR, UNIVERSITY OF CALIFORNIA TRANSPORTATION CENTER, UNIVERSITY OF CALIFORNIA, BERKELEY

Dr. DEAKIN. Thank you, Mr. Chair. I was asked today to speak about some research that we did at the University of California on Intelligent Transportation Systems (ITS), and let me start with—

Chair WU. Dr. Deakin, is your microphone on?

Dr. DEAKIN. It seems to be.

Chair WU. Okay. Pull it a little bit closer.

Dr. DEAKIN. Let me pull it closer.

Chair WU. There we go.

Dr. DEAKIN. Is that working?

Chair WU. Yes.

Dr. DEAKIN. Okay. I would like to talk to you about the research findings from our study of Intelligent Transportation Systems and how to get them into the mainstream in transportation. This is a study that was funded by CalTrans, who had spent a good deal of its own money, as well as federal funds, to invest in intelligent transportation and was concerned about whether they were getting their dollars' worth from the projects.

What we found in a series of interviews with decision-makers, as well as with technology experts and the decision-makers both in the public and in the private sector, was that while there were some valuable gains in such things as traffic signal timing, road tolling, better data collection, cheaper methods for gathering data and assembling it, monitoring the systems, and managing them, there also is a concern among the decision-makers that there really was a need for a tougher, more arms-length evaluation of the cost effectiveness of these investments, and there also was a need for a business plan for these investments that hadn't yet been developed.

And one of the reasons for that was a lack of real focus on institutions and business budgets and costs and effectiveness. This is social science research. There is a lot of interest in what kind of institutions it would take to implement these kinds of strategies.

One of the problems is that we have tried to include deployment in ITS projects, but it has been done by the technology experts, who are not necessarily the experts in institutions and planning and policy. And so we have concluded that we need to create a different framework and a different set of research foci that would compliment the technology development, really help it move into implementation. And that might extend to new kinds of partnerships and oversight that involves the private sector as well as government to really do a tough business plan for these technologies as they are being developed.

I was also asked to address the question of University Transportation Centers (UTCs), something that I have some experience with, having directed the center in Region Nine for ten years. University Transportation Centers do research, they do tech transfer, and they produce graduates. The graduates are a form of technology transfer in some ways because they go out into the agencies and the consulting firms and the private sector with the latest knowledge and learn on the job how to deploy that knowledge. So we look at them as an important product.

The Transportation Centers Program expanded greatly under the last Transportation Bill from the original ten to a total of 60 centers now, 20 of which competed for their funds and 40 of which were selected by Congress. My own view is the competition is a very good way to choose transportation centers because it assures that the best ideas are able to compete and win in a kind of marketplace. I also have to acknowledge, though, that some of the earmarked centers have used that opportunity as a chance to really show that they could develop and have developed and become successful.

A big issue on both the UTCs and ITS is measuring performance, and I think performance has to be measured on outcomes, not on

inputs, not just on the number of counts of papers produced or dollars spent, but actually what has been accomplished that has changed things, that has made the transportation system better, cheaper, faster, more equitable, and more environmentally sound. And we need to move in that direction quickly.

One way to do that is to increase coordination in research, which is the third topic I was asked to address. I think that can be, and is being, done much better than it was even a few years ago because of investments that the Transportation Research Board, that RITA, and that others have made in creating really good websites where we can coordinate the research and see what everybody else is doing. There really is no excuse for duplication with the kind of information that is now being made available.

On the other hand, I don't think that all projects that are doing the same thing are duplications. Sometimes we learn by doing multiple cases, and we really need to be able to do that. So replication has to be distinguished from duplication, and we will go ahead faster and gain better if we do that.

I do think that the strategic plan that Mr. Brubaker just described is a critical element in being able to manage research. We have to have a new strategic plan that really represents the new directions in policy that the country is pursuing under this Administration and under the changing information about science and technology that comes along. We need to keep that plan up to date and renew it, and I think the partnerships have to go beyond just DOT. They have to go to other agencies in a much stronger way than they have, to agriculture, to energy, to environmental agencies, and further, they have to go to the private sector in a stronger way than they have because we can't do this alone. And we need some new models on how to deliver our transportation systems so they will be cost effective.

And so I really think that plan has to be the starting point. It has to be outcome-focused. It has to be across the board integrating all the ideas and issues that we have to address in the next few years. We need to develop the plan quickly so that we will be able to have a framework for making decisions on what is a good investment in research and technology.

Thank you.

[The prepared statement of Dr. Deakin follows:]

PREPARED STATEMENT OF ELIZABETH DEAKIN

Millions of dollars are spent each year on transportation research. How can we be sure that these investments are effective and that the research findings are reflected in transportation decision-making? Here I briefly consider investments in Intelligent Transportation Systems, in University Transportation Centers, and in USDOT-led research, and recommend three strategies that could improve research and its utility: more emphasis on social science research to frame and complement technology-focused R&D; investing in long-term and exploratory research as well as in short-term, problem-solving studies, and framing research and investment in a strategic planning and evaluation context focused on outcomes rather than project categories.

A Bigger Role for Social Science Research: Evidence from Studies of the Implementation of Intelligent Transportation Systems

In a study conducted in 2003, researchers at the University of California investigated factors affecting ITS implementation as a "mainstream" transportation planning activity (Deakin et al., 2002; Deakin, 2006). We conducted a detailed literature

review, interviewed fifty-one leaders from a cross-section of California jurisdictions and agencies, surveyed 228 California transportation engineers, planners, and transit staff members, and had follow-up interviews with 52 of the staff members and 20 national transportation leaders with expertise in ITS.

ITS experts felt that ITS implementation has been slow, and attributed this to a lack of knowledge about ITS among elected officials and the public, as well as a lack of funding specifically for ITS. In contrast, our interviews with California leaders—elected officials and agency heads—revealed widespread familiarity with ITS concepts and applications (though many were irritated by ITS jargon and were unwilling to use it). Policy-makers cited freight applications, electronic toll tags, improved traffic signal systems, bus rapid transit projects, and traveler information signage as examples of ITS success. From the policy-makers' perspective, ITS elements that are not proceeding well suffer from institutional and political problems (e.g., efforts to route additional traffic on local arterials when the freeway is congested) or market weaknesses (e.g., efforts to sell traffic information to third party providers). Overall, most elected officials and senior policy staff members felt that ITS innovations are being implemented at a reasonable pace.

Elected officials were concerned, however, about a lack of good information on ITS benefits and costs, and some expressed concern that ITS evaluations have been less than arms-length. A number of leaders also commented that ITS proposals have focused too heavily on transportation system management benefits rather than traveler benefits. Some also argued that the private sector should be left to implement ITS applications such as traveler information systems.

Respondents suggested that the state DOT should lead by example, implementing ready-to-go technologies on its own facilities and within its own agency. Stronger partnerships with local government and other State agencies, developing mutually beneficial, multi-purpose applications, were recommended. Finally, respondents urged that future ITS work should pay more attention to legal and institutional issues and provide a clearer sense of "next steps."

Interviews with national experts identified additional issues. There was near-unanimous agreement that DOTs are having difficulty with ITS implementation because partnerships are needed to implement and partnerships necessitate a change in agency culture, including less hierarchical decision-making. In the experts' view, separate ITS units and ITS implementation plans can foster strategic thinking about ITS technology development but may hinder ITS incorporation into ongoing plans, programs, and funding streams. Earmarked funding for ITS was seen as appropriate for demonstration projects, to test concepts and provide examples, and when ideas are accepted but resources are low; traffic signal timing, which produces valuable cumulative benefits but is low-visibility and typically a low priority for local governments, was given as a case where earmarked funds may be needed to induce action.

Based on these findings, we recommended a refocusing of applied ITS research across a wider range of applications, as well as greater attention to research on implementation, including market studies and work on strategies to foster consensus building and partnerships for ITS.

A follow-up study currently underway suggests that many findings of our earlier work still hold true (Deakin, Frick, and Skabardonis, forthcoming). While efforts have been made to increase deployment of ITS, these efforts have continued to focus primarily on technology details rather than evaluating the broader questions of costs and benefits, markets and institutions that are also needed. Agencies have tried to address the latter issues and bring greater attention to implementation by requiring "technology transfer" elements in every project, but we find that this has been less successful than the agencies had hoped. One reason is that the assessments are often done as an add-on to a technology development or field test, often by the same staff members who developed the technology or test. But experts in science, engineering and technology are not necessarily expert in economics, policy design, planning, public support, and implementation, which are all social science fields of inquiry. We should not expect that our technical experts will excel at market studies, policy analyses, or social, economic, and environmental assessments any more than the marketing and public policy department of a technology firm would be expected to do engineering and technology development. Investments in social science research are what are needed, especially in the form of independent assessments conducted in consultation with technology developers. Such efforts could help us match technologies to markets, improve the research selection process, and speed up implementation of research findings when such implementation is warranted.

University Transportation Centers: Research and Human Resources

Since the late 1980s the Federal Government has devoted a portion of its funding for transportation to university transportation research centers. Originally the federal program funded ten centers, one per federal region, with center designation determined through a competitive process involving peer review of proposals. In the ensuing years, Congress has expanded the program several times, naming additional centers but also requiring that after an initial funding period, most centers must compete for continued designation. Currently there are sixty centers, with 20 selected through competitive reviews and 40 named in SAFETEA-LU. Centers fall under several classifications with differing funding levels. Most centers are required to secure a dollar-for-dollar "match" for federal funds, and state DOTs and other local transportation agencies are commonly called upon to provide this match. USDOT's Research and Innovative Technology Administration (RITA) manages the program with a small but highly effective staff.

All of the UTCs conduct research. The UTCs also support university transportation degree programs and offer continuing education, conferences, and symposia to help practitioners stay abreast of new methods and findings. However, the UTCs are a varied group, ranging from top-ranked research universities to smaller regional or local universities oriented principally toward education and training. The UTCs' emphases and work products likewise vary.

Most UTCs carry out a mixed portfolio of research projects, ranging from basic, exploratory research to highly applied projects. Each center has a strategic plan that outlines the areas in which it will concentrate. Most centers also refer researchers to the USDOT strategic plan and similar documents that identify research needs and project ideas. For most UTCs, however, the required "match" has a strong influence on the projects selected, since State and local agencies often will fund only those projects that they view as meeting their pressing, short-term information and training needs.

California UTCs have been somewhat of an exception. California UTCs have had the benefit of a generous match guarantee since the start of the UTC program, with Caltrans staff participating in peer review of research proposals but not directing research selection. Most other centers have had less flexible arrangements and as a result do a higher share of short-term, applied projects than the California UTCs.

California has had the ability to provide the UTCs this match and allow them this flexibility because of the size of its transportation program. However, with five UTCs now designated in the state and an increasingly constrained transportation budget, the UTCs have become a significant part of Caltrans' research expenditures and Caltrans is feeling the squeeze on its funding. Smaller states are even harder pressed for research funds and UTC match can eat up a large chunk of available funds. Under these circumstances, the states understandably want to see their funds used to meet their current need and are less interested in longer-term, riskier research. Some are also concerned that the growth of the UTC program amounts to de facto "earmarking" of State research funds that they would otherwise use at their own discretion.

The pressure for UTCs to show short-term payoffs in ways that are relevant to current agency problems is substantial. Yet long-term, researcher-initiated studies can pay off immensely. Since the start of the UTC program, California UTC researchers have carried out investigations on such topics as strategies for greenhouse gas reduction, new fuels and new vehicle technologies, measurement and control of particulate emissions from trucks, freight logistics, management of traffic to and from ports, congestion pricing, parking pricing, land use-transportation coordination, outcome-oriented performance measures, and collaborative strategic planning processes (to name just a few of the topics studied). Much of this work was initiated well before there were federal or State transportation policies or research programs on such matters. One result of this investment in long-term, exploratory research—research that was NOT clearly tied to existing public policies and programs—is that the research itself has helped identify new ideas and directions. It has given California a strong evidentiary basis for action and has inspired new State legislation and new agency programs. As a result, California is now positioned to lead implementation efforts in key policy arenas that now are attracting national attention. The research might have been risky, but it has given us a distinct advantage in information and know-how.

At the same time, the UTC program has produced literally thousands of graduates in transportation, at least some of whom would not have entered the field had UTC-funded fellowships and research appointments not been available. Many of the graduates from early days are now in positions of leadership and are helping to reshape transportation policy and practice. This cadre of young transportation profes-

sionals is an important product of every UTC program and their accomplishments are a key measure of the program's productivity.

Indeed, a major way that UTCs disseminate research results—their own, and others'—is to train graduate students, who then enter the field armed with the latest methods and findings which they then introduce into their workplaces.

The consequences of the proposal to change the UTC match ratio from 50–50 to 80–20 will depend on the specifics of implementation. If the lowered match requirement is combined with a cap on federal funding for the UTC program at or near existing levels, and the number of UTCs stays the same or expands, both graduate student support and UTC research output is likely to decline. The UTC projects that do get funded are likely to be framed in longer-term, bigger picture terms, and while riskier, more of these projects may be of lasting consequence. In other words, less State funding may mean less pressure for short-term applications. However, there will of necessity be fewer projects, fewer graduate students supported, and as a result, a lower level of infusion of new knowledge into the profession. Not all UTCs will suffer, of course; the UTCs most successful at attracting funds from the private sector and foundations will refocus their efforts. Other UTCs will have to contract, and issues of public rather than private interest might receive less attention than they do today.

Of course, states could choose to continue a research program much as the one they are now funding through the UTCs, with consultants as well as universities able to compete for the available funds. Competing for these funds would allow UTCs to offset some of the reduced match “hit” on UTC funding levels.

If on the other hand Congress boosts the program funding to maintain or increase the funds available to the UTC program, while reducing non-federal match, a greater focus on national objectives and on longer-term innovation in research could be possible.

Congressional decisions on whether to designate more UTCs or endorse competition and peer review also will affect the quality and the scope of the UTC program. Research universities have concluded, based on the evidence, that competition and peer review are the best ways to produce quality results. However, in the UTC program it also is evident that earmarks have allowed some universities to develop transportation programs that have successfully competed for funds in later rounds. Building in an expectation of competition for all centers after an initial period of designated support appears to work reasonably well.

Finally, multiple year grants are important because they provide the predictability that enables graduate programs and research programs to mesh well. Sudden shifts in funding levels and expectations for match could cause significant disruptions to graduate programs, as could delays in reauthorization. Continuing the program as it stands for at least a year (rather than shorter periods that don't match grant cycles) is a preferable option to the difficult short-term continuations we experienced before SAFETEA–LU was enacted.

Coordination of Research Initiatives

Practitioners and policy-makers often ask how we coordinate research programs funded variously by the USDOT, other federal agencies, the states, foundations and other nonprofits, and the private sector. The USDOT's Research and Innovative Technology Administration (RITA) has provided leadership in this regard. The USDOT's strategic plan provides a framework for priority-setting in research, and USDOT and RITA help insure that there is a basic level of information on DOT activities both by making information on the department's research initiatives available on the web and by organizing and by reporting on collaborations with other departments of the Federal Government (http://www.rita.dot.gov/about_rita/). Online publication of research results and abstracts in journals and on university websites and academic/practitioner conferences such as the annual Transportation Research Board meeting are also important ways to share information.

However, there is more to be done. Compared to the EU and other economically advanced countries, the USDOT's strategic plan is narrowly framed; for example, there is no clear mention of global warming or many other environmental issues, and such matters as transportation's role in economic development, in social equity, and in quality of life are not given much attention. Further, the scope of the USDOT's collaborations with other federal agencies is quite limited and appears to be narrower in some cases than Congress apparently contemplated (e.g., in the Congressionally-requested Transportation Environmental Research Program, which was recommended as a collaboration with other agencies, states, and the private sector, but was instead instituted as a program within FHWA). U.S. research, development, and implementation practices also are narrower than those of other countries such as Canada, Australia, or the UK, where strong linkages have been forged among

transportation, housing, and economic development planning, and among water, waste disposal, communications and transportation infrastructure investments.

A big worry for many public agencies is that research will be duplicative. However, a distinction needs to be made between intentional replication and unintentional duplication. Research is often replicated intentionally, or conducted with a series of test conditions, to determine whether the results are robust and generalizable, and not just a fluke or limited to a specific case. Such replication is highly desirable because it reduces risk and builds confidence in research findings. On the other hand, research is published in journals so that other researchers can discover and evaluate what has been found in previous studies, and avoid unintentional duplication. If the latter occurs, the researcher has not done his or her job well—it is this sort of uninformed duplication that should be avoided.

University researchers are evaluated by their peers not only on the quantity they produce but also on the intellectual content of the products, asking what's new and innovative, what new insights were generated, what linkages were identified that were previously overlooked, what changed in research directions or in theory, method, policy, or practice as a result of the work. These are outcome measures.

In contrast, many transportation agencies evaluate the research they fund only on output measures (e.g., the main evaluation criteria are whether required products were produced on time and on budget, not whether the projects produced new knowledge, altered practice, or improved conditions). The same is true, of course, for most on-the-ground transportation projects: they are evaluated on design compliance and whether they are on time or on budget much more often than they are graded on whether they actually improved services, the economy, or quality of life. Changing evaluation expectations from output-focused to outcome-focused could significantly improve the results for all of us, in both spheres of activity.

One of the problems with evaluating based on outcomes is that if negative outcomes automatically mean failure, embarrassment, and potential job loss, no one will want to admit to a negative outcome. Yet we know that most new products never reach market and only a fraction of those that do are true successes. The private sector knows this, and so does academia: ideas that are proven wrong and proposals that fail are nevertheless valuable products for researchers. "Failed" research efforts can lay the foundation for future research, push it in new directions, suggest alternative applications for the failed product, and highlight challenges to innovation. These are valuable lessons, not embarrassments (Zhang and Sternberg, 2006).

Creating an environment where risks can be taken, failures assessed fairly, and rewards given when due has been hard for the public sector. This may be a reason to rely more on private sector organizations and to give academics more independence, and more responsibility, for R&D. Risks and responsibilities are also reasons to promote competition and peer review; it shares the risk and responsibility for both research initiation and research evaluation among a number of experts.

Implications: Improving Technology Transfer and Incorporating Research Findings into Transportation Investment Policy

Our research speaks to the need to complement technological R&D with research and development in the fields of economics and finance, markets and consumers, law and institutions, planning and policy-making. This is true with regard not only to the latest ITS technologies but more generally to all investments in transportation and other infrastructure.

A new USDOT strategic plan may be a way to organize these efforts. Work conducted last year as part of a study on how to respond more effectively to California's growth proposed the establishment of a new strategic planning process whose goals would be faster and more cost-effective delivery of infrastructure, better management of existing facilities and services, better value for money invested, greater accountability to customers, and the possibility of attracting private capital for infrastructure projects (Dowall and Reid, 2008). The strategic planning process would be focused on outcome-oriented measures such as quality of service and how they are valued by customers rather than on inputs, e.g., how to allocate categories of funds. The process would involve creating a vision of the future and the investments needed to attain that future; evaluating a broad set of alternatives including both capital projects and "soft" investments such as regulation or pricing in deciding what infrastructure is needed; determining the best way to deliver needed projects—direct public or private provision, contracting, partnerships; and providing technical assistance to State agencies and local governments ranging from opportunities for bundling demand to information on best practices. Linkages modes (air, rail, highway . . .) and across fields (transportation, energy, housing, agricultural lands, environmental quality . . .) would be made explicit and tradeoffs examined. Priorities for investment would be identified.

Such a process, which is being pioneered in several Canadian provinces as well as in a few U.S. states, could not only improve transportation investments but could help governments determine how to allocate scarce resources more effectively. State plans of similar scope are being developed and could greatly improve State and local priority setting, investment decision-making, and partnership opportunities.

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BIOGRAPHY FOR ELIZABETH DEAKIN

Elizabeth Deakin is Professor of City and Regional Planning at UC–Berkeley, where she also is an affiliated faculty member of the Energy and Resources Group and the Master of Urban Design group. She is completing her second five-year term as Director of the UC Transportation Center this spring. She formerly served as Co-Director of UC–Berkeley's new Global Metropolitan Studies Initiative, which involves nearly 70 faculty members from 12 departments. Before heading up UCTC, she was Acting Director of the UC Institute of Urban and Regional Development.

Deakin's research focuses on transportation and land use policy, the environmental impacts of transportation, and equity in transportation. She has published over 200 articles, book chapters, and reports on topics ranging from environmental justice to transportation pricing to development exactions and impact fees. She currently is carrying out research on sustainable development policy in China, Latin America, the EU, and the U.S., with funding from the China Energy Foundation, the World Bank, the World Resources Institute, the USDOT, and Caltrans.

Deakin has been appointed to a number of government posts including city and county commissions and State advisory boards. She has taught courses at universities in Australia, Germany, Sweden, France, and China and has served as an adviser to the Organization for Economic Cooperation and Development, the European Council of Ministers of Transport, the World Bank, and MISTRA (the Swedish sustainable development foundation). She chaired the NAS/TRB committee mandated by Congress on transportation environmental research.

Deakin holds degrees in political science and transportation systems analysis from MIT as well as a law degree from Boston College.

Chair Wu. Thank you very much, Dr. Deakin.

Mr. Saenz, please proceed.

STATEMENT OF MR. AMADEO SAENZ, JR., EXECUTIVE DIRECTOR, TEXAS DEPARTMENT OF TRANSPORTATION

Mr. SAENZ. Good morning. Chair Wu, Members of the Science and Technology Committee, thank you very much for the opportunity to participate in this hearing. My name is Amadeo Saenz. I am the Executive Director of the Texas Department of Transportation (TxDOT). Today I would like to accomplish several things with my testimony.

First, I would like to give you a State perspective on federal research investment. I would also like to talk about the barriers that we face, some of the stakeholder involvement in transportation research and development, and finally, I would like to list some possible improvements that could make research and development more helpful.

Federal investment in transportation research and development is invaluable to the State DOTs. Because of the federal research we now have high-performance concrete, high-performance steel, and accelerated bridge construction methods. In Texas our highways are based on design criteria developed through the national—through national research.

We now use cable barrier systems developed through the National Cooperative Highway Research Program. These barriers have reduced crash severity in our highways, and this translates to countless lives saved. We installed, as part of a safety program, over 400 miles of cable barrier two years ago. We went back to evaluate those particular highways, and we saw that we were able to save 18 lives over that one year and 26 serious accidents from what it was prior. So measuring what you do and what you put in place is very important.

The Strategic Highway Research Program Concrete and Structures Initiative is another federal program we found to be very beneficial. The Texas Loretta Road Overpass in Houston was the first project in the country to use high-performance concrete throughout the bridge. The use of high-performance concrete has allowed us to realize tremendous savings and efficiency in the construction of our bridge structures across the state. So far we think we estimate and we save about \$10 to \$20 million a year in bridge construction.

In 2002, to demonstrate the impact of that research and development has on Texas, on the Texas transportation system safety and cost effectiveness, Texas DOT performed an analysis of 21 of over 200 improved technologies that had been developed through our research program. A benefit period of ten years was used to determine what kind of returns we were going to get, and the findings showed that the products provided a net return of our investment of over five to one. We currently have the Texas Transportation Institute updating our report because we now have more data on it, and preliminary indications are that the original five to one investment is still a good number.

These are just a few samples of the benefits that we have been able to realize from the transportation research and development, but like with every other government program there are some barriers. The competing challenges of relentless congestion, lack of adequate funds, and the need to move people and goods across towns, across the—and across the country with really—I am sorry. Excuse me. The competing challenges of relentless congestion, lack of adequate funds, and the need to move people and goods across town and across the country demand that we generate answers very quickly. We need to anticipate future needs and begin research today to address those needs.

One of the largest barriers to overcome in research and development is to overcome the institutional inertia and resistance to change. When we entered these new specifications, new standards, or construction techniques, we saw that there is contractor resistance, and there are also cost increases because of the unknown. There are implementing—therefore, implementing research becomes difficult due to staffing and funding shortages. And with the uncertain economy that we have today, the State resources are

stretched just by maintaining our existing systems, and sometimes research has to take a back seat.

At TxDOT all levels of employees are involved in the research and development program. For example, we have set in place research management committees. These committees are made up of key administrative and key lead people, district engineers, that work hand in hand with researchers who have the technical expertise in the different areas. This committee has established the priorities and selects the research that is to be conducted. We have more employees involved in each of the projects from within the Department to ensure that they work hand in hand with the researchers, to ensure that everything stays on track and will result in information that TxDOT can use as part of the research program.

In addition, the Department has also seen very important to set aside money to be able to implement some of the research findings that come out of our research program, and we put in place a \$5 million a year budget amount to be able to address, to implement these new technologies that come out of our research program.

The Federal Government can help states, counties, and cities with the use of the newest technologies in several ways. One, first you need to understand what the needs of our states are and what the needs of our local communities are. Information, guidance requirements developed at the national level should be provided in a ready-to-use format and in an understandable language.

And we must also form partnerships between the federal, State—federal and State DOTs to maximize and share all of our information, our assets, and expertise. We need to all work together instead of all working separately and independently and reinventing the wheel every time.

Partnership is a major focus for us in Texas. We believe that only through partnership and coordination we will be able to meet our mission, and the same level of coordination and focus would be helpful in all federal research programs.

As Congress looks to reauthorize the Nation's Surface Transportation Program and the research that underpins it, there are some simple but important changes that would reenergize the research and would cost little or nothing, little or very little to put in place. Not since President Eisenhower have we had a national plan for infrastructure, and if I have to guess, Congress is starting to think that we need to have a new national plan. Our national plan should not only be for highways, it should also include all modes of transportation, whether it is mass transit, high-speed rail, freight rail, aviation, and ports. We have to measure how well we succeed or how much—by how much we have missed our goals. We will need to move into measuring real congestion relief, lasting cleaner impacts, safety improvements, and sustainable maintenance programs. That way we know whether we got what we expected from our research program.

If Congress is serious about making us perform, then a well-organized research program can get us there. Congress should set our goals and then the states and the Federal Government should work in partnership to define what and how we measure our success. We need to avoid developing systems independent of each other as I

mentioned because this leads to additional cost. A nationally-coordinated approach worked well for mapping the Genome Project, and it can certainly help us in advancing our research program and the development of transportation systems.

Mr. Chair, thank you for allowing me to provide this testimony. I look forward to your questions and will be happy to answer them. [The prepared statement of Mr. Saenz follows:]

PREPARED STATEMENT OF AMADEO SAENZ, JR.

Introduction

This testimony will provide the Committee on Science and Technology with the State of Texas perspective on the federal research investment, barriers we face, and stakeholder involvement in transportation research and development. It will also address the impact to states and possible improvements that might make the entire R&D endeavor more useful.

At TxDOT we strive to be a progressive State transportation agency that provides safe, cost-effective, efficient, environmentally sensitive and aesthetically appealing transportation systems to the citizens of Texas.

Federal Investment

The federal investment in research and development has impacted transportation practices and investments in many positive ways. First, the federally funded national programs are the basis for the development of national, State and local operating processes, standards and specifications. These programs consolidate information and experience from around the United States and produce usable documentations for new methods. They also obtain results that might otherwise take individual states decades to complete. Federal research and development has brought the transportation industry high performance concrete, high performance steel and accelerated bridge construction, which have significantly improved the efficiency and the durability of bridges. These, of course, are not the only examples.

In Texas, the safety devices along all of our highways are based on design criteria developed through national research. For example, the National Cooperative Highway Research Program (NCHRP) Report 350, "*Recommended Procedures for the Safety Performance Evaluation of Highway Features*," has been used for selecting cable barrier systems. The installation of these barriers on Texas highways has dramatically reduced crash severity and saved several lives. NCHRP projects have helped TxDOT in other programs as well, like the repair of prematurely failing modular joints on bridges. If these systems are poorly designed, specified or installed, which had happened previously due to a lack of national specifications, they can under-perform and result in costly bridge damage and premature replacement.

NCHRP has assisted Texas in many ways. It helps us provide secure highway and bridge infrastructure by presenting the results and findings that enable transportation professionals to deal with emergency preparedness functions. The NCHRP reports also help TxDOT identify and quantify environmental impacts in the earliest phases of project planning, making that complex process more effective and avoiding costly changes later. The research associated with new regulatory requirements can address lawsuit findings and help facilitate more efficient and effective environmental clearance and improve project delivery.

Another great federal program example is the Strategic Highway Research Program (SHRP) Concrete and Structures initiative, which promoted the interchange of ideas and information among representatives of Federal, State and local government agencies; the construction industry; and the academic community, an effort which provided High Performance Concrete (HPC). The Texas Louetta Road Overpass in Houston was underway and was the first highway bridge construction project in the United States to use HPC throughout the bridge.

Additional benefits from SHRP continue today. The current Superpave asphalt binder specifications that the Nation uses today were developed through the initial SHRP. For example, Expert Task Groups, or ETGs, for binders and mixtures that were originally organized for implementing Superpave still function to research changes needed in testing and specifications that were not adequately addressed during the original funding for SHRP. The FHWA formed a working group for the implementation of the Mechanistic Empirical Pavement Design Guide that is being developed to replace the existing American Association of State Highway and Transportation Officials (AASHTO) design guides. The end product should improve the ac-

curacy and reliability of pavement design in the United States. An ETG for pavement models was organized to evaluate prediction models including fundamental properties to predict pavement performance. This Long-Term Pavement Performance project was used to develop the new pavement design guide and provided several valuable lessons from the Special Pavement Sections. FHWA also uses ETGs to evaluate the measurement of pavement performance characteristics such as smoothness, rutting and cracking with goals to standardize the practices of calibration and data collection.

TxDOT has built a very robust research program funded through the federal State Planning and Research Program involving many of the Texas universities. We perform research in areas such as pavements, materials, construction, planning, environment, right of way, public transportation, operations, safety, hydraulics and structures. Some of our recently completed research projects are:

- **The Role of Preferential Treatment for Carpools in Managed Lane Facilities**, which involved a review of carpool preferences on managed and tolled lanes; a stated-preference survey of HOV lane users with respect to carpool preferences relative to price; development of a predictive demand model; and an assessment of mobility, revenue and environmental impacts.
- **Impacts of Current and Future Demographic Trends on Transportation Planning in Texas**. One of the deliverables from this project was a *One-Stop Demographic Data Analysis Tool*, which will provide a starting point for reporting and comparing demographic characteristics of selected areas for transportation professionals.
- **Synthesis Study of Programs Used to Reduce the Need for Inspection Personnel**. TxDOT is looking for more effective ways to manage the workload involved in construction project testing and inspection. This project identified strategies that could help TxDOT do this while maintaining quality.
- **Development of An Advanced Overlay Design System Incorporating Both Rutting and Reflection Cracking Requirements**. TxDOT spends millions of dollars each year designing and placing overlay on its existing highways. The tools developed in this study will assist TxDOT engineers in designing and implementing longer lasting overlays. The software can address issues such as where to use high-performance mixes and optimal thicknesses, particularly in the area of jointed concrete pavements where joints must be repaired prior to placing any overlay.

A January 2003 TxDOT report titled *"The Value of Texas Transportation Research"* stated the following:

"To demonstrate the impact that research has on transportation system safety and cost effectiveness, 21 improved technologies and methods produced by TxDOT's research program were selected from a three-year period, 1999 through 2001. The selected products are considered to be among the best of over 200 beneficial initiatives implemented from those three years of the research program. A benefit period of ten years was used for determining the returns from the selected research program products. This is a conservative assumption, since many benefits never become truly obsolete as newer technology is layered on earlier innovation."

"The estimated ten-year cost savings in department operations, stemming from these 21 research products, are more than \$322 million. The research program budget total for fiscal years 1999, 2000, and 2001 was approximately \$54 million (less than 0.4 percent of the department's budget). The total operational cost savings derived from these 21 products exceed the cost of the research program by approximately \$268 million. This is a net return on investment ratio of 5:1, without considering the value of the numerous other products implemented from that three-year period of the research program."

This report is currently being updated by the Texas Transportation Institute. However, preliminary indications are that the original findings remain valid.

Research and Development Barriers

The competing challenges of relentless congestion, lack of adequate funds and the need to move people and goods across town and across the country demand that we generate answers quickly. In some instances, we need the answers today—so we cannot wait on a research question to be posed with answers to be presented two years down the road. The public expects the best transportation system at the lowest cost, and research facilitates this but we have to do a better job of anticipating

our questions and issues. We must begin research now so we have the answers available when tomorrow comes.

A key barrier we have to overcome is institutional inertia and resistance to change based on rational aversion to risk. Contractors in Texas, as in other states, are used to standards and consistency, so when we introduce new specifications, standards or construction techniques, resistance and cost increase is certain. Another barrier to implementing research is quite simply staffing and funding shortages. As you know, there is a cost to implementation and changeover to a new technology. With reduced budgets today and our uncertain economy, our resources are already stretched in our ability to just maintain our existing systems.

Some other barriers include failure to get useful information to decision-makers, reluctance by some to embrace advanced technologies (perhaps due to lack of understanding), lack of clarity or understanding of potential benefits, and unavailability of specifications. Some research outcomes may have to be validated by environmental regulatory agencies and go through rule making by multiple regulatory agencies before being implemented (for example, alternative mitigation strategies that research has shown to be superior to earlier practice). This barrier is exacerbated by the chronic shortage of staff in the federal regulatory agencies.

Proprietary issues continue to hinder implementation. Frequently, successful research must be converted to hardware, software or new materials by vendors before it can actually be effectively used. Sometimes we must wait to implement a research result until we have enough vendors for competitive bidding. Manufacturers are often reluctant to add new features or applications that resulted from research. Another potential obstacle is that there must be agreement on the limits of the use of data available from the new technology (i.e., electronic tolling).

The Federal Government can help states, counties and cities use the newest available technologies in several ways. First, there must be an understanding at the federal level of State and local issues and needs. It's a long way from Washington, D.C. to Austin, Texas, and things can get lost in translation. Information, guidance and requirements developed at the national level should be based, where necessary, on sound research. This information should then be provided in clear, "ready to use" format and language. Distributing reports that are unread and put on the shelf or stored on the Internet is not the answer. Research results need to be communicated at all levels. Professionals and first-tier government decision-makers must share the details of research results and agree on standard processes and methods; i.e., safety related road design, clearance zones and access management. Transportation department regional and discipline specialist leaders must agree with local leaders on the value of, and the resources for, implementing research results; i.e., real-time monitoring at Traffic Management Centers. Senior transportation leaders and elected or appointed officials must ask for and then implement research on major requirements; i.e., alternative funding methods, linking planning with the *National Environmental Policy Act*, global warming and greenhouse gases. The Federal Government can assist in developing specifications and standards. Perhaps funding more demonstration projects highlighting technologies with potential big pay-off could also help.

At TxDOT, we have made some changes in policy to assist in overcoming some of these barriers. For example, deliverables required on some TxDOT research projects include a specification, standard, or "manual pages" in the proper format ready to insert into our documents. This makes it easier and quicker to implement the results. Some research project results are such that a formal implementation project is developed. An implementation project is typically triggered by the need for specific funding to help integrate a product, new method or process, or innovation into department operations. Examples include:

- The incremental cost for the first use of a product or innovation in construction or maintenance operations.
- The purchase of newly developed equipment for use in the field.
- Training of field personnel in the use of new equipment or methods.

Training is also a significant tool for ensuring that planning and construction use the newest available technologies. Universities must also maintain strong research programs to attract high quality students to continue graduate level study. Continuing research progress must be matched with money, resources and materials to understand and implement new technologies. Basic and continuing education and technical skills training at multiple levels is needed equitably across the country. In Texas, for example, over 300 department employees have been trained in the past 18 months on research project specific best practices and implementations. Topic areas include Wireline Communication Design, PASSER V Signal Optimization, Dy-

namic Message Signs, Managed Lanes, Measuring Access to Public Transportation, Procedures for Setting Curve Advisory Speeds and Spall Repair.

Recently, the research project on Transversely Varying Asphalt Rates has been added as a course that will be available to the department employees in March 2009. We have also partnered with the National Highway Institute and the Transportation Curriculum Coordinating Committee (TCCC) to place all new TCCC Web-based training on the department's Learning Content Management System. This allows immediate access to these new courses in a secure environment for department employees. We are involved with the Texas Pavement Preservation Center, a collaborative association with the department, Center for Transportation Research, the Texas Transportation Institute and private industry, and have developed a series of training courses that are delivered on an established schedule to department employees and private industry. Over 400 employees have been trained on best practices in asphalt preservation methodology and design in the past 15 months.

The department is a firm believer in the use of technology not only in application in the design, build and maintenance of roadways, but also in the delivery of training and access of the latest cutting-edge technologies for its employees. The department has an extensive video teleconferencing system that has been in place since 2002. In FY08 alone, TxDOT used over 8,700 hours of connectivity to delivery training. TxDOT's Learning Content Management System now hosts over 400 course titles and is used by every employee for a variety of courses and access to resources. The Local Technical Assistance Program (LTAP) is also a valuable program for assisting cities and counties with technical issues and training. Some of the specifics of the LTAP in Texas include:

- Distributing technology transfer materials (videos, CDs and publications) to local government officials upon request.
- Providing technical information, advice and guidance upon request of local agencies.
- Conducting or arranging seminars or training courses including Bridge Maintenance, Road Maintenance, Culverts and Drainage, Vegetation Control/Herbicide Use and Using a Motorgrader to Shape Gravel Roads.

Stakeholder Involvement

Lastly, we believe the current level of stakeholder involvement in determining DOT RD&T priorities at the federal level is sufficient but needs improvement. The stakeholders included at the federal level, for example, are FHWA, RITA, TRB, State DOTs, local agencies, highway industry and highway users. But sheer volume does not necessarily mean that the programs and priorities are well coordinated and focused. As a result, we have unnecessary duplication, significant research gaps and increased difficulty in sharing results that can be used across the country. The challenge is big. All 50 states are conducting their own research. In addition, RITA, TRB and the FHWA have numerous research programs (for example, NCHRP, SHRP 2, and STEP). Some possibilities for improvement include:

- Defining the roles and "boundaries" of the various programs more clearly. It should be much clearer at the federal level how the "pieces of the puzzle" fit together. For example, how does the research conducted by RITA relate to the research conducted by FHWA? Is there duplication? Are there gaps? How and where does one see how this "puzzle" fits together?
- The goals and focus areas of the multitude of research programs at the federal level should be clearly and succinctly outlined, put in the same format for easy comparison and kept current in one electronic document. In essence, "What is everyone doing and where do I find it?"
- Focus the coordination efforts so that the right stakeholders are involved in the right programs. More importantly, ensure that the "products" resulting from these stakeholder meetings and interactions are specific, meaningful and measurable. Too often, many groups at all levels meet to develop research agendas. The problem occurs when there is no accountability and no follow-up.

The National Vision and Transportation Research

As Congress looks to reauthorize the Nation's surface transportation program and the research that underpins it, some simple but important changes would not only re-energize that research but would cost little or nothing to do.

As we look forward to the 2009 authorization cycle, Congress should define a national strategy and provide the policy framework that empowers states and regions

to set goals, make decisions and deliver projects that implement the national strategy. Not since President Eisenhower have we had a national plan for infrastructure, and if I had to guess, Congress is starting to we think should have one, too.

Our national plan should not only be for highways. It must include all modes of transportation: mass transit, high-speed rail, freight rail, aviation and ports. Congress should enact consumer-focused legislation and recognize that Americans expect congestion relief, cleaner air, improved economic opportunity, well maintained roads and increased safety.

And we're going to have to measure how well we have succeeded, or occasionally, how spectacularly we have failed. In the stimulus legislation that's presently under consideration, a good portion of the discussion is on measuring results. Right now it tends to be about the number of jobs created, which is good, but we're going to need to move into measuring real congestion relief, lasting clean air impacts, safety improvements and sustainable maintenance programs. That way we can know if we get what we expected to get out of our transportation investments, a level of thinking that is absent these days.

The national research program to some degree mimics the transportation plan we have today. There's little central coordination or vision, everyone's off doing their own thing with inadequate funding and we generally do nothing more than follow processes. When we spend a federal dollar, the question we're asked isn't "Did you relieve congestion?" but rather "Did you follow all of the processes?" If we happened to actually accomplish something, then we got lucky.

If Congress is serious about making us perform (and I hope it is), then a well organized national research program can get us there. It can define what we measure and how to best measure it. I think it could also develop the software to do it so we we're not all developing systems independent of each other at a tremendous cost or buying it from different vendors at an equally high cost.

A nationally coordinated approach worked for mapping the human genome project, and it can work for mapping the next advances in our transportation system.

BIOGRAPHY FOR AMADEO SAENZ, JR.

Amadeo Saenz Jr., P.E., is Executive Director of the Texas Department of Transportation (TxDOT). Under Texas Transportation Commission direction, he manages, directs, and implements TxDOT policies, programs, and operating strategies. He represents TxDOT before the Texas Legislature, the United States Congress and other entities. He was appointed as Executive Director of TxDOT in 2007. Mr. Saenz is a trailblazer in transportation and was the first Hispanic to hold this position in the agency's 90-year history.

After earning a Bachelor of Science degree in civil engineering (with honors) at the University of Texas at Austin, Mr. Saenz joined TxDOT in 1978 in the Pharr District as an engineering laboratory assistant. As a TxDOT employee he succeeded through various positions to learn the agency and transportation from beginning to end.

He was named district engineer in the Pharr District in 1993 and held this position until 2001 when he was appointed as Assistant Executive Director for Engineering Operations in Austin. In this role, he implemented and managed TxDOT's engineering operations policies, programs and operating strategies according to federal and State laws and Texas Transportation Commission regulations and directives.

A native of Hebbronville, Texas, Saenz is a past member of the Rotary Club and was active with the Boy Scouts. He served on the Civil Engineering External Advisory Committee for the University of Texas at Austin. He owns and operates a small cattle ranch in South Texas, where he enjoys horseback riding and hunting. Mr. Saenz and his wife, Geraldine, have two children, Priscilla Marie and David Aaron.

Chair Wu. Thank you very much, Mr. Saenz.

Mr. Skinner, please proceed.

STATEMENT OF MR. ROBERT E. SKINNER, JR., EXECUTIVE DIRECTOR, TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

Mr. SKINNER. Good morning, Mr. Chair and Members of the Committee. My name is Robert Skinner, and I am the Executive Director of the Transportation Research Board (TRB) of the Na-

tional Academies. My testimony this morning is based upon the work of expert committees appointed by the National Academies to carry out projects for the Federal Highway Administration's (FHWA) Research and Technology Programs and for the Research and Innovative Technology Administration (RITA). I emphasize highway research programs in my testimony, but most of the lessons drawn are applicable and transferable to research in other modes.

The administration of our highway system is incredibly decentralized with tens of thousands of states and local governments owning pieces of the system. Even though the Federal Government owns and operates relatively few highways, it plays a crucial role in research and the innovation process. The Federal Government funds about two-thirds of the total Highway Research and Technology Program, enables training and technology transfer activities, and is the sole source of funding for higher-risk, potentially higher-payoff research.

Now let me turn to the questions provided in advance and highlight some of the points that are made in my written testimony. The first question referred to R&D priorities, alignment with stakeholders, and changing priorities. The TRB committee that reviewed RITA's first five-year DOT-wide strategic plan identified several constraints on having a truly strategic plan.

The research title of SAFETEA-LU (*Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users*) contains numerous, narrowly-defined designations, and many R&D activities are earmarked to specific recipients. As a practical matter, most of the needed research identified by stakeholders is mode-specific in character. Finally, the ability for USDOT to direct or control research programs from a top-down perspective is in a natural tension with efforts of the modal administrations to be responsive with stakeholders.

Given the decentralized administration of the system, responsiveness to stakeholder needs and perspectives is crucial. FHWA may have the most extensive interactions with stakeholders of the modal administrations but even it could be doing more.

Regarding changing priorities, the research proposals for reauthorization that the TRB Executive Committee looked at last spring did not adequately recognize the growing importance of reducing transportation greenhouse gas emissions and energy consumption. TRB now has a study underway that will make recommendations before SAFETEA-LU expires regarding research on climate change mitigation and adaptation.

The second question concerns improvements to transportation R&D investment structure. In concept, the portfolio of programs funded through SAFETEA-LU is appropriate, but the program, as authorized, is far more detailed than necessary. Compare that to NSF (National Science Foundation), which has a budget that is 10 to 15 times greater with fewer line items.

Other weaknesses in the structure include: too small a share of the funding is devoted to advanced or longer-term, higher-risk research; policy research is neglected; there is too little emphasis on data collection; and inadequate attention to technology transfer.

The third question, in fact, addresses improvements to the technology transfer programs. FHWA provides extensive information about new technologies and practices, administers the Local Technical Assistance Program (LTAP), and offers training on new technologies and practices. These activities, however, are not sufficient to fully overcome the significant barriers to innovation that exist.

Our recently-released report on implementing the results from the Strategic Highway Research Program (SHRP) provides a model of what is required to assist the states in deploying new technologies and practices. For SHRP products the committee recommends a large-scale implementation effort totaling \$400 million over six years. It would be guided by a formal stakeholder advisory committee and detailed, publicly-available implementation plans.

The final question asked about lessons learned from the last reauthorization, excuse me, the final question asked about lessons learned from the last reauthorization of Surface Transportation Programs. The principles for research articulated in the preamble to Title V are good ones, and I hope they will be retained, and more importantly, followed. They encourage stakeholder involvement, competitive award of funding based upon merit review, advanced research, and a federal program that spans the entire innovation process.

Along with fewer, more-broadly defined line items, adherence to these principles would restore funding to policy and other core missions, including enhanced technology transfer, and provide flexibility needed to respond to changing needs. Specific recommendations based on our assessment of SAFETEA-LU's Title V are included in my written testimony.

Thank you for this opportunity to appear before the Committee. I look forward to answering any questions you may have.

[The prepared statement of Mr. Skinner follows:]

PREPARED STATEMENT OF ROBERT E. SKINNER, JR.

INTRODUCTION

Good morning, Mr. Chairman and Members of the Committee. My name is Robert E. Skinner, Jr. I am the Executive Director of the Transportation Research Board (TRB) of the National Academies. TRB is one of the five divisions of the National Research Council (NRC), which, in turn, is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. This complex of organizations is collectively referred to as the National Academies. The institution operates under the charter given to the National Academy of Sciences by Congress in 1863 to advise the government on matters of science and technology.

From the 1920s until 1975, my organization was named the Highway Research Board. In 1975 the organization became multi-modal and was renamed the Transportation Research Board. TRB's mission is to promote innovation and progress in transportation through research. It is best known for its role in promoting innovation and information exchange by maintaining approximately 200 standing technical committees in all modes of transportation and hosting an Annual Meeting that attracts more than 10,000 participants from the United States and around the world. TRB also conducts policy studies for Congress and the executive branch, and is increasingly called upon to administer research programs for others that are stakeholder-directed and primarily award research funding based on competition and merit review by peers.

The testimony I will give today is based upon the work of expert committees, appointed by the NRC, and serving without compensation to carry out projects for the Federal Highway Administration's (FHWA) research and technology programs and the Research and Innovative Technology Administration (RITA). I have cited these

different reports throughout my testimony, and they are listed at the end of this document.

We also have committees at work reviewing the research programs of the Federal Railroad and Federal Transit Administrations, and TRB manages cooperative research programs for transit agencies and airports. I have not addressed these modes in my written testimony in any detail but will be happy to comment on these activities if requested. I emphasize highway research programs in my testimony, but most of the lessons drawn are applicable and transferable to research in other modes.

Importance of Highways

The American lifestyle is absolutely dependent on highway transportation. Americans use personal vehicles for 87 percent of daily trips and 90 percent of long distance trips. The decentralized U.S. economy would be unimaginable without the access that highways provide for motor carriers. Truck ton-miles represent about 30 percent of total ton-miles of freight; more importantly that tonnage accounts for nearly 75 percent of the value of freight shipped domestically.

With the fourth largest land area of any country, the United States is surely the most reliant upon roads and highways. The Nation has 8.4 million lane miles (3.2 million miles) of roads connecting metropolitan areas, towns, and counties across the country to serve its 300 million residents and seven million business establishments.

As valuable and important as highway transportation is, it also faces enormous challenges. For example, demand on the system increased sharply in recent years resulting in the congestion we have become all too familiar with. Total highway travel in personal vehicles, motorcycles, light and heavy trucks totals nearly three trillion miles annually. Total travel has leveled off in the last couple of years, but it increased 25 percent between 1997 and 2006. Not only is much of the highway system reaching or exceeding its expected service life, it is also carrying a much heavier burden than expected. The amount of traffic on rural Interstates more than doubled between 1970 and 2005, but the loadings placed on those highways, due largely to more trucks traveling more miles, increased six-fold during that period. The system is facing unprecedented challenges in overall demand, safety, the cost of paying for system preservation and operation, and environmental impact. Because there is not enough money to meet all these challenges, research and innovation is desperately needed. For example, we must learn how to reconstruct highways more efficiently at lower cost and do so while continuing to maintain service with minimal disruptions. We must also strive to meet ever-higher standards for providing capacity with minimal disruption to communities and the environment.

AN OVERVIEW OF U.S. HIGHWAY RESEARCH & TECHNOLOGY PROGRAMS

Decentralized Responsibilities

Highway research, like the management of the highway system itself, is highly decentralized, and appropriately so. Roads and highways are owned and operated by the states, thousands of counties, and tens of thousands of cities and municipalities. These many and varied organizations make all the key decisions about investment, operation, and preservation of roads. Aside from the roads on federal lands, the Federal Government has little direct connection with the pressures of financing, building, maintaining, and operating roads. Doing so is a massive enterprise. Roughly \$94 billion is spent every year on roads and highways.

Each state has its own highway research program, and states, in turn are providers of technology and innovation to cities, counties, and municipalities. States' R&T programs often provide the final step in implementing new technologies, and they must meet the particular needs of individual states' soil conditions, climate, and institutional arrangements. Pavement design itself, for example, is highly dependent upon local soil conditions, moisture levels, temperature ranges, and sources of local aggregate. Operational needs range widely between states with major metropolitan areas and states mostly made up of rural areas. State policy concerns about economic development, finance, environmental issues, and safety also vary considerably across states. State research programs support research initiatives in all these areas.

The existence of 52 programs might suggest that duplication would occur, but, in fact, states have a system of sharing resources in order to study topics of collective interest, and the states and federal transportation agencies, through TRB, maintain a database of completed research and research in progress, which states are required by FHWA to consult before initiating new projects. State highway research programs are mostly funded through federal aid. For decades, the federal aid title

of surface transportation authorization (Title I) has required states to spend a small percentage of federal aid on planning and research. (The State Planning and Research (SP&R) program currently sets aside two percent of selected highway program funding of which 25 percent must be spent on research.) States pool some of their resources in the National Cooperative Highway Research Program (NCHRP), which is managed by TRB on the states' behalf, as described in more detail below.

Federal Role

Even though the Federal Government has a minor role in owning and operating highways, it plays a virtually indispensable role in the research and innovation process. The Federal Government funds about two-thirds of total highway research and technology programs (Table 1), plays a critical role in training and technology transfer, and is the sole source of funding for higher-risk, potentially higher-pay off research.

The Federal Highway Administration (FHWA) is the principal agency managing highway research at USDOT. It has research activities in each of its mission-area responsibilities: infrastructure, operations, environment and planning, safety, and policy. Through its research and program office staff in these areas, FHWA interacts with experts and stakeholders in the public and private sectors to develop multi-year program plans for their research and development activities.

The Intelligent Transportation Systems (ITS) research program, initiated and formerly managed by FHWA, is now managed by the Research and Innovative Technology Administration (RITA). The ITS program is multi-modal, but most of the projects and funding are highway-related. In addition, the University Transportation Centers (UTCs) conduct highway research (generally with federal funding); this program is administered by RITA. The UTC program is multi-modal, but 69 percent of the projects in 2008 were focused on highway topics,¹ hence I have included it as part of the federal investment in highway research. Various private entities fund highway research, but their role is surprisingly small.² Because of the large public presence in roads and highways and the nature of public procurement of highway goods and services, there are relatively few opportunities for the private sector to capitalize on private research. Consequently, the share of private funding is small and the public responsibilities for encouraging innovation are large.

¹ *The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses*, Special Report 295, Transportation Research Board of the National Academies, Washington, D.C., 2008, p. 75.

² *Building Momentum for Change: Creating a Strategic Forum for Innovation in Highway Infrastructure*, Special Report 249, Transportation Research Board of the National Academies, Washington, D.C. 1996, p. 14–15. See also Chapter 6 of *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life*, Special Report 296, Transportation Research Board of the National Academies, Washington, D.C. 2009.

Table 1: National Highway Research, Development, and Technology Expenditures, 2006 (\$000s)³

	Federal	State	Private	Total
FHWA				
Surface Transportation R&D	133,000			133,000
Training & Education	23,000			23,000
RITA				
University Transportation Centers	60,000			60,000
ITS program	96,400			96,400
States	165,800 ^a	160,200		326,000
Strategic Highway Research Program 2	36,200 ^b			36,200
Associations			25,000-50,000	25,000-50,000
Companies			50,000-100,000	50,000-100,000
Total	512,700	160,200	75,000-150,000 ^c	747,700-822,700
Percentage	62-69%	19-21%	10-18%	100-100%

^aState Planning & Research Funds, Title I of SAFETEA-LU.

^bFunded from Title V 2005-2006 and Title I in 2008-2009.

^cEstimated in 2001 in *The Federal Role in Highway Research* TRB Special Report 261, Transportation Research Board of the National Academies, Washington, D.C., 2001.

³ *The Federal Investment in Highway Research 2006-2009: Strengths and Weaknesses*, Special Report 295, Transportation Research Board of the National Academies, Washington, D.C., 2008, Table 2-2, p. 21.

FHWA is closely connected to the states though its federal aid and RD&T programs and has offices in each state. RITA, in addition to administering the ITS and UTC programs, has a role in strategic RD&T planning for the department. Because of the extent of earmarked research and detailed designations of research programs in the *Safe, Accountable, Flexible, Efficient, Transportation Equity Act of 2005* (SAFETEA-LU), about which I will say more later, RITA has had limited opportunity to influence the scope and direction of highway research.⁴

A federal role of growing importance is the support for higher-risk, potentially higher pay-off research. TRB has been administering an NRC-appointed expert committee to provide guidance to the FHWA RD&T program since 1992. The Research and Technology Coordinating Committee (RTCC) has consistently encouraged FHWA to invest in this kind of research.⁵ The vast majority of the highway research conducted in this country is highly applied, problem-solving research, as it should be. But no agency has been funding more exploratory research that is seeking new understanding that could lead to new breakthroughs. The Exploratory Advanced Research program authorized in SAFETEA-LU is an example of this kind of research and a welcome change. In principle, this kind of research should also be supported through UTC program, but the dollar-for-dollar matching requirement of the UTC program has driven this program to focus on applied research.

Special Initiatives

Over the years stakeholders in the highway community have requested special initiatives to meet special needs. Most of these initiatives have been governed by stakeholders and funded with federal aid and rely on competition and merit review to award contracts and grants.

AASHTO Road Test and Long Term Pavement Performance Experiment.

In the late 1950s an extensive series of tests was conducted for the American Association of State Highway and Transportation Officials (AASHTO), then named the American Association of State Highway Officials (AASHO), on a pavement test track. These tests established the empirical relationships between pavement load-

⁴ Committee for the Review of the USDOT Strategic Plan for R&D, Letter Report, August 2, 2006. http://www.trb.org/news/blurb_detail.asp?id=6582

⁵ *The Federal Role in Highway Research and Technology*, Special Report 261, Transportation Research Board of the National Academies, Washington, D.C. 2001.

ings and distress that that became the basis of the first AASHTO pavement design guide issued in 1961, which subsequently determined pavement designs in the United States as well as influencing them around the world. TRB, then the Highway Research Board, administered these tests for AASHO.

The AASHO road test, however, did not adequately account for variations in soil conditions, materials, climate, and other factors that influence pavement deterioration in addition to loadings. The Long-Term Pavement Performance (LTPP) experiment, begun 20 years ago, and costing over \$260 million in federal funding, will be nearly completed this year. FHWA has managed the experiment in collaboration with the states, which have invested at least double the federal share in constructed pavements and data collection. An NRC-appointed committee administered by TRB has advised FHWA and the states on the conduct of this experiment. The data collected to date have already been influential in implementing the new Mechanistic-Empirical Design Guide being implemented by the states and will likely be as influential in future pavement design as the AASHO road test.

Intelligent Transportation Systems (ITS) program

In the late 1980s a broad-based public-private stakeholder group known as Mobility 2000 began promoting the need to apply computer and electronic communications technologies to increase the capacity and safety of highways. The research and demonstration program that was initially funded in the *Intermodal Surface Transportation Efficiency Act of 1991*, has since invested more than \$1.2 billion in developing, testing, and implementing ITS technologies. ITS America, an outgrowth of Mobility 2000, was originally designated as the formal advisory body for the program; RITA now has a designated ITS advisory committee for this purpose.

Strategic Highway Research Programs (SHRP) 1 and 2.

Originally conceived by an NRC-appointed committee administered by TRB, the first SHRP program was a fixed-duration \$150 million research effort focused on materials and maintenance practices that produced significant breakthroughs in asphalt mix design procedures and winter maintenance practices. FHWA, AASHTO, and TRB collaborated in the development of detailed research plans. The program was authorized in the 1987 surface transportation reauthorization legislation. A special unit of the NRC was created to allow for stakeholders governance of the program and convene expert panels to produce requests for proposals (RFPs), provide merit review of the proposals, recommend selection of contractors, and manage the contractors.

In the *Transportation Equity Act for the 21st Century*, Congress requested that TRB convene another NRC-appointed committee to determine the need for a second SHRP. A committee made up of leaders from the highway community recommended an ambitious program to significantly improve safety, provide capacity in greater harmony with community values and the environment, improve travel time reliability, and renew highway capacity more efficiently and effectively while under traffic.⁶ SAFETEA-LU authorized a six-year, \$205 million program for this purpose. Under a three-way partnership with AASHTO, FHWA, and TRB, the program is governed by stakeholders and administered by TRB. Eighty-five percent of the research funds are awarded competitively based on merit review by peers.

National Cooperative Highway Research Program (NCHRP)

Since 1962, under a cooperative agreement among AASHTO, FHWA and TRB, TRB has administered the NCHRP program. In this cooperative program, the states select the topics to be studied through the Standing Committee on Research of AASHTO. TRB then forms panels of experts to issue RFPs, review proposals, select contractors, and oversee the research. TRB administers similar programs for transit agencies (Transit Cooperative Research Program, since 1991), and airports (Airport Cooperative Research Program, since 2005).

Other Cooperative Research Programs

SAFETEA-LU authorized two relatively small-scale cooperative programs that TRB administers for others. One program, recommended by AASHTO, addresses intermodal freight research issues. Another pilot program, recommended by an NRC-appointed committee convened at the request of USDOT, addresses hazardous

⁶ *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life*, Special Report 260, Transportation Research Board of the National Academies, Washington, D.C. 2000.

materials transportation.⁷ As with other cooperative programs, stakeholders provide the governance and TRB provides the administration.

In 2002, an NRC-appointed committee also recommended the creation of a Surface Transportation Environment and Planning cooperative research program.⁸ The committee that authored that report was chaired by Betty Deakin, who is also invited to testify today. A key concept behind this proposal was to bring the highway and environmental communities together to govern a research program that would use the best science and technology to address and resolve some of the contentious issues and questions that separate these two constituencies. SAFETEA-LU authorized such a program and left it to the discretion of USDOT whether to manage it directly or have TRB form a stakeholder committee to provide governance of the program. Partly due to the funding constraints SAFETEA-LU imposed on USDOT, FHWA chose to retain the program, which, nonetheless, does have an extensive outreach component.

The structure of the highway research program appears complicated, and it is. The genius of the design, however, is that the programs and initiatives are structured for the most part so that they are close to the various problems they are designed to address. In principle, the various programs provide a portfolio that ranges from highly applied to more exploratory research. In the view of many, the balance is not quite right, and, for the amount of money being spent, there appear to be far too many categories and far too little flexibility to shift program priorities in response to new opportunities, such as nanotechnology, or emerging needs, such as security and climate change.

FINDINGS AND RECOMMENDATIONS FROM RECENT NRC REPORTS

Two NRC-appointed committees have recently completed reports that address the questions posed by the committee. After summarizing the main findings and recommendations of these reports, I respond to the Committee's questions more directly.

Last November the NRC released the RTCC report entitled *The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses*. This report evaluates the federal highway RD&T programs in terms of the principles for research that are articulated by Congress in the introduction to Title V of SAFETEA-LU. Some of these principles are based on recommendations made by the RTCC in its 2001 report, *The Federal Role in Highway Research*. These principles address:

- the scope of the federal RD&T program;
- when federal investment is justified,
- the content of the program, including fundamental, long-term research; gap-filling research; and policy or planning research;
- stakeholder input;
- awarding R&D funds primarily through competition and peer, or merit, review; and
- evaluation of research.

The main findings of the RTCC are as follows:

- Despite the progress made in overall funding in SAFETEA-LU, highway research programs are significantly under funded compared with the level of R&D investment in private industry. Public and private highway research is funded at only 25 percent of the level of industrial R&D in the United States (0.9 percent of highway expenditures compared to 3.4 percent of industrial sales).
- The research programs funded in SAFETEA-LU meet the Title V principles with these main exceptions:
 - Extensive earmarking (62 percent) of the University Transportation (UTC) Program and additional earmarks scattered across FHWA programs (equal to at least 18 percent of total funding) violate the SAFETEA-LU principle of awarding research funds according to competition and merit review.

⁷ *Cooperative Research for Hazardous Materials Transportation, Defining the Need, Converging on Solutions*. Special Report 283. Transportation Research Board of the National Academies, Washington, D.C., 2005.

⁸ *Surface Transportation Environmental Research: A Long-term Strategy*. Special Report 268. Transportation Research Board of the National Academies, Washington, D.C., 2002.

- The programs funded in SAFETEA-LU do not include all the content areas Congress requested. Due to funding constraints in Title V caused by a considerable number of narrowly-designated programs and earmarking of more programs than were authorized, FHWA was forced to cut important areas of research in safety, operations, planning and environment, and policy. Funding for research and data gathering to support policy decisions was eliminated and funding for planning was greatly reduced. Other areas that are funded, such as deployment and technology transfer, are nonetheless inadequate to the task.⁹
- The 50–50 matching requirement for the UTC program biases this program toward highly applied research and away from advanced research that is one of the main rationales for having a university research program.
- Due to funding constraints, FHWA has inadequate funds to carry through on commitments it has made in its *Corporate Master Plan for Research, Deployment and Innovation* to engage stake holders more broadly in agenda setting, merit review, and program evaluation.
- The SHRP 2 program meets all the research principles, but is funded at only one-third the level and for two years less than stakeholders requested. The down-scaled program will not be able to meet all the original goals envisioned.

The committee also makes several important recommendations.

1. To the maximum extent practical, research funding should be awarded through competition and merit review.
2. All UTC funds should be awarded to universities competitively. The 50–50 matching requirement for UTC research should be reduced to a 20 percent university match to allow universities to conduct more advanced research.
3. The Exploratory Advanced Research program should be continued.
4. The State Planning and Research (SP&R) program should be continued.
5. Cuts in policy, safety, operations, and planning and environmental research at FHWA should be restored. Funding for research and data gathering to inform policy decisions should be increased to meet pressing national needs. The surface transportation environmental and planning research program should be authorized as a cooperative research program in which the stakeholders are enabled to govern the program. In the planning area, additional funding for expanded data collection and improving regional travel forecasting models should be provided.
6. Congress should consider extending the SHRP 2 program for two years into the next authorization and funded under Title I. (Under Title I, the funding would come from states' construction budgets, which they have approved.)
7. Other research programs strongly supported by stakeholders responsible for administering highways, such as the Long-Term Pavement Performance Program¹⁰ and the Long-Term Bridge Performance Program should be continued.
8. Adequate resources should be provided to FHWA for a robust program for deployment of research results to states, local governments, and private vendors.
9. Resources should be provided to FHWA to institute a process of ongoing priority setting for highway research that engages the entire highway community. The results of these efforts would inform all highway research programs and improve the ability of all programs to focus efforts on the highest priorities.

A second NRC committee has recently recommended a deployment program that would implement the results of the SHRP 2 program in its report, *Implementing the*

⁹ SAFETEA-LU technical corrections legislation of 2008 restored some of FHWA's lost funding and gave the agency discretion over about an additional \$14 million annually.

¹⁰ The recently issued NRC report, *Preserving and Maximizing the Utility of the Pavement Performance Database*, Transportation Research Board of the National Academies, February 2009, recommends completing the data collection from the 500 or so highway sections of the LTPP experiment that will still be providing important information at the end of 2009 and establishing a permanent database to allow researchers to mine these data and complete the analysis originally envisioned for this experiment, which has not been conducted due to funding constraints.

Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life.

The committee recommends that a large-scale deployment effort totaling \$400 million over six years be carried out by FHWA in partnership with AASHTO, the National Highway Traffic Safety Administration (NHTSA), and TRB. The committee also recommends that:

- this implementation effort be guided by advice from a formal advisory committee made up of key stakeholders who must implement the results from SHRP 2 and
- detailed, publicly-available implementation plans be developed with stakeholder input.

I include these recommendations of this report because the large-scale, organized deployment program envisioned provides a model for how FHWA should be organizing itself to support the delivery of innovation. The RTCC report calls for funding a “robust” program of deployment and this is certainly an example of a robust program. It has to be. Innovation in the highway sector is challenging. The largely public-sector highway field results in an extremely risk-averse environment. The barriers to innovation are high. The procurement of highway goods and services is highly detailed and specified as public procurements often must be. There are severe penalties for failures and few rewards for success. The key concepts of this committee’s proposal are its guidance by stakeholders, its degree of organization and dedication, and the scale of funding necessary to deliver results to overcome the barriers to innovation.

RESPONSE TO QUESTIONS POSED BY THE COMMITTEE

1. *How are R&D priorities developed and coordinated within DOT and how are they aligned with the needs of the user community? What is your assessment of these priorities? Do we need to change any R&D priorities to address major challenges such as environmental impact and energy consumption?*

R&D Priorities

SAFETEA–LU charged RITA with preparing a multi-modal strategic five-year RD&T plan and required that the plan be reviewed by the National Research Council. The five-year plan was released in 2006.¹¹ An NRC committee reviewed this plan and found that it was best described as a summary of what research the various modal administrations were funding rather than a true strategic plan.¹² There are important reasons why this plan was not truly strategic from a top-down perspective. First, the research titles of SAFETEA–LU contain numerous narrowly-defined designations and many R&D activities are earmarked to specific recipients. These designations and earmarks exceed the amount authorized, which effectively removes agency discretion in shifting resources to respond to USDOT priorities. Second, as a practical matter, most of the needed research identified by stakeholders is truly modal in character. Pavements and structures, for example, are such a large share of highway agency responsibilities and expenditures that it is natural that FHWA would conduct extensive research in these areas with an interest and focus not shared by other modal administrations. Safety is another important area for FHWA, and its areas of highway safety responsibility are well delineated and distinct from those of NHTSA and the Federal Motor Carrier Safety Administration. Finally, the ability of USDOT to direct or control the research programs from a top-down perspective is in a natural tension with the efforts of the modal administrations to be responsive to the “bottoms up” needs for research identified by stakeholders. It is appropriate for USDOT to set broad goals and objectives for the RD&T program, allocate resources according to direction set by Congress, support advanced research, and conduct mission-critical research for federal regulation and oversight. FHWA should be taking more of a leadership role in developing research priorities in concert with the entire highway community. Because USDOT is so disconnected from responsibilities of actually delivering and operating infrastructure, however, the federal RD&T program should be largely driven by stakeholders.

¹¹ Transportation Research, Development and Technology Strategic Plan, 2006–2010. U.S. Department of Transportation, Research and Innovative Technology Administration.

¹² Committee for the Review of the USDOT Strategic Plan for R&D, Letter Report, August 2, 2006. http://www.trb.org/news/blurb_detail.asp?id=6582

Alignment with needs of user community

The research programs of the modal administrations reach out to stakeholders to inform their selection of research priorities and projects. As mentioned previously, TRB has expert committees reviewing the research programs of FHWA, FTA, and FRA as well as committees of experts reviewing the FHWA's pavement research and deployment activities and the conduct of the Long-Term Pavement Performance experiment. TRB also manages the SHRP 2 research program, which was identified and is governed by stakeholders. The FAA has an extensive advisory committee structure for its aviation research program.

The FHWA probably has the most extensive interactions with stakeholders, as described in some detail in Chapter 5 of *The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses*. FHWA's different R&D offices for infrastructure, operations, safety, and planning and environment have varied outreach efforts to different constituencies, including AASHTO committees, Metropolitan Planning Organizations (MPOs), industry associations, public-private consortia, standing committees of TRB's Technical Activities Division, environmental and safety groups, and others. The program and research offices have developed multi-year R&D program drawing on stakeholder input. Moreover, FHWA has committed to working even more extensively with stakeholders in its *Corporate Master Plan for Research, Deployment and Innovation*, although the RTCC notes in its 2008 report that because of the constraints in Title V, FHWA has not had the discretionary resources to carry out the commitments it made. Despite FHWA's extensive and varied outreach to stakeholders, however, it is fair to say that FHWA could do more to make these activities more transparent to others. Many of the interactions between research and program offices and various stakeholder groups are carried out informally. FHWA should be communicating via its website the opportunities for stakeholders to participate in the shaping of its program, documenting the input it has received, and posting its multi-year research program roadmaps. FHWA is clearly listening to and working with stakeholder groups and most of its R&D programs and initiatives within these programs are aligned with stakeholder interests. Because the Federal Transit Administration's program is so heavily earmarked, it has relatively little discretion over what research it conducts, but its research office should be reaching out to the American Public Transportation Association and other transit industry stakeholders in the ongoing development of its strategic RD&T plan.¹³ Much of the Federal Railroad Administration's R&D program is safety-oriented research driven by its safety regulatory mission, but it also could be more attuned to research the states and passenger and freight rail industries would benefit from.¹⁴

Changing Priorities

The TRB Executive Committee recognized in mid 2008 that the surface transportation research proposals for reauthorization being developed by various groups were deficient in not recognizing the growing importance of reducing transportation greenhouse gas (GHG) emissions and energy consumption. TRB has self-initiated studies under way that we anticipate will make recommendations to Congress before SAFETEA-LU expires regarding research in climate change mitigation and adaptation and will identify policy options for reducing transportation energy consumption and GHG emissions.

Despite what I anticipate will be recommendations for dedicated research in the areas of climate change and energy conservation, I hesitate to recommend cutting existing programs to shift funds to these areas. The RTCC report notes that highway research is significantly underfunded. The share of annual revenues devoted to highway research is only one quarter as large as industry generally and comparable to the lowest of the low-technology sectors of industry. But the challenges faced in the highway sector are among the most complex and important of society. We have a sunk investment in infrastructure worth well over a trillion dollars that has to be maintained. We lose more than 40,000 people each year in traffic crashes. The motor vehicles that use the highway system burn petroleum-based fuels almost exclusively and are a main source of our dependence on imported oil. We must find a funding mechanism to replace or supplement the gasoline tax as the mainstay for funding highway and transit programs. And highways are significant sources of neg-

¹³ Transit Research Analysis Committee, Transportation Research Board of the National Academies, Letter report of May 4, 2007. Washington, D.C. http://onlinepubs.trb.org/onlinepubs/reports/trac_may_2007.pdf

¹⁴ Committee for the Review of the Federal Railroad Administration Research and Development Program, Letter report of April 29, 2008. Transportation Research Board of the National Academies. http://onlinepubs.trb.org/onlinepubs/reports/frar&d_April_2008.pdf

ative environmental impact. Because we are also so heavily dependent on highways to serve our economy and society, the need for innovation to address these problems has never been greater.

2. How would we improve our transportation R&D investment structure?

R&D Investment Structure

In concept, the portfolio of programs funded through SAFETEA-LU is appropriate, but the program is far more detailed than necessary. In an ideal world, the programs would mirror FHWA's mission, goals, and operational areas (infrastructure, operations, safety, planning and environment, and policy) with flexibility for the agency to be responsive to new issues and stakeholder input. FHWA's share of Title V, Surface Transportation Research and Technology Deployment, has 42 line items to allocate \$130 million, many of these line items are at the research project level. Compare that to NSF, which has a budget in excess of \$6 billion and roughly the same number of line items.

There are several federally-managed programs funded through Title V that are clearly aligned with stakeholder interests; the State programs are supported through the State Planning and Research (SP&R) provisions in Title I; special initiatives such as the fixed-duration Strategic Highway Research Programs have been funded from time to time; and support for university-initiated research is provided through the University Transportation Centers Program.

A principal weakness in the portfolio is the scant funding for advanced, or longer-term, higher-risk research. The creation of the Exploratory Advanced Research Program (EARP) in SAFETA-LU is a step in the right direction. In its 2001 report, the RTCC recommended that 25 percent of the FHWA program be devoted to "longer-term, higher-risk" research. Applied research is the central element of the federal program, and it should be, but it is also incremental in nature. Such research is unlikely to result in breakthroughs that can transform practice. At present the EAR program represents about six percent of FHWA's overall program. It is a good start, but far from the goal the RTCC has suggested.¹⁵

The RTCC's 2008 report recognizes the role that the UTC program could be playing in advanced research. Universities are ideally suited for creating new knowledge and understanding, and the UTC program is one of the few surface transportation research programs that can fund investigator-initiated research. The RTCC finds, however, that the UTC program is mostly conducting applied research. A scan of highway research projects under way in the UTC program indicates that at least 80 percent are highly applied.¹⁶ The RTCC concludes that the dollar-for-dollar matching requirement of the UTC program drives it toward applied research. Most of the providers of matching funds are state DOTs, which they typically provide from SP&R funds, and they tend to want their SP&R funds devoted to solving the many immediate problems they face. An important reform of the UTC program recommended by the RTCC is to change the matching requirement to a 20 percent university match. This would free up universities to devote more of their available funding to the kind of advanced research the program was created to conduct in the first place. At the same time, of course, the UTCs should be selected competitively, rather than having 62 percent earmarked.

Another weakness of the structure of the program is the relative neglect of policy research. Many important transportation policy questions are going uninvestigated because of lack of any funding for this purpose, forcing infrastructure owners to make decisions while ill informed. This is the kind of research that ought be conducted to guide decisions about intermodal investments, such as inter-city passenger rail, improved highway access to ports, short-sea shipping, and policies to enhance the effectiveness of transit. The lack of policy relevant research significantly hampered the work of the two commissions Congress created in SAFETEA-LU to advise it on, among other things, the future viability of motor fuels taxes to fund highway and transit infrastructure. Gaps in knowledge about how sensitive travelers are to rising fuel prices and increased congestion, or how freight traffic might switch modes for these same reasons, for example, undermine confidence in projecting future revenue streams for the highway trust fund, which is one of the key policy con-

¹⁵ There are earmarked programs that are addressing, in part, advanced research in asphalt. The RTCC, however, recommends that advanced research conform to the principles Congress established in Title V—that funds be awarded based on competition and merit review of proposals by peers.

¹⁶ *The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses*, Special Report 295, Transportation Research Board of the National Academies, Washington, D.C., 2008, p. 76.

cerns for reauthorization of the highway program in 2009. Policy funding was reduced to almost zero as a result of the over-designation and earmarking of funds in Title V. Funding that had been about \$9-10 million annually was eliminated. Last year's technical corrections legislation helped, but restored but \$1 million annually for the Office of Policy.

Much greater emphasis on data collection is also necessary. Being able to answer many of the most important policy questions in highway transportation requires much better data. Research in the planning area to develop the advanced modeling tools needed to meet federal and local planning and environmental mandates also require better data. States and MPOs rely heavily on the National Household Transportation Survey, which was dropped by the Bureau of Transportation Statistics (BTS), whose funding was also sharply reduced in S-LU. (Fortunately FHWA and other administrations within USDOT have stepped in to provide stop-gap funding to maintain this critical survey.) Similarly, improved, and more timely, data on freight movements is essential for improved planning; the Commodity Flow Survey, which is still part of BTS's portfolio but nonetheless underfunded, should be sustained and enhanced to meet user requirements.

Proposals already circulating that address reauthorization of the surface transportation program, including the reports of both SAFETEA-LU commissions, recommend that the federal-aid program become performance based. A true system of performance measures will create enormous new demand for better data on inventory condition and value, real-time system performance, safety, environmental protection, and other performance metrics.

Technology transfer is another area of weakness, as I explain in response to Question 3.

3. *How can we improve the transfer of transportation technology from the R&D stage to deployment and adoption in the field? As we prepare for major investment in infrastructure, how do we ensure that the latest proven technologies are utilized?*

Deployment of new technology and practice does not receive the attention it deserves. It is important to recognize, however, that FHWA does carry out considerable technology transfer activities. FHWA has extensive information on its program office web pages about new techniques, as well as technical briefings, manuals, and implementation guidance. These activities are partially funded with R&D funds. FHWA also administers the Local Technical Assistance Program (LTAP) and offers training on new technologies and practices through the National Highway Institute. FHWA's field offices in every state are also sources of information for State practitioners. These activities, however, are not sufficient.

FHWA formerly had resources explicitly devoted to technology transfer, which were lost in 1998 in TEA-21, and the office that had specialized in this activity was subsequently disbanded.¹⁷ FHWA then allocated technology responsibilities to program offices in concert with the office of research and technology, but this responsibility was added to other responsibilities of FHWA's existing staff. The barriers to innovation, however, are high and the expertise required for successful technology transfer requires a strategic plan, dedicated and expert staff, and adequate resources to overcome these barriers.¹⁸ The SHRP 2 implementation report provides a model of what is required to assist the states in deploying new technologies and practices. In addition, the RTCC's report indicates that adoption of innovations may require incentives that reduce the risk of trying something new. FHWA used to have resources, for example, that would allow 100 percent federal funding for implementing promising, but not quite fully proven, technologies or techniques.

4. *What are some of the lessons learned from the last reauthorization of the highway bill (SAFETEA-LU)? What improvements can we make?*

The principles for research articulated in the preamble to Title V of SAFETEA-LU are good ones and I hope they will be retained and followed. They encourage stakeholder involvement, competitive award of funding based upon merit review, advanced research, and a federal program that spans the entire innovation process. There are, however, too many designated programs and earmarks in SAFETEA-LU that constrain FHWA and RITA from carrying out a research programs consistent with these principles, reduces funding to core mission activities of FHWA, and deny the agencies flexibility in responding to emerging issues and the needs of stakeholders.

¹⁷ *Managing Technology Transfer: A Strategy for the Federal Highway Administration*, Special Report 256, Transportation Research Board of the National Academies, Washington, D.C. 1999.

¹⁸ *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life*, Chapters 6 and 7.

In terms of other improvements, I refer back to the committee recommendations from the two reports summarized in the previous section.

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All documents are available on TRB's website, *TRB.org*. Most are available as PDF files for download. Congressional staff can receive free paper copies upon request.

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BIOGRAPHY FOR ROBERT E. SKINNER, JR.

Robert Skinner has been the Executive Director of the Transportation Research Board (TRB) of the National Academies since 1994. TRB is a non-profit organization that promotes transportation innovation by sponsoring professional meetings and publications, administering applied research programs, and conducting policy studies. It serves as an independent adviser to the Federal Government and others on scientific and technical questions of national importance.

Prior to becoming Executive Director, Mr. Skinner directed TRB's policy study activities. Before joining TRB in 1983, Mr. Skinner was a Vice President of Alan M. Voorhees and Associates, a transportation consulting firm.

Mr. Skinner recently served on the Metrolink (Los Angeles) Commuter Rail Safety Review Panel and chaired the Special Advisory Panel for the Stem-to-Stern Safety Review of the Boston Central Artery/Tunnel Project. In addition it serves on a number of university and research advisory groups including the Board of Trustees for the School of Engineering and Applied Sciences at the University of Virginia, the Advisory Board for the Center for Urban Transportation Research at the University of South Florida, the External Review Committee for the MIT–Portugal Project, and the Advisory Board for the School of Public Policy at George Mason University.

Mr. Skinner earned his Bachelor's degree in civil engineering from the University of Virginia and received a Master's degree in civil engineering from the Massachusetts Institute of Technology. A registered professional engineer, Mr. Skinner received the James Laurie Prize from the American Society of Civil Engineers in 2003.

Chair Wu. Thank you very much, Mr. Skinner.
Mr. Wise.

STATEMENT OF MR. DAVID J. WISE, ACTING DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. WISE. Chair Wu, Ranking Member Smith, and Members of the Subcommittee, thank you for the opportunity to discuss research and development and technology coordination and evaluation at the Department of Transportation. RD&T (Research, Development, and Technology) activities are vital to meeting DOT's transportation priorities such as increasing safety, enhancing mobility, and supporting the Nation's economic growth.

DOT's budget in this area totaled about \$1.1 billion in fiscal year 2008, primarily for projects undertaken by the Federal Highway Administration and the Federal Aviation Administration (FAA). Over the years we and others have raised concerns about DOT's capacity to improve RD&T coordination and evaluation across the agency. As a result, in 2004, Congress created the Research and Innovative Technology Administration, RITA.

My testimony has two parts. I will discuss, one, the importance of coordinating and evaluating RD&T to ensure federal dollars are used effectively and efficiently, and two, the progress RITA has made implementing the seven recommendations in our 2006 report on coordination and evaluation of transportation and research at DOT.

On the first point, in today's environment of expected trillion dollar deficits and stimulus spending, the need for careful RD&T decisions is more critical than ever. Coordinating and evaluating research are key elements to federal stewardship of taxpayers' money. The Committee on Science Engineering and Public Policy, a joint committee under the auspices of the National Academies of Science, has recommended a formal research coordination process to enhance collaboration, explore research questions, and reduce inefficiencies.

In addition, the committee notes that evaluating the agency's research against established performance measures helps assess research quality and achieve agency goals.

In the same vein, the *Government Performance and Results Act* (GPRA) of 1993 requires federal agencies to set performance goals and measure performance against those goals to ensure the effectiveness of federal investments. GPRA's emphasis on results suggests that federal programs contributing to the same or similar outcomes should be closely coordinated to ensure the goals are consistent and complimentary and that program efforts are mutually reinforcing.

On the second point, while we have not performed new assessments of RITA since our 2006 report, we have tracked the seven recommendations from that report. These seven recommendations are summarized in the table on pages three and four of my written statement.

RITA has implemented five of the recommendations aimed at preventing duplication of research efforts, ensuring research is evaluated in accordance with established best practices, establishing database systems to inventory and track research, communicating research evaluation efforts to Congress, and documenting the process for evaluating the results of multi-modal research pro-

grams. RITA has implemented a strategy consisting of ongoing internal reviews to coordinate RD&T activities and look for areas where joint efforts would be appropriate.

RITA has partially implemented the two other recommendations directing it to develop performance goals and overall implementation strategy, an evaluation plan, and performance measures. As a result, it is still a challenge for RITA to determine its relative success overseeing the effectiveness of RD&T activities.

In conclusion, since becoming operational in 2005, RITA has made progress towards becoming a DOT-wide resource for managing and determining effectiveness of RD&T activities. We will continue to monitor RITA's efforts to implement our two open recommendations. We look forward to assisting Congress as it considers RITA's activities during the reauthorization process.

Mr. Chair, this concludes my statement. I would be pleased to answer any questions you or Members of the Subcommittee may have.

[The prepared statement of Mr. Wise follows:]

PREPARED STATEMENT OF DAVID J. WISE

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to participate in this hearing on the Department of Transportation's (DOT) research, development, and technology (RD&T) activities. RD&T activities are vital to meeting DOT's transportation priorities, such as increasing safety, enhancing mobility, and supporting the Nation's economic growth. In fiscal year 2008, the department's RD&T budget totaled over \$1.1 billion, primarily for projects undertaken by DOT's Federal Highway Administration and Federal Aviation Administration. Coordinating RD&T throughout DOT and reviewing it to make sure that it is evaluated is important to ensure the efficiency and effectiveness of RD&T investment.

Over the years, we and others have raised concerns about DOT's capabilities for improving RD&T coordination and evaluation across the agency.¹ In part to ameliorate those concerns, in 2004 Congress created the Research and Innovative Technology Administration (RITA).² RITA is responsible for coordinating, facilitating, and reviewing the department's RD&T programs and activities to identify research duplication and opportunities for joint efforts and to ensure RD&T activities are meeting intended or other goals. These include activities conducted by DOT's operating administrations as well as other RD&T and statistical programs managed by RITA (e.g., the Bureau of Transportation Statistics and University Transportation Centers). RITA carries out its responsibilities through multiple groups and actions, including its two coordinating bodies—the RD&T Planning Council and Planning Team—and budget reviews. While RITA has DOT-wide responsibilities, it does not have the authority to direct changes in the operating administrations' RD&T activities. In 2006, we reported on RITA's progress in overseeing RD&T activities and made seven recommendations to enhance RITA's ability to manage and ensure the effectiveness of these activities.³

My testimony today addresses the importance of coordinating and evaluating RD&T so that federal dollars are used efficiently and effectively, as well as RITA's progress in implementing our 2006 recommendations. It is based primarily on our 2006 report, a review of best practices for coordination and evaluation, and follow-up discussions with RITA officials on actions taken on our recommendations. We have not assessed whether RITA's actions have improved the effectiveness of the department's RD&T investment since our 2006 report. We conducted this work in January and February 2009 in accordance with generally accepted government auditing

¹GAO, *Transportation Research: Actions Needed to Improve Coordination and Evaluation of Research*, GAO-03-500 (Washington, D.C.: May 1, 2003).

²The Norman Y. Mineta Research and Special Programs Improvement Act of 2004, which also dissolved RITA's predecessor administration, the Research and Special Programs Administration.

³GAO, *Transportation Research: Opportunities for Improving the Oversight of DOT's Research Programs and User Satisfaction with Transportation Statistics*, GAO-06-917 (Washington, D.C.: Aug. 15, 2006).

standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Coordination and Evaluation of RD&T Activities Help Promote Efficient and Effective Use of Federal Research Funds

Coordinating and evaluating research are important elements in ensuring federal dollars are used efficiently and effectively. RITA is responsible for coordinating and reviewing the DOT operating administrations' RD&T activities so that (1) no unnecessary duplication takes place and (2) the activities have been evaluated in accordance with best practices. The Committee on Science, Engineering, and Public Policy—a joint committee of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine—has emphasized the importance of careful coordination and focused evaluation of federal research and developed principles to help agencies evaluate their research programs.⁴ The committee recommended establishing a formal process to coordinate research across agencies. While this recommendation is focused on cross-agency research, the goals—enhancing collaboration, ensuring that questions are explored, and reducing inefficiencies—are important and applicable within agencies as well. Coordination of research ensures that information is shared so that, if necessary, research can be adjusted to ensure a field is appropriately covered and understood. In addition, the committee noted that evaluating research against established performance measures in agency strategic plans, developing measures that are appropriate for the type of research being developed, and using expert reviews aid in assessing the quality of the research.

Relatedly, the *Government Performance and Results Act of 1993* (GPRA) requires federal agencies to set performance goals and measure performance against those goals to ensure the effectiveness of federal investments. GPRA's emphasis on results implies that federal programs contributing to the same or similar outcomes should be closely coordinated to ensure that goals are consistent and complementary, and that program efforts are mutually reinforcing.

Making appropriate and cost-effective investment choices is an essential aspect of responsible fiscal stewardship. Such choices are even more important in today's climate of expected trillion-dollar deficits. Careful decisions will need to be made to ensure that RD&T activities achieve their intended (or other) purposes and do so efficiently and economically.

RITA Has Made Progress in Improving Its Coordination, Review, and Performance Measurement of DOT's RD&T Programs

In 2006, we made seven recommendations to enhance RITA's ability to manage and ensure the effectiveness of RD&T activities, including developing strategies for coordinating and reviewing RD&T activities and developing performance goals and measures. (See Table 1.) RITA has implemented five of our recommendations and is making progress on implementing the remaining two.

⁴Committee on Science, Engineering, and Public Policy, *Evaluating Federal Research Programs: Research and the Government Performance and Results Act* (Washington, D.C.: February 1999).

Table 1: Status of RITA's Implementation of GAO's 2006 Recommendations

Recommendations	Status
Develop and incorporate into RITA's annual budget process and the RD&T strategic plan:	
• a strategy for identifying and reviewing all of DOT's RD&T projects to determine areas of unnecessary duplication, overlap, and opportunities for joint efforts	Implemented
• a strategy to ensure that the results of all of DOT's RD&T activities are evaluated according to established best practices	Implemented
• a DOT-wide database of all of DOT's RD&T projects that will support RITA's coordination, facilitation, and review efforts and will assist in the implementation of the strategies discussed above	Implemented
• a summary of all of DOT's RD&T program evaluations, including ongoing and completed evaluations, and a schedule of future evaluations	Implemented
• a description of RITA's process for systematically evaluating the results of its own multimodal research programs and how this process will be applied to future multimodal research programs that RITA conducts	Implemented
Develop and incorporate the following into RITA's year annual budget process:	
• performance goals, an overall implementing strategy, and an evaluation plan that delineate how the activities and results of its coordination, facilitation, and review practices will further DOT's mission and ensure the effectiveness of the department's RD&T investment	Partially implemented
• common performance measures related to DOT's RD&T activities, which should be developed in consultation with the operating administrations	Partially implemented

Source: GAO analysis of RITA information.

RITA Implemented a Coordination and Review Strategy, Developed a DOT-wide Database of RD&T Activities, and Communicated Results of Evaluations

Preventing duplication of effort. In response to our recommendation, RITA developed a strategy to ensure that no unnecessary duplication of research programs occurs within the department, incorporated the results into various high-level DOT planning documents, and reported the results in its strategic plan. RITA's strategy consists of ongoing internal reviews of all of DOT's research programs. These reviews are conducted by (1) convening meetings in which officials from each of the operating administrations share information about areas of ongoing and planned research, seeking opportunities for joint effort, and (2) conducting annual reviews of each operating administration's research plans, looking for research duplication, among other things. In addition, RITA has formed eight working groups, in concert with DOT's operating administrations, to foster collaboration on cross-modal issues. According to a RITA official, results of these reviews have identified several areas for cross-modal collaboration, including climate change, freight capacity, security, alternative energy technologies, and advanced materials and sensors. According to RITA officials, as a result of these actions, RITA is better able to meet legislative and DOT requirements for coordinating its research, leverage resources for cross-modal research initiatives, and prevent unnecessary research duplication.

Following best practices. RITA also developed a strategy to ensure that the results of all DOT's research activities are evaluated according to established best practices. The strategy includes three primary mechanisms: (1) ensuring systematic application of the Office of Management and Budget's Research and Development Investment Criteria (relevance, quality, and performance) and the Program Assess-

ment Rating Tool by the operating administrations;⁵ (2) annual internal program reviews with self-reporting by the operating administrations; and (3) documenting the operating administrations' external stakeholder coordination and review. According to RITA, reviews conducted in fiscal years 2007 and 2008 focused on how well the operating administrations are implementing best practices, including external stakeholder involvement, merit review of competitive proposals, independent expert review, research performance measures, and external research coordination. RITA reports the results of its reviews to the department's RD&T Planning Council, which consists of administrators from each of the operating administrations, including RITA, and officials from DOT's Office of the Secretary. According to RITA officials, as a result of these efforts, RITA is better able to determine the quality and effectiveness of its research activities and investments and determine whether they are achieving their intended (or other) goals.

Establishing RD&T project databases. RITA created two database systems to inventory and track all of DOT's research activities and provide tools for querying and searching individual projects to identify potential duplication and areas where operating administrations could collaborate. The first database, the RITA Research Notification System, captures research investments at the transaction level, allowing users to search by activity, contracts and grants, and contractor names, enabling identification of funded programs for coordination, collaboration and review. The second database is part of the annual Research Planning and Investment Coordination (RPIC) process, which captures research at the budget request level, allowing for department-wide transparency and coordination of proposed programs and projects. According to a RITA official, eventual combination of the two databases will offer a mechanism for measuring and tracking investments from request through funding and execution.

Communicating evaluation efforts. To communicate its efforts in evaluating DOT's research to Congress, senior DOT officials, and the transportation community, RITA and its predecessor organization published a summary of all research program evaluations for 2004 through 2006 and included that summary in a high-level DOT planning document and in a report to Congress. First, RITA's predecessor published what was essentially a summary of all research program evaluations conducted in fiscal year 2004—in the form of a summary of the results of its review of the operating administrations' application of the Office of Management and Budget's Research and Development Investment Criteria—in its 2005 annual RD&T plan. Secondly, RITA developed a summary of the results of its fiscal year 2005 and 2006 research program reviews, and a schedule of RITA's planned fiscal year 2007 reviews, and included it in DOT's *Research, Development and Technology Annual Funding Fiscal Years 2006–2008, A Report to Congress*.⁶ This report also includes summaries of research program evaluations conducted by modal research advisory committees, the Transportation Research Board, and key modal stakeholders in fiscal years 2006 and 2007. According to RITA officials, as a result of this reporting, RITA has provided better continuity and context to Congress and the transportation community about the results of its research evaluations.

Documenting processes. RITA has also acted to document its process for systematically evaluating the results of its own multi-modal research programs, such as the Hydrogen Safety Program and various grant programs. RITA evaluates the results of its RD&T activities by ensuring they align with DOT goals, meet the research and development investment criteria, and are subject to an annual peer review process. RITA has documented this process in its strategic plan.

RITA Has Not Yet Developed an Overall Implementing Strategy, Evaluation Plan, or Performance Measures

Establishing performance goals. In 2006, we found that RITA lacked performance goals and an implementing strategy and evaluation plan to delineate how the activities and results of its coordination, facilitation, and review practices will further DOT's mission and ensure the effectiveness of the department's RD&T investment. RITA has partially implemented our recommendation that it develop these elements. Setting meaningful goals for performance, and using performance infor-

⁵ According to the Office of Management and Budget, these criteria are rooted in best practices and include peer review as a mechanism for assessing program quality. The Program Assessment Rating Tool was developed to assess and improve program performance to inform funding and management decisions. It consists of a series of questions covering program purpose and design; performance measurement, evaluations, and strategic planning; program management; and program results.

mation to measure performance against those goals, is consistent with requirements in GPRA. Developing an evaluation plan and analyzing performance information against set goals for its own coordination, facilitation, and review practices could assist RITA in identifying any problem areas and taking corrective actions.⁶ Linking performance goals with the planning and budget process, such as DOT's annual budget process, can also help RITA determine where to target its resources to improve performance.⁷ Guidance provided by the Committee on Science, Engineering, and Public Policy notes that evaluating the performance of research in the context of the strategic planning process ensures the research is relevant to the agency's mission.⁸ Without such goals and an evaluation plan, it is difficult for RITA to determine its success in overseeing the effectiveness of DOT's RD&T activities.

According to RITA officials, while an overall implementing strategy and evaluation plan has not yet been established, RITA has created performance goals. A RITA official told us that the RPIC process—a relatively new process that integrates the budget and strategic planning processes—will help in creating an implementing strategy. The RPIC process is meant to provide information to the Planning Council and Planning Team, which is responsible for defining the department's overall RD&T strategic objectives. The RPIC process assesses the department's RD&T activities in terms of the following performance goals: (1) balanced portfolio (e.g., mix of basic, applied, developmental, and high risk RD&T), (2) alignment of RD&T programs with DOT goals and each operating administration's mission, and (3) return on investment. The RPIC process has been in place only for fiscal year 2009, and as a result, the Planning Council does not yet have the information needed to make decisions about a strategy. In addition, RITA does not yet have an evaluation plan to monitor and evaluate whether it is achieving its goals. A RITA official told us that the RPIC process needs to be in place for two or three fiscal years before it can provide enough information for RITA to establish a strategy or evaluation plan.

Developing performance measures. In 2006, we also found that RITA did not work with the operating administrations to develop common performance measures for DOT's RD&T activities. According to RITA officials, RITA has partially implemented our recommendation that it do so. Without common performance measures for the RD&T activities of the operating administrations, RITA and the operating administrations lack the means to monitor and evaluate the collective results of those activities and determine that they are achieving their intended (or other) results and furthering DOT-wide priorities. In response to our recommendation, RITA officials told us that they are working with the operating administrations through the RD&T Planning Team—made up of senior officials in RITA and each of the operating administrations. During Planning Team meetings, representatives from each of the operating administrations share information about how RD&T projects are measured and prioritized. For example, according to a RITA official, the Federal Railroad Administration measures how frequently its RD&T projects are used in real-world applications. Once representatives from each operating administration have had the chance to share information, RITA officials will then look for commonalities and determine whether any of the measures could be adopted for the department's RD&T activities.

In closing, since it became operational in 2005, RITA has taken a number of positive steps to meet its vision of becoming a DOT-wide resource for managing and ensuring the effectiveness of RD&T activities. While we have not assessed the effectiveness of these efforts since our 2006 report, we believe that RITA has made progress. We will continue to monitor RITA's performance in implementing our recommendations. As reauthorization approaches, we look forward to assisting Congress as it considers RITA's management of DOT's research program, to better ensure that taxpayers receive the maximum value for DOT's RD&T investment.

Mr. Chairman, this concludes my prepared statement. I would be pleased to respond to any questions that you or other Members of the Subcommittee might have.

⁶ Use of performance goals can help ensure that programs are meeting their intended goals, allows programs to assess the efficiency of their processes, and promotes continuous improvement. Where activities may be fragmented or overlap, performance information can also help identify performance variations and redundancies and lay the foundation for improved coordination, program consolidation, or elimination of unneeded programs. GAO, *Managing for Results: Using the Results Act to Address Mission Fragmentation and Program Overlap*, AIMD-97-146 (Washington, D.C.: Aug. 29, 1997).

⁷ GAO, *Managing for Results: Enhancing Agency Use of Performance Information for Management Decision-making*, GAO-05-927 (Washington, D.C.: Sept. 9, 2005).

⁸ Committee on Science, Engineering, and Public Policy, *Evaluating Federal Research Programs: Research and the Government Performance and Results Act* (Washington, D.C.: February 1999), 37-38.

BIOGRAPHY FOR DAVID J. WISE

Dave Wise began his career with GAO in 1981. He worked at GAO until 1991, including a four year tour in GAO's former Far East Office in Honolulu, Hawaii. Dave then moved to the Department of State's Office of Inspector General, where he specialized in reviews of consular and international programs, with a focus on counter-narcotics. In 2000, Dave became a Foreign Service Officer, serving tours as (1) political officer/narcotics coordinator in Hanoi, Vietnam; (2) Director, Narcotics Affairs Section, Vientiane, Laos; and (2) political advisor, Provincial Reconstruction Team, Helmand Province, Afghanistan.

Dave returned to GAO as a Senior Executive Service candidate in September 2007, where he is working with GAO's Physical Infrastructure team on surface transportation, communications, and real property issues.

Dave has a BA in political science from the University of Pittsburgh and an MA in public administration from Pitt's Graduate School of Public and International Affairs.

DISCUSSION

Chair Wu. Thank you very much, Mr. Wise, and now we will open for our first round of questions, and I recognize myself for five minutes.

Mr. Brubaker, you referred to some of the challenges that you faced as head of RITA, and Mr. Wise, you have—you and your organization have performed a lot of analysis on RITA's functions. There has been some reference to RITA's responsibilities versus its authority to implement what it is responsible for.

Mr. Brubaker, would you care to expand on your experiences in facing the frustrations of that, and Mr. Wise, if you would care to join in or any other of the panelists.

Mr. BRUBAKER. Sure. You know, I said sometimes being at RITA I sort of felt like John Belushi in the movie "Animal House" where he runs out of the room, and he says, "Let's do it," and nobody follows him. That is kind of how it felt dealing with some of the cultural obstacles that we faced in the Department.

We do have, frankly, the responsibility and the authority. The legislative authority is very clear about what we are supposed to do. What we ran into were some cultural obstacles to change, and I have got to tell you, I am kind of shocked, and GAO is used to getting criticized sometimes, and they are going to feel weird because I am a little critical that we actually met five of their open—their recommendations of the seven and partially achieved two of them. I would strongly suggest they go back and really take a hard look at all seven of those vis-à-vis RITA and see really the—and make a judgment on the efficacy of how we responded because—

Chair Wu. So you are actually saying GAO might have been too generous.

Mr. BRUBAKER. I think they were, frankly. There are, I mean, they may not have reviewed, we may have just done a really good job of responding to the open recs or something, but the reality from my perspective was there was just so much more we could have done from a select control evaluate perspective of the research portfolio. But we ran into every mode sort of wanting to play hide the ball and protect their existing portfolio of research. It made it very, very difficult to ensure that the underlying research was strategically relevant.

Now, we did, like I said in my opening testimony, we did achieve a level of transparency. We know what the underlying research

projects are, but we have made no value judgment relative to how they fit in the overall strategic direction. Do they plug in nicely to the strategic buckets that are described in the strategic plan? Yeah. We were able to force-fit most of that research, but the grim reality in my perspective is that we weren't particularly effective at creating a process by which we could actually control the research through its execution and then evaluate it in terms of outcomes.

Chair WU. What mechanisms do you think RITA needs to implement, to achieve that?

Mr. BRUBAKER. It is like my good friend, Lieutenant General Bob Shay always used to say. At the end of the day it comes down to leadership. I think there is a leadership issue where the, you know, you have got to have strong leadership in the RITA position, you have got to have accepting leadership among the modes, you have got to have strong leadership at OSC (Office of Special Counsel) where the Secretary says thy will be done, to push the authorities and to ensure that the authorities are actually executed.

At the same time, I think there are some structural things that are missing. Like I said, the National Transportation Research Agenda. I don't see that. You know, we have got this RD&T Strategic Plan, and frankly, again, the first pass at it was a force-fit of all the existing research into the strategic plan of the Department. It didn't really reflect a strategic direction or a very good alignment of research, the research portfolio to achieving the objectives of the Department. That is what has got to happen, but it has got to be broader than the objectives of the Department. It has got to take into account stakeholders, universities, users, economic development people, because the transportation infrastructure is so critical to the economic health and well-being of this nation.

We saw it over the summer when fuel prices went up, you know, astronomically. We saw the impact that that had, and frankly, I think we are still feeling the effects of that increase. What would have been great had, if we would have had the data and the research capacity to do modeling and simulation and be able to understand the impact that that would have on the supply chain, on modal choices, and ensure that we were responding appropriately. And we just simply didn't have that knowledge because we have never laid it out that that is strategically important.

Chair WU. Mr. Wise, I want to give you a cut at it, and a couple of you also referred to cultural issues in research. I want to finish up that—with that—and I will also announce from the Chair that it is my intention to use a soft gavel on this hearing since there are only three of us here, but there will be a gavel, but please proceed with a set of answers about this topic and the cultural issues. And then we will proceed to Mr. Smith.

Mr. Wise.

Mr. WISE. Thank you, Mr. Chair. Also thanks to Mr. Brubaker for his frank opinions and interest in the GAO report from 2006. I think it is important to make a point that when we did this work, which is now probably just over—about four years ago, RITA had just stood up. It was a new organization, and essentially we were looking, it had just taken the place, after the Mineta Act of the, of RSPA (Research and Special Projects Agency). And we were basi-

cally looking to see that processes were in place to do the mission that it was set up to do.

Quite frankly, we have not been, other than following up on the recommendations that indicated these processes are in place, we have not really done a formal assessment to go back and see how well the organization is actually carrying out all its responsibilities. That is something that if the Committee were interested that maybe would be a useful project as the Committee sees fit.

So in that respect it is difficult to give a learned assessment of how well RITA is doing, because it really wasn't the focus of what we did in that 2005/2006 work.

Chair Wu. And before we finish, anyone who wishes to address the inertia or the cultural issues, and I heard that mentioned by more than one witness.

Dr. Deakin, please.

Dr. DEAKIN. It seems to me that the cultural issue is really very serious, actually, and we have organizations that are modeled in many cases for building the interstate highway system, and they haven't really changed the organizational structure much since. They are very hierarchical. They are rather slow in being able to respond to things. They are pretty top-down. That is not true across the board. Some agencies have actually tried to innovate the organization structure, but it is pretty true for a lot of these agencies, and there isn't any real incentive for change, partly because there is no outcome focus in the legislation and partly because there is no outcome focus in the State legislation saying you have to show what you are actually producing in terms of cost effectiveness of the investments, producing outcomes like economic prosperity, lower costs for users, environmental quality improvements that you can measure and demonstrate, greenhouse gas reductions, more equity in your system. We could give them those kinds of mandates and say we want reports to come back and tell us what these are going to look like, and we haven't really done that.

Now, Congress did that with reports on the state of infrastructure some years ago, and it took awhile for all the states to get used to having to collect it and report it. They didn't always do it well, but gradually they all got so they were reporting these data, and those data have been very useful. So, again, giving them a mandate and saying, do this, let the best states do what they are already doing, and it gives everybody else a push. Everybody does better, and you actually could measure outcomes and not just dollars spent and, you know, what is being turned over but see what we are actually accomplishing with these investments.

So I think Congress could take leadership on giving us some clear mandates to show what we are producing. Thank you.

Chair Wu. Mr. Skinner, if you—

Mr. SKINNER. Just very briefly. I think Dr. Deakin is correct in relating—

Chair Wu. Microphone.

Mr. SKINNER. Excuse me. I think Dr. Deakin is correct in relating the cultural challenges to the institutional challenges that we have, and one could imagine an institutional arrangement that is not nearly so decentralized without so many thousands of players who are—who own our transportation system. We could imagine

that, and we might think that it would be more effective, not only for research but for managing and operating our transportation system.

And that may be true, and that is a big question. But from the research perspective, research is unlikely to drive that change in the institutional arrangements. And so the research community is confronted with this enormous technology transfer challenge, and so this, the question of stakeholders and how to involve them and how to have them meaningfully connected to the products—and connected so that when products come out they are all ready, the skids are already greased for them to implement and try these products, that is a critical feature of any strategic approach to R&D and surface transportation.

Chair WU. Thank you very much, Mr. Skinner. We may return momentarily to these cultural issues before we move onto some of the output and matrix sides, and meanwhile, I want to recognize other Members of the panel, particularly Mr. Smith, who has been very forbearing in permitting this series of answers be completed.

Mr. Smith.

Mr. SMITH. Thank you. I—this is all very interesting, especially as a relatively new Member to listen to the various challenges, and I appreciate your willingness to tackle these. And I think it speaks to kind of the largeness of the issue, the complication of the issues, not even to mention funding, that, funding of research, and then funding of carrying out that research in a useful manner. And in a way that leverages other opportunities.

I know that we had some controversy in Nebraska when the director or, well, when a person said that the Department of Roads in Nebraska really wasn't in the economic development business. And you can imagine that there was some resistance to that statement and for good reason. And when I look at the various issues, whether it is the energy issue of our vehicles, we have much different issues in rural America than urban, wherein urban America we subsidize less vehicle travel and virtually in rural America we subsidize more vehicle travel with various roads and systems.

A hybrid, for example, the benefits are less meaningful when a commute is done at 65 miles an hour or maybe a few more miles per hour on the way to work and home. So the benefits are certainly less. So we—I think we need to allow some flexibility.

That being said, Dr. Deakin, if you would perhaps point to maybe a specific research project that you could identify where many of the obstacles that have been mentioned here have taken place, maybe how you would change things but maybe a specific project as tangible as possible, if you could elaborate.

Dr. DEAKIN. Yeah. I would be glad to. The project that was mentioned by several people at our research was the installation of call boxes along part of the freeway system in Northern California at a time when wireless technology, cell phones, were proliferating already, and the call boxes I think had a useful life of about 15 minutes—a very, very short period because by the time they were actually out there along the road, most people were already using cell phones.

So it really wasn't paying attention to market. The project got put in a pipeline and pushed through because the money was

there, it had been allocated, and you know, you get in a program or projects. But it wasn't an effective investment of the funds.

That is a situation where I think that the remedy is pretty obvious. If there had been more discussion with the cell phone companies about the technologies they were developing—and we were sitting right there with Silicon Valley people who know about marketing for these things.

I disagree a little bit with Bob Skinner. I think there is a lot of research on how to change institutions, done by business schools, not in transportation institutions necessarily, but making those connections could happen.

I think there are opportunities to begin to think about how to really bring private marketing, private knowledge about markets and also university research on institutional change and markets into play much more than we have, and that is how I would fix that kind of a problem.

Mr. SMITH. Okay. Thank you. That is a perfect example. I appreciate hearing that.

In, even in places other than Nebraska, I am sure, we have what I think is a response to gridlock that is very reactive in nature. It is kind of like, well, let us wait for the problem to form and then we will solve it.

I guess, Mr. Brubaker, if you wouldn't mind responding to how we could get beyond that, what obstacles you currently see in place. I know it is going to be funding, you know, a part of that, but, again, I would say with the funding issue, I mean, the more successful we are with conservation measures when we fund our roads with a per-gallon fuel tax and there are fewer gallons being used but yet more vehicles, more tires on the road, wheels on the road, that is not a sustainable formula. If you could respond.

Mr. BRUBAKER. Sure. I just, you know, at the end of the day, yeah. Everything winds up being a resource issue, but it could be a resource allocation issue of existing resources to solve things like congestion or, for example, I mean, you heard Bob Skinner mention, you know, \$400 million unencumbered for SHRP. Well, you know, that is all fine and good, but is the \$400 million better spent in some other areas, like, for example, congestion mitigation, for example, rural safety research that involves more than just roads. It can involve some other things. It can involve some behaviors, human factors stuff.

It is not all about the hockey pucks. I mean, you know, the—sorry—the concrete research. I mean, I am all about, you know, it is great to have different types of asphalt and appreciate all the geographic disparity and the reasons to better understand and spend money on research for concrete and asphalt, but, you know, we have got to kick it up a higher level and look at this more holistically like you say in terms of, you know, what we can do and where we are best spending that limited resource that we already have before you start talking about more money.

Mr. SMITH. Okay. Anyone else wish to respond.

Mr. Skinner.

Mr. SKINNER. Let me just, since it was mentioned, the Strategic Highway Research Program implementation effort is not directed at concrete and asphalt research. It is a large-scale safety accident

causation project, and a large project aimed at renewing our highways in a more accelerated manner with less disruption, longer-lasting afterwards. Another piece is dealing with non-recurring congestion incidents and the like and figuring out ways to reduce that element of congestion. And another piece that is oriented towards planning and environment is looking to streamline ways to plan for new capacity in a more environmentally-sensitive and community-sensitive manner.

I think all those things would fit within strategic objectives that one would come up with for the Department as a whole and our transportation system.

Mr. SMITH. Okay. Thank you. I will have more questions later.

Chair WU. Thank you, Mr. Smith.

Mr. Lipinski. Please proceed.

Mr. LIPINSKI. Thank you, Mr. Chair, and thank you for holding this hearing early on. I know that this is an issue that is really very important to me being not only on the Science and Technology Committee but also on the Transportation Committee. I also have a background in engineering. I studied something called engineering economic systems, which was what it used to be called at Stanford, but there is a lot of operations research, optimization, all kinds of puzzles trying to—we worked on trying to solve, trying to give us the skills to solve these puzzles, which really relate very well here when talking about transportation.

There are, you know, endless possible goals that we could have, and I think it is very important that we are here talking about what these are. I mean, are we just going after, you know, trying to lessen the traffic congestion? Are we trying to cut down on fuel usage? Are we trying to make the roads safer? Then other questions of, you know, talking, besides talking about roads, are we talking about rail? What about just general inter-modal, you know, transportation and not just for people but also for freight.

And you can get into endless questions here, which—and we could so much better, I think, be using our transportation system that we have and planning our transportation system if we really got our hands around some of these issues.

And I am very happy to be here in the Science and Technology Committee and hear a witness talk about how crucial—Mr. Brubaker did—how crucial transportation is to the economy. I hear that all the time in the Transportation Infrastructure Committee but not oftentimes here. So it is good to hear that here.

So I just wanted to—there are so many different things that we could talk about, but I just want to, first of all, a question for Dr. Deakin and anyone else who wants to respond. Are we really making sure or how can we make sure we get the best bang for our buck from money that we are spending here? You know, there are a lot of great ideas, and as you put out that example there, where we put the call boxes out on the road, but we missed the fact that the technology would be changing, and it really wouldn't be that useful.

So how do we—what can we do to get the biggest bang for our buck with ITS systems and the deployment of ITS systems? I mean, I see these signs along the road, electronic signs that I don't

really see that they are being put to much good use, but we put the money out there so——

Dr. DEAKIN. The signs that say, congestion ahead when you are already in a stop-and-go traffic jam aren't particularly helpful to any of us, I think. But I think we are getting better at some of this. There are some technologies that have more applications than others, and this one example I would give you relates to Mr. Smith's question about what do we do about fuel taxes.

We are getting a lot better devices that would let us measure vehicle miles traveled in obtrusive ways, ways that don't invade people's privacy. We all know the fuel tax is running low. You know, we could raise it if there were political will to do that, and it would last for awhile. But cars have to get more efficient. They are going to change. So that doesn't seem to me to be a long-term strategy. And if we started implementing technologies that would let us monitor vehicle miles traveled in cheap, fast, safe ways of doing it, still protect people's privacy, we would also open up the possibilities of congestion pricing in those places where it is needed, and there is political will for it, which is not everywhere, but it is definitely some places. It opens up the possibilities for making it easier for people because I could pay my toll, I could pay my parking, I could, you know, get around in my transportation system a lot faster.

And there are similar things we can do in transit, by the way. So I don't want to make it sound like this is just for highways since there are a lot of options in transit as well. That is almost a no-brainer in my opinion, and it is the sort of thing where the big issue right now is which technology: are we talking wireless, are we talking radio signal devices? So there are technology competitions, but in some ways that seems less important than the fact that we have to start testing those technologies and giving the states both the authority and probably the mandate to do it would be one way to get going on that.

For making sure that these things are cost effective, there is nothing like doing a business case, and that is what I have seen missing is really the development of business cases. And, again, I think business cases are often best developed by third parties who are a little bit at arm's length and not necessarily the advocates of the project just because you need somebody else with eyes on this to make sure that we are really making wise decisions on the investment. That is what we do when the private sector is working properly, and we try to use business cases to test that.

And then post-hoc evaluations: we just haven't seen very many post-hoc evaluations, and again, they have to be done at arm's length, not by the project proponents, because if they are not at arm's length, then they are always a little suspect. So stepping back—and these are the kinds of research that can help. There is a research component to that. There is also practical partnerships that can be done to make that happen better, and I think, again, the legislation could help encourage that kind of arm's length evaluation, learning from that arm's length evaluation would then happen. They could require that business cases be developed. I actually think a lot of the DOTs are trying to do this and would welcome having that kind of support saying, yes, we have to do that, we

have to spend our money in a smarter way than we have been spending it.

And then focusing on outcomes. Are you actually—what are you actually wanting to get from these projects? It is not just turning the dollars out. It is seeing that we actually have a lasting value that is cost effective, and we know how to do that. I used to work in Terman [Hall at Stanford] before I moved up across the bay to the private—from a private to a public sector. So I know the program that you are a graduate of, and as you know, there are lots of people who know how to do these kinds of evaluations. We could put them to work.

Mr. LIPINSKI. Thank you. Mr. Wise, do you have—

Mr. WISE. Yes. I think that something that might be of interest to you either in your role in this subcommittee or on your role on House T&I (Transportation and Infrastructure) is that we have just started recently some work on real-time traffic information systems. This is a subset of ITS. And of course, I defer to Dr. Deakin, who is a recognized expert in this field, but just kind of getting into it in the beginning, we are looking at some areas that I think might be getting at some of the things you were alluding to in your question. And we are looking at things like the cupboards that exist on real-time traffic information technologies, the information that is available on the impacts and costs of the systems, and then I think one of the more interesting aspects is the option for developing a nationwide real-time traffic information system and the potential benefits of, and the barriers to developing such a system.

In different parts of the country, of course, it means different things to different people. If you are in the western suburbs of Chicago, congestion is a major issue. If you have got a 60,000 square mile district, and there is an accident on the interstate, it is good that somebody can know about it. And as Dr. Deakin was mentioning, there are serious questions about the technology. It is a very fast-moving target right now with lots of evolving technology. I think there is some interesting pilot work going on out in the [San Francisco] Bay Area on GPS cell phone technology. I think that the private sector will probably be playing a major role here, and the question is what will be the DOT or the government's role.

So there are a lot of interesting issues out there in this area. I will be happy to keep the Committee apprised of the progress as we work through this issue.

Mr. BRUBAKER. I just want to mention something. On this Safe Trip 21 pilot that Mr. Wise is referring to, you know, that is really something that I don't think would have been done in the normal construct. We actually were able to pluck that out at RITA and sort of lead that but pull together a lot of different modes to make that happen. That is a transit, that is a highway, that is a very—that is an individual mode of transportation, be it bicycle or walking. I mean, there is a whole host of things that play into that, which is really kind of an interesting approach and a unique approach.

But we started with kind of the outcome in mind of what we wanted to present, and as somebody who knows systems engineering pretty well, you know that we have really—we really kind of designed the protocol in a way that would support, you know, that outcome that we wanted to achieve.

Mr. LIPINSKI. Thank you.

Chair WU. Thank you, Mr. Lipinski.

Dr. Deakin, when you referred to Terman, were you referring to a building——

Dr. DEAKIN. Yes, I was. That is the engineering building at Stanford.

Chair WU. I spent many a lovely evening at the Earth Sciences Library nearby.

Dr. DEAKIN. Yeah.

Chair WU. Wonderful place.

Mr. Saenz, did you have something to add to the last back and forth?

Mr. SAENZ. Yes, sir, and I think one of the things when, you know, the question was how do we make sure that we get the best bang for the buck, and you know, I think it starts from being able to identify some goals within your research right now, really some goals in the management of the organization that will lead to some goals or some—and then how do you measure them.

And one of the things that we started doing in our research program a few years back is we put in place the teams at a high level that were the experts, both from, on the Department side, academic side, and even the private side, to identify some goals that we wanted to accomplish in the different—the research management areas.

And one of the things that we really looked for is we wanted to identify some research that would result in the implementation of a technology that would give us a savings. Very similar to what I talked about with—we used some of the national research in the barrier cable, but even within the Department we looked at what can be looked at that will help us create a much safer transportation system, and then how can we measure what we are accomplishing.

And that leads to ensuring that you spend your money in a safe and wise way.

Chair WU. Thank you very much, Mr. Saenz.

Ms. Edwards, please proceed.

Ms. EDWARDS. Good morning, and thank you, Mr. Chair.

For Mr. Brubaker, I wonder if you could elaborate a bit on—and good that you are the former administrator, because I think sometimes we can see things differently inside versus outside, and I wonder if you might elaborate on priority setting. I think it is easy—it is an easy answer to say, well, we just need more money to do X, Y, and Z, and I know that in some of your testimony you focused on priority setting and, you know, rejiggering the kinds of research that we are doing. And so I wonder if you might elaborate on that.

Mr. BRUBAKER. Sure. I would be delighted to.

You know, the—what we have never really done, again, and I mentioned this in my written testimony, is establish this national transportation research agenda, which I believe should really be the driver of all the research investment rather than try to force-fit, you know, activity that we are already doing, things like SHRP, for example, that we are already doing into specific buckets.

And I don't mean to pick on, you know, the Federal Highway Administration, but, you know, they kind of want to be left alone in that prioritization process, as does federal transit, as does rail. Everybody wants to kind of be left alone and do their own, you know, research.

And I think it is absolutely critical that we call a time out, we take a step back, we assess what we want our priorities to be, we clearly state those in terms of what kind of outcomes we want. For example, I had the Intelligent Transportation System Joint Program Office under my purview when I was at RITA. I actually shared it administratively with the Federal Highway Administration, which created some really interesting situations, which I can elaborate on off-line. But the point is that they have always sort of just been doing projects, and what I asked them to do was really focus in on what they wanted to achieve in terms of, you know, did they want to take a safety focus and reduce the six million crashes that we have every year using Intelligent Transportation Systems, making a big dent in the 40,000 lives that we lose every year. And put those, make that a priority. Really design the research program to have a measurable impact on reducing crashes, reducing the fatalities, reducing the \$230 billion in economic costs that we incur every year because of those six million crashes. And put it in terms of outcomes. And then how do you basically reverse engineer the research program to achieve those results.

That is the kind of thing I am talking about but on a macro scale for the entire Nation. What are like the five or six things that we really want to accomplish? Reduce congestion, greenhouse gas emission reduction, you know, rural safety. I mean, what are the big impact things that we need to do. Then we need to look at that \$2.1 billion—

Ms. EDWARDS. And how to develop a system—

Mr. BRUBAKER. Right on. We have got to take that \$1.2 billion and then begin to plan how we spend it to achieve the outcomes in those big areas. So that is what I am talking about.

Ms. EDWARDS. I appreciate that.

Let me just—Dr. Deakin, very quickly, can you talk to me a little bit about what you think the appropriate role for social science research is in thinking about a more coordinated transportation system?

And I want to just share with you, you know, I know locally we, you know, we have an economic development team that works on economic development in one spot. And then you have a set of transportation people who go, oh, we are doing an economic development project. We need to think about transportation. And those things are thought about very separately, and so the rail people are in one place and the roads people are in another place, and it never seems that we are really looking at the linkages there.

And then how are we going to use that? As a consumer, what does a system mean for me? And so I wonder if you could talk about the way that we could use a social science research base to inform more strategic thinking around transportation planning.

Dr. DEAKIN. Yeah. I would be glad to. It seems to me that those linkages are exactly where social science can shine and make a big contribution to helping us figure out how to do this better, because

the social sciences, among which I would include planning and policy sciences in, as well as business administration and management sciences, as part of a bunch of people whose expertise is to really think about organizations and organizational behavior and how to create collaborations. There is a lot of work that has been done in collaborative processes. Some of that is theoretical. Some of it is evaluating different processes to see which ones work and which ones don't and is very practical.

So there is a whole range of social science work that is looking at how different organizational structures—how to flatten organizations because we have got a lot of evidence that flatter organizations are more efficient. But networked organizations, organizations like Google are not highly hierarchical. They are pretty flat, but they have got a lot of networking and a lot of linkages. The importance of informal networks of knowledge as a way of really quickly getting new ideas out in the field.

It is not, you know, that people go and read papers. They call a friend that they know because they met at a meeting or a conference and say, "Hey, what is going on in your field?" or, "What do you think about this idea?", and how to facilitate that sort of behavior instead of punishing it, which actually happens in some of our current organizations. Don't talk to your boss's boss without permission, or you might be in trouble in hierarchical organizations. Of course talk to your boss's boss and then tell everybody what was said is a flat organization approach to that. So that is what is coming out of the social sciences on how to restructure institutions, new institutional ways of doing business.

Studies on public-private partnerships. What does it mean to have a public-private partnership? That term captures a lot of territory, and some of these partnerships work well, and some don't work well at all, and we really need to get that knowledge into people's hands about what has been effective and what hasn't been effective. And it is social scientists who are doing that research.

I think it is a question of specialization. My colleagues who are mechanical and civil engineers and electrical engineers and computer scientists are really good at what they do, and I don't want to try to do their work for them, because, boy, I couldn't do it. By the same token, they are not necessarily very good social scientists. They are not necessarily the best people to be doing evaluations. They are not necessarily the best people to be thinking about markets or institutions. There are other disciplines that do that, and that is where the social science people, I think, really can help us a lot.

Ms. EDWARDS. Thank you. Thank you, Mr. Chair.

Chair WU. Thank you, Ms. Edwards, and since we have had a couple of folks on this side of the aisle, Mr. Smith, why don't you proceed.

Mr. SMITH. Okay. Thank you, Mr. Chair.

Mr. Saenz, in your testimony you state that the boundaries of various State and federal programs need to be defined more clearly. Can you describe how the multiplicity of R&D programs affect the planning and operations at TxDOT?

Mr. SAENZ. A lot of times as we are doing our work we work with different areas. We got planning, and you have the, more of the

technical side, and then sometimes we don't have the good communication or the good coordinated effort. What we have been trying to do at our level, at the State level, is, as I do have the research management committees, we also have an oversight committee that is made up of all of the chairs of our research management groups, as well as our key administrative staff of the Department so that when we can coordinate and then we can—that way we can communicate with the different areas as we go up to the federal side.

We just, all I think we need is more cooperation, more coordination.

Mr. SMITH. Okay. Thank you very much. You know, it is interesting as we hear, you know, kind of a request, somewhat of a request for more clearly-defined programs, you know, that, if you get too detailed, then I think we discourage that cross-communication. And so that is interesting, and I am not criticizing your suggestion for more-clearly defined responsibilities, but do you sense any obstacles such as that?

Mr. SAENZ. No. I think what we are trying to get is I think we need some definite goals and then we can work together at both the State and the federal level to identify these strategies as well as the implementation plans. And then at the same time we can define the roles and responsibilities of each so that we don't have the duplication of efforts, and we in a sense get more done with less is where we are trying to get at.

Mr. SMITH. Okay. Thank you.

Chair WU. Thank you, Mr. Smith.

I have two major areas that I want to explore and then two smaller areas, and at least in this round the major area I want to open up to the extent that folks don't want to continue talking about cultural issues or inertia, because I want to fully explore that topic before moving on.

But in a related field a number of you have referred to a concern about developing a coordinated research agenda in moving to outcome-based measures, and I wanted you to finish addressing any of the cultural and inertia issues that we face, and the challenges of moving to a coordinated research agenda. And what would be outcome-based metrics and to give further examples and then elaborate on your written testimony.

Whoever wants to begin to take a cut at those areas.

Mr. Brubaker.

Mr. BRUBAKER. If I may, yeah. And I will try to keep my answers a little briefer than they have been in the past here. I am just remembering from my staff days. The, you know, it is really interesting that as we look toward developing a coordinated agenda, to understand that how we move people, how we move freight today is multi-modal, it is multi-dimensional, it is multi-disciplinary and keeping that in mind. So you have got to bring—and I think Dr. Deakin really nailed it when she said, you know, how you approach these things. It is not just a civil engineering problem. It is an electrical engineering problem, it is a, you know, structural engineering, it is social science, it is economists. All of them have to be in the room to help develop this thing.

Chair WU. So the problem is siloed—

Mr. BRUBAKER. Siloed thinking. Right. You know, you go to, I mean, and here is the problem that I have got, and with all due respect to Bob Skinner and TRB and Federal Highway Administration with SHRP, is that it is housed in Federal Highways. You are more likely to get a Federal Highway type answer to the question, even though it might be taking advantage of a multi-modal problem, even like cooperative freight research, for example, you know, we have done research and funded research and are aware of research where we track shipments of things like seafood from the Pacific Northwest down to the Southeast of the United States. And we see that it travels by short-sea shipping, it travels on rail, it travels on the highways. So you have got to have an in-depth understanding of all those things, plus the economics, plus the behavioral issues, you know, to really understand how that system works holistically.

I keep coming back to this term, holistic, because things really are multi-dimensional and multi-modal and multi-disciplinary, and you have got to break down that siloed thinking, and there is really no place in the Department I think to do that other than RITA.

Chair WU. Anyone else?

Mr. Skinner, since you have been referred to.

Mr. SKINNER. Yes. Well, let me just—I just want to emphasize what I think is, that it is an enormous challenge to have a broad, integrated research plan.

Chair WU. Uh-huh.

Mr. SKINNER. The transportation sector is roughly the same size as the health care sector, and so imagine what our comprehensive health care research R&D program would look like. Now, I am not saying we are as good as the health care sector in constructing a research plan, but I just want to stress the enormity of the task that would be before us.

And linking that, I think the strategic plan, yes, it has to think about the goals, it has to think about outcomes. But it also has to think about processes and how do we allocate our resources across the entire innovation cycle so that some research that is of a highly-applied nature, relatively, can be implemented fairly soon, and we can judge it pretty easily, perhaps with respect to its rate of implementation and its outcomes.

But for other research such as, say, the SHRP work on understanding accident causation, crash causation it will be years before that fairly advanced research is translated to specific changes in the way the vehicle is designed or the roadway is designed. But it holds the promise of giving us the knowledge that we need 10 years from now, 15 years from now, for having breakthroughs in understanding the interaction between the driver and the vehicle and the roadway in accident causation.

Chair WU. Thank you for that insight, Mr. Skinner. When you think about it, the health care sector, the transportation transit sector, and the housing sector are roughly equal in size. If you consider the amount of research that goes into each of those and the nature of that research, it is very, very different. And if you consider energy savings, the building and housing sector is much more ripe than either transportation or some of the other areas.

Anybody want to address the out—I am sorry. Dr. Deakin or anybody else wants to address the metrics side of this challenge? And Dr. Deakin, you may have something on the existing topic.

Dr. DEAKIN. Yes. Actually, I have been doing some research on how other countries are actually handling this problem of a research agenda, and we are falling behind our competitors on this. The EU countries, Canada, and Australia all have been trying to develop these kinds of strategic plans that are really focused on outcomes, and the kinds of outcomes they are measuring: Are we getting good value for dollars spent, and what is good value? They are measuring, are we getting faster, cheaper, more reliable transportation service than we would have without that investment and for how—for what period of time, because not all of them last forever. Are we reducing greenhouse gasses? Are we reducing pollutant emissions? Are we providing better service to everybody? Is service equally, you know, equitably distributed to our population?

So those are measures of outcomes. You know, is there—basically they are looking for economic performance and economic development is certainly one of those things that you want to measure, you know, did it help get you better, you know, more access to jobs?

We can argue about how to actually measure those things, and there is a lot of research actually that has been done on what are good performance measures and not-so-good performance measures that we can look to on this.

So I think measuring outcomes is something we can actually look to our trade partners for and see how they are doing it, borrow their ideas, and build on what they have done and go a step farther and get ahead of the game on this. So I don't think that is—that part I think we could do pretty easily.

I think there is a difference between focusing on what to do and focusing on what to achieve. I mean, what to achieve is the outcome measure. With what to achieve you might say to people, you know, you decide what is the best way to improve the reliability of your transportation system, but you have got to show that the reliability is being improved. And they pick—figure out what is the best way for them to do it in their own situation.

An output—that is really different from saying a highway design manual where you have to look it up and do it by the book, and we have done I think a little too much of the “by the book” we are going to tell you how to do it, and not enough of the, we are going to focus on what you accomplish by making those investments.

The final point I would make, and this is echoing something Bob Skinner just said, sometimes we do need to set aside money for research that is not immediately tied to a product, because that long-term research is incredibly important. And I want to speak on behalf of CalTrans on this. CalTrans had the confidence in its universities, they gave us matching funds for our transportation center funds without earmarking a penny of it. They didn't tell us what to spend it on.

And we ended up with a very mixed portfolio of projects, some of which were applied and actually were done with CalTrans, but some of which were on topics that weren't on the national or the State agenda, including research that was done on what we could accomplish in transportation systems with new fuels, new vehicle

technologies, and other technologies, and travel demand management strategies, transportation pricing studies, all of which were done well before any of this hit either the State or the national agenda.

And because of that I think we are way ahead of the game in being able to provide leadership on these issues as we are coming to the conclusion we need to address these kinds of topics now, because we have got that research that started in the late '80s, early '90s that we kept building on it, and it wasn't, we couldn't have said at that point, what did this study on transportation pricing alternatives actually do for CalTrans or for anybody else for that matter. But now we can look at that study and use it and say, well here are some ideas, and here are some analyses that actually show you what we might be able to accomplish if we did a VMT (vehicle miles traveled) price instead of a fuel tax, or what we might get if we did congestion pricing and how effective it would be, and where it would be. And oh, by the way, what are the politics of congestion pricing in our major metropolitan cities, because that is not a straightforward thing.

So we did that research, there wasn't a clear tie to a deployment immediately, but it has helped us 10 and 15 years later.

Chair WU. Terrific. Before I turn to Mr. Smith, anybody else on this topic?

Mr. Smith, please.

Mr. SMITH. Thank you, and anyone wishing to respond to this, but when we talk about the matching fund requirements and changing those to a heavier federal side of the funding, what do you think, how would that impact, obviously it would free up funds locally or at the transportation, the TRB, and given the fact that, and we have heard criticism of current research programs as lacking the technology transfer, are the UTCs (University Transportation Centers) capable of turning long-term projects into the real-world benefits given a funding, matching, matching funding change?

Mr. SKINNER. Okay. I will start. I imagine this is a topic others will address. You have a center director here with us, and you have the former administrator responsible for UTCs.

And the—as mentioned in my testimony, a committee that we had that looked at the Federal Highway Administration's research program, which—of which a big component of UTC research is highway research. That committee recommended that the matching percentage drop from 50/50 to a 20 percent match. And the argument there is that many states were not operating in the manner that Dr. Deakin described for California in that they were—they did have expectations if they were providing matching funds, and those expectations were towards fairly highly applied research products.

And the universities have this opportunity, which Dr. Deakin has explained, to do longer-term, higher-risk, blue-sky research on the areas that we haven't thought of, and our committee felt that that was being stifled to a degree by that matching percentage. And so if the matching percentage is reduced, the universities would have greater autonomy in setting their own agendas. There would still be the opportunity for overmatches by states and others. Some uni-

versities, no doubt, would choose to continue to do highly-applied research, but other universities might choose to go off in the direction of longer-term, higher-risk research, and others might have a mix like Dr. Deakin described.

Chair WU. Mr. Smith, may I jump in just for a second?

I understand where we are going with this change from 50/50 to a 20 percent match, but can't you earmark just as effectively with a 20 percent portion and leverage the other 80?

Mr. SKINNER. I think in certain cases that would happen, but I think it would certainly happen to a lesser degree with 20 than it does with 50/50. As you said, even, as Dr. Deakin explained, even with the 50/50 California allows quite a bit of latitude.

So I think it is, I think our committee, you know, whether the number should be 30, should it be 15, should it be zero. They settled on 20 as a step in the right direction.

Mr. BRUBAKER. Okay. I will go next.

On a non-controversial subject, you know, my experience with the 50 percent match is that it works, and it leverages the dollars that we invest into the system.

I come back to the—sort of the fundamental objective for what historically we have tried to achieve under the University Transportation Center Program, and that is training the next generation of transportation leadership. That in many cases, in fact, in most cases involves training individuals who go out and work in the field. Work in the field on applied—on real live applications, things they need to do.

So there has been a criticism that the program is a little too focused on applied research, and I don't know that that is such a bad thing when you are actually training people who need to go out and work in the field and be marketable. And if they are doing really the squishy, sort of basic research that, where there isn't really a solid performance-type outcome but it leads to other research or further sustains the knowledge, which by the way, is very good, then, you know, I would expect that person or those people to be a little less marketable or a little less attractive to the field.

So, frankly, I think the program has been fairly effective. I think, well, actually, not fairly effective. I think it has been very effective in the current mix and how things are sort of arranged, and I would hate to see us tinker with something that I think is fairly well leveraged today and fairly well balanced and produces the result that we expected to create.

Mr. SMITH. Anyone else wishing—

Dr. DEAKIN. Yeah. I obviously have a self-interest in this topic. We have over 100 faculty members in the UC (University of California) system who participate in the UC Transportation Center, and we let any faculty member who does transportation research at any of our campuses compete for funds. The funds are reviewed entirely outside our university by people who don't have any close connections. It is an NSF (National Science Foundation)-kind of review process. CalTrans also reviews them and then we meet and prioritize which ones will be funded.

We use the USDOT research agenda as one of the bases for prioritizing what we fund. We also use Cal Trans research priorities since they are providing matching funds. We, as I said, end

up with a mixed portfolio. We have produced literally 100 students a year for 20 years who have gone to work in transportation. So that is a pretty big chunk of people coming out of that program for the investment. And many of them have now risen to positions of leadership. In my home state, in California, both assistant directors at the Metropolitan Transportation Commission are graduates of our program, Jose Luis Moscovich of the San Francisco County Transportation Authority, Christine Monsen of the Alameda County Transportation Authority, Malcolm Carson of the LA DOT Commission for the city, and I could go on and list all kinds of people who have been out of school for awhile and have now risen to positions where they are in considerable positions of authority and are really providing a lot of leadership.

So we are pretty proud of that as part of our product in addition to our research product.

Frankly, we couldn't have attracted some of those students into transportation, into transportation as opposed to another area of work, if we hadn't had the ability to offer them fellowships and graduate research assistantships through our research. And if we got hit with a cut, and you know, CalTrans might be generous enough, but our State budget is in a terrible situation so I am not so convinced, we might get some of the match. They might not be able to do it. I don't think it is because they don't love us. I think they do love us. I think it would be because they don't know where their next dollar is coming from.

So that kind of a loss of match would certainly hurt us, would hurt our ability to produce the students, would hurt our ability to produce what I think has been overall a very positive set of research findings, many of which have been implemented, many of which are changing policy and creating new ideas all the time.

So, you know, it is basically a cut in funds for the transportation centers, I think, is the only way to realistically look at that. It doesn't mean that we couldn't make it up later when it looks like CalTrans might not, we might have a budget this year in California. I scrambled around and looked at foundations and found money from Hewlett and the Energy Foundation, but even they, now with the downturn are telling us that they lost 30 percent of their endowments. And so that is not even going to be easy in the future.

So I think you have to look at it as if you cut it to 20 percent, it is going to be a cut in the amount of funds, a cut in the amount of the research, and a cut in the amount of product that you are going to get, and that is the only way I can interpret it.

Mr. SMITH. Thank you, Mr. Chair.

Chair WU. Thank you, Mr. Smith.

A number of you have referred to technology transfer problems, consulting with end-users, implementers before proceeding on research, in the course of research, and in implementation phases. Could you expand on some of the pinch-points, some of the impediments, how to overcome them, your recommendations for more effective tech transfer going forward?

Whoever wants to start. As an end-user. Mr. Saenz.

Mr. SAENZ. And I think I will tie it really to not just the research program but the—anything that we do. We in Texas have 25—the

state is broken up into 25 districts. Sometimes I think we have 25 Departments of Transportation, and a lot of our district engineers in a lot of those offices work independently, and they try things, and they do things, and they evaluate things, and they identify best practices. And even within our state we were having problems in sharing that information so that the state could benefit as a whole.

One of the things that we have been trying to do as a whole is, under my administration, I put in place an assistant executive director that is working with all of our outside offices to ensure that we do get that kind of information collected, presented, using different methods through, either through reports, through being able to use technology, chat rooms so that we can get that information to the other people across the state because we can generate some efficiencies.

The same thing can be done on the research program. We already communicate closely, but I think we always need to look at what we are doing today and how we can make it better. Because we thought we were communicating as a state in sharing information district to district because they communicated, but we found out that there was a lot of things going on that one area of the state did not know anything about.

So we need to always go back and look at what we are doing, how we are doing it, how we are sharing it, and how could we ensure that we are doing it. Again, you measure your success of what you are doing.

Chair WU. Thank you very much, Mr. Saenz.

Mr. Skinner.

Mr. SKINNER. We could talk all afternoon about tech-transfer, and I would probably enjoy it. We manage cooperative research programs, what we call cooperative research programs in highways, transit, and airports. Each one of those programs is governed by a committee that is not created by TRB. It is a—the institutional arrangements vary, but for example, the committee of—the research committee of the American Association of State Highway Officials governs our highway cooperative research program, and the Secretary of Transportation appoints the governing group for the airport program, and so on.

These programs are highly applied, and so the tech transfer problem is not nearly so great for that kind of research, because stakeholders know what their problems are, they program money to deal with those projects. Oftentimes they are connected with the association committees and the operators. And so the panels that we put together that steer the research have the people on-board that would help with tech transfer later on.

So that those kind of programs work very well, but I would never claim that the entire research program should be comprised of these programs. They are—they don't handle crosscutting issues very well. They are at the highly-applied end of the scale. They are not doing the longer-term stuff. And for the kinds of programs implementation is a considerable challenge, particularly when it must ultimately trickle its way down to county road officials.

So they are relying on, you know, there is no perfect set of things. The Federal Highway Administration has a Local Govern-

ment Assistance Program. That is good. Many local governments have terrific relationships with states and depend on the—depend on minimizing essentially State practices and materials and designs. MPOs—Metropolitan Planning Organizations—probably depend heavily on their own network and individual contacts for improvement in planning methods. And champions in getting states to go out and pilot and then lead the way for others is terribly important.

So, again, I just would stress that this is a complicated subject. There is no one answer, and there are a lot of different tools in the toolbox that have to be employed.

Chair WU. Well, believe me, we work on tech transfer, whether it is from NIH (National Institutes of Health) labs to transportation to nuclear detection, and I guess it is what I think Boswell or Johnson said about dogs walking on their hind legs. It is not done well, but one is amazed that it is done at all.

Mr. SKINNER. At all. Right.

Chair WU. And a lot of the world thinks that we do it better than most, but I am kind of amazed by that, too.

Mr. Brubaker, you had something to say.

Mr. BRUBAKER. Ditto. I couldn't agree with you more. Yeah. I mean, fundamentally, and I am going to say something which may be a little controversial here, but it is designed to have a little bit of an impact, but I don't think tech-transfer is truly a priority of the Department's research program, and it needs to be. I think the priority needs to be clearly stated. I think it needs to be programmed. I think you need to take some element of existing resources and direct it toward a tech transfer and commercialization-type activity.

I used to serve as Chairman of Virginia's Innovative Technology Authority, and that whole authority was established almost exclusively and initially, when it was initially established to do tech transfer from Virginia's colleges and universities and laboratories and to ensure commercialization of the most promising technologies. And Virginia, frankly, had done a really good job of doing that, and helped manage the SBIR (Small Business Innovation Research) program, and the context of tech transfer and doing some other things.

So I come at this with that background. So I actually believe that there should be a very deliberative program, activity around technology transfer and commercialization where we can glean some best practices from some of the universities that do a really good job, some of the State associations that do a really good job, some of our overseas, you know, folks who do a really good job of it. Glean those best practices and apply them.

I am amazed at some of the things that I have seen in terms of technology transfer by some of the universities, particularly, I mean, I think UC-Berkeley has a good program, I know Texas A&M does because we have gotten underneath it pretty substantially, and I think there are some clear lessons that can be learned by that.

But I am perplexed because—and I do think this is, again, a function that really needs to be in RITA, and I will tell you why. Because I am really perplexed by how you can promote something

like the Universal Freight Shuttle that was developed out of the Texas Transportation Institute, which is effectively a new mode of transportation. It is a monorail effectively that uses individual rail cars that move freight containers through—from, you know, ideally when it is originally, when it will be deployed, it will be Monterey, Mexico, through Laredo, up to a land port in Dallas, Fort Worth. At least that is the initial design of it. But it doesn't fit nicely into federal railroads, it doesn't fit nicely into highways, but here this is this great innovation, and I know that they had a heck of a time trying to figure out how to commercialize something like that, how to get the knowledge out.

One of the things that I think we fall victim to in the Department is we tend to have researchers and create forums where researchers talk to other researchers, which is a form of tech-transfer, but it is not necessarily getting the technology out in a forum where it can be effectively utilized.

So I think we need to take a look at this. I think the Department needs to make it a priority. It should be a priority in the next reauthorization, and it should be programmed and resourced effectively.

Chair WU. Thank you very much, Mr. Brubaker.

Anyone else on this topic of tech-transfer, impediments, and procedures going forward?

Dr. Deakin.

Dr. DEAKIN. I think there has been a model of tech-transfer that it is something that happens at the end of a process, that you develop research and then you move it forward into refinement, after refinement, and then eventually you deploy it, and at that point you start doing tech-transfer. And that is, I think, a recipe for failure, that kind of a model. I think you have to start thinking about users, demand, markets in the beginning, and one of the—if it is short-term research as Bob Skinner pointed out, that is easier to do than if it is long-term research. But in other areas we have business councils and business science, science councils that help talk about these things and keep this on track. And there are other mechanisms I think that could be devised that would help us integrate thinking about what is—where are we headed, what is the vision for this, what is the scenario that we have in mind.

Mr. Saenz was saying to me that he thought that the things we ought to be doing are scenario planning and use, having think tanks but also doing scenario planning and then doing evaluations on projects. Each of those could use some guidance from people who are really thinking, what is the vision here that we have. Is that a realistic vision, challenging that at the beginning, sharpening up that vision of where it is going.

Let me give you an example. A problem we have in California a lot is that people say, gee, if we could manage the freeway system and the arterial system as a couplet, then everything would be a lot more efficient, and we could spread traffic around, and we wouldn't have so much congestion. We could put, you know, make use of the capacity better. Well, if the arterial happens to be the kind of arterial where having more traffic on it is okay, that might work. But two-thirds of the time, in my experience, those arterials are also main street, residential streets, shopping streets. They have got all kinds of other values associated with them, and maxi-

mizing throughput is not the objective of the owners of those facilities.

And so we actually had to change our thinking about that and recognized that we have to do context-sensitive design and context-sensitive operation. But I still hear some of my colleagues on the technology side say, gee, if we could only operate this system as a whole, not even recognizing that there are these other values that have to be brought in.

And that is just a question of not communicating with the right people, because other people could tell them, let us talk about the context in which that will work and the context in which that won't work.

So starting to think about deployment, starting to think about markets and public consent and people's values and what is being proposed fits with values and markets and preferences really from the beginning seems to me to be critical to make tech-transfer work.

Chair WU. Thank you very much, Dr. Deakin.

Before we turn to what I hope to be one final topic here, Mr. Skinner, since I made an at-best neutral comment about one of your findings earlier, I wanted to return to that and give you a chance to address it.

In your written testimony there was a number of a \$400 million increase in research funding, and before we head into a, shall we say, disjuncture between aspirations and resistance to additional research funding, I want to ask you about where you get your number about 0.9 percent of sales, research for transportation versus 3.6 percent of sales in other industries. And then, and also to give you a chance to address what I take you to say as not just an increase in current surface transportation research but perhaps a re-orientation of that research into other fields where there may be current research going on but to associate that with transportation.

Please proceed, Mr. Skinner.

Mr. SKINNER. Thank you, Mr. Chair. That is quite a lot. Let me first start by saying that I certainly didn't want to leave the impression, and I don't think our reports wanted, committees wanted to leave the impression, that the answer is money, and money alone.

Chair WU. We have parallel goals.

Mr. SKINNER. That regardless of what—of the resources that are available, there are a variety of things that our committees have documented—and are in my written testimony—that we can do to make our research programs—technology programs more effective.

The 0.9 percent of total expenditures is arrived at simply by adding up all of the highway research program spending that we can find in the United States and comparing that to total highway expenditures, and that compares with this, you know, three percent figure, which comes from—it is not compiled by us. It is probably compiled by the Commerce Department. It is referenced in our report.

And I think you will find in the private sector that even mature industries spend at least one percent and—

Chair WU. Let me ask you about that. You are probably including industries like pharmaceuticals where the spending is in the

mid teens. You might be including technology industries where the spending is at a slightly higher percentage. But if you compare it to, shall we say, heavy industries, like steel or ag, that might be perhaps more—although it is unfair because we are also talking about computer systems and transportation.

Mr. SKINNER. That is right. You are making my point, that it is quite a range. It is one, you know, one to ten to fifteen percent, depending on these very high-tech industry and the like. And my point there is that this is not a low-tech industry. Yes, we have very mature technologies that are difficult to change like asphalt and concrete, but we have Intelligent Transportation Systems, we have very complicated institutional problems that the private sector doesn't deal with. We have behavioral issues related to safety, and travel demand, and the like.

So, yes, you know, as to where we should be in that spectrum, we are just observing that we are on the, you know, on the low end.

Chair WU. So it is different percentages, if you will, different—a different baseline for different parts of transportation research because it is a large segment of the economy just like health care, just like construction.

Mr. SKINNER. Right. I mean, we spend, I think, probably three times more to try and save a life in our cancer research than we do in research related to highway safety. So—but now let me—so that is the first number. Where I got the 0.9 percent.

The other one was the \$400 million, which is relating to, you know, the total expenditure that we estimated in a Congressionally-requested study on the implementation of the Strategic Highway Research Program products. And there is a little bit of a crystal ball work there because the research program is still just fully underway, and we were required to submit a report this year.

But it is, we—it is illustrative of how much importance our committee placed on the tech transfer process and its complexity. In this particular case I will say that there is a bit of apples and oranges, because this—I referred earlier to the accident causation piece of it, where at the end of the SHRP program, we will have a very large database. So the \$400 million also includes the care and feeding of that database, as well as further research on the—on that database, which will hopefully give us the products that will make their way into vehicle design and roadway design.

Chair WU. Now, do you have a recommendation about a proper amount of funding for the next appropriations period, for the next highway bill period, and what the uptake limitation might be for the research infrastructure that we currently have in place?

Mr. SKINNER. Thankfully, I do not have a recommendation.

Chair WU. I will tell you what. For each of the panelists and your friends in the research community, that is a question that I am very, very interested in, and I am sure that other Members of the Committee would be very interested in that as we develop the research title of this reauthorization.

Mr. SKINNER. Right. I mean, our committee has, you know, we have observed that we could, you know, we could—more money could be justified, but certainly if the money were doubled or something of that nature, there would be the capacity issue that you are referring to. And regardless of the money, there are a host of re-

forms that we can make to make the overall program more effective.

Chair WU. Terrific. Thank you very much, Mr. Skinner.

Anybody else on that topic before—Mr. Brubaker.

Mr. BRUBAKER. Yeah. I mean, I come back to this that I said in my oral testimony and that I referred to in my written testimony, and that is that I think it is really difficult to assign, I don't know how you can assign a number as to what the right number is for what we should be spending on transportation research.

I go back to that national transportation research agenda as sort of being the driver. The right number is the number that it takes to spend on research to achieve the outcomes that you are looking to achieve. But I would really caution that the thing to do or to ensure as part of the process is that there is an ability to select, control, and evaluate the research portfolio. That is—and I view that as an inherently-governmental function. It should rest somewhere in the Department. In fact, I think it should, the development of that plan and the monitoring, the execution I believe should rest in RITA.

You know, and moreover, I mean, if somebody really wants to increase the funding, maybe make it, maybe gate that funding, maybe make it, you know, there is a percentage increase that increases every year of the authorization where, perhaps, it is predicated on successful implementation of such a construct of oversight, if you will, where you are actually controlling and evaluating those underlying research programs.

That I think would be a responsible, frankly, approach to that type of a discussion.

Chair WU. Terrific. Thank you.

Dr. Deakin.

Dr. DEAKIN. I guess I take a slightly different way of thinking about this myself. We could draw a technology innovation curve and think about that as when you are first starting to develop technologies, high risk, potentially high payoff, you have to spend a lot of money on research. When technologies are well understood, well deployed, the rate of change, rate of innovations slows down a bit (and this is over-simplification, obviously), you don't need as much research money.

And so the question is not just a question of how much do you need in transportation but what are you going to do in transportation and where do you want to put that money, on the innovations or on the stuff that is relatively stable? And that is a curve, and you can actually do an analysis and figure some of that out, I think, a little better than maybe we have done in the past.

We have had a tendency to staple together everybody's proposals in the past, and stapling is not the best way to do this, I don't think.

The other piece of it is, I think, this is a huge question about what you want to count as being as part of the problem, part of the problem set. If you think about the supply of transportation, just the supply, you have got vehicles, fuels, operations, and facilities. And DOT doesn't do most of the vehicles and fuels. Those are actually private sector, EPA (Environmental Protection Agency) and DOE (Department of Energy). And if you are going to talk

about transportation systems improving as a whole, and you are only talking about the facilities and operations, you are already shooting yourself in one foot. If you don't recognize that the private sector has to be part of that discussion because they are producing most of what we are talking about, you are shooting yourself in the other foot.

So it seems to me that that is a big issue that the way DOT has been organized and the difficulty that DOTs had, not just internally, which Mr. Brubaker spoke about, but also in creating those partnerships that go to EPA, that go to DOE, that go to the Department of Agriculture, that go to Housing [and Urban Development] (because there is a big housing and community development aspect) that go to Commerce on the economic development aspect, are also part of what would really have to be discussed seriously here. And that affects how much money you want to spend in research. You know, it doesn't seem to me that all the research is necessarily going to be inside Department of Transportation. It might be in these kind of new forms of organizations that might be semi-formal, that is they might be partnerships mandated by Congress among agencies that create networks and advisory committees to supervise how the dollars are spent.

They are really different from what you have been doing. They are not all internal. It might not be in RITA at all, or it might have RITA manage part of the process but have to be told to create these partnerships and do it in a different way.

So I just think we could open this up and really think about it differently.

Chair WU. And that is part of the opportunity and the frustration of this moment. You are quite correct that the transportation issues are not just in DOT, and it would be much better to have linkages between DOT and DOE, for example, but this committee, or this, the larger Science and Technology Committee, does have jurisdiction over the research components of DOE and DOT.

And the opportunity is that the new Energy Secretary is very, very enthusiastic about moving forward on a broader front and coordinating with other agencies and is very cognizant of issues of culture and inertia.

In fact, to speed up the research process in his agency, he is looking at bringing in folks from ag because they have dispersed funds faster, traditionally.

Mr. BRUBAKER. Right.

Chair WU. So that is part of the reason why we focused on cultural issues a little bit because, you know, there is a lot of discussion about how to get agencies reoriented to address issues. I mean, we push legislation out of here, and we kind of assume that it is done when we push legislation out, and it could be three to five years later and it hasn't hit the ground yet.

Mr. BRUBAKER. Right.

Chair WU. And I just want to be very sensitive to the multiple layers that it has to go through before it hits the ground.

Mr. Brubaker.

Mr. BRUBAKER. Can I—I would like to add something to that because I think we did something fairly unique when I was over at DOT that in the alternative fuels arena where we did engage the

Department of Energy, and we had really close relationships with the folks in EERE, on—the Energy Efficiency and Renewable [Energy] folks. We had good relationships with them, particularly as it related to hydrogen fuel cell vehicles and battery development and some of the things that we were really interested in.

To my knowledge, and I don't know, I hope that that activity is still going on, but that was informal, and I think as we begin to have, you know, a new generation of people who come into the government, government service, and are used to collaborating and are used to dealing with Facebook and are used to picking up the phone and asking people questions no matter where they sit or what organizational stovepipe they are in, that is going to be more of the rule rather than the exception.

But I will tell you, I got a lot of raised eyebrows when I first started to engage our colleagues at the Department of Energy on these issues, and initially, you know, there was some dancing around, turf battles, and, you know, like whose turf is what, but when we broke through all that stuff, I think we had—and they played an integral part in the success of a hydrogen road tour that we did over the summer where we took a fleet of hydrogen fuel-celled vehicles from Maine to Los Angeles, across the country. And we were in lockstep for that particular project. That wasn't formal. It wasn't mandated by anybody. It was just something that we did.

At the same time at the secretarial level we were not at the plate at all when gas prices were going through the roof, but the impact that those fuel prices were having, you know, at—on the transportation infrastructure, on our supply chain, our passenger movement system was profound. And it is unfortunate, but I almost think it is sort of a generational issue where people are used to collaborating who—when they are somewhat younger or more, you know, more interested in that sort of thing. And when you get to sort of the older folks who are used to working in their rigid agencies, and you know, they are getting advice that they have to stay in that lane, that occurs. And fortunately, I think technology is going to break down all that stuff ultimately but—and create new paradigms for work, but I just wanted to offer that concrete example, although it is not a concrete example.

Chair Wu. Thank you very much. I have always thought of myself as a young pup, but now as I get older I find that, you know, I am more sympathetic to the old dogs and maybe I am one, but there has been constant reference to the sociological aspects of organizations and technology and a more intermodal approach rather than a pyramidal approach to problems and organizations.

Anybody else on this topic before we move onto my final one. And I will also give you all a chance for a catch-all at the end of this.

Well, for me the last topic I have is the proposals for reorganization of UTCs or organizing them differently. We have already addressed the splits for funding matches, and we might return to that at a different moment in time as we get closer to reauthorization, but there has been some discussion on a competitive process versus whatever you would call the process that we currently have. It occurs to me that we have 50 centers, we have 50 states. That could be a coincidence, but, you know, I know that coincidences do occur. I just haven't seen one in Washington yet.

But to the extent that any of you would like to address the—what it would look like to have a competitive system for UTCs and awards, what the criteria would be, I would like to hear your—I would like to have your input on that topic.

Mr. BRUBAKER. Mr. Chair, I don't mean to—I am very, I hate to say this in this way, but I can't think of a better way to say it. I am passionately indifferent to whether they are competitive or not. I have seen ones that have been competitively awarded. I have seen ones that are earmarked, and both to a large extent are effective. There are a handful that may need some help on both sides of that equation, you know, so I, frankly—it is not one of my—the recommendations that I am passionate about in any way, shape, or form.

So I just think, you know, not that I want to say don't rock the boat on this thing, but it seems to be, the system seems to be working reasonably well. I am a big proponent of competition. I love competition in contracting and you know, everything else, but the reality is I think we have struck this delicate balance, and it is probably best not to expand or contract in terms of the number of centers; contract because I don't think you want to deal with, I don't think anybody wants to deal with the political fallout that is a grim reality of this situation. But at the same time I am more focused on what can you do to make whether they are earmarked or competitive more effective.

Chair WU. Well, I was not aware that this issue existed until fairly recently, and I guess I am trying to decide, Mr. Skinner, whether I should be passionately indifferent or, you know, passionately care about this.

Since you all have had some recommendations, let us hear from you next.

Mr. SKINNER. Yeah. I think on this topic, and I think I am on firm ground in saying that throughout the work of the National Academies, that we consistently come down on the side of competition and merit review as one of the hallmarks of quality control in scientific research.

Now, does that mean that someone can't do excellent work at an earmarked center? No, of course not. And the program is fairly mature now, so that it is conceivable that the current portfolio of centers is better than the ones that we had 15 years ago.

But I do think that if one did want to open up a purely competitive environment and restructure the program in that manner, I think there would be this question that Dr. Deakin alluded to—is the dual purpose of the program; research on the one hand but also attracting young, talented professionals into the field and giving them a good educational experience.

And that—it is not that you can't do both of those things, and probably there are many people in this room that were in programs that did both, but I think it would require some thought. Because there are other ways to provide support for graduate students besides University Transportation Centers programs. And so that would have to be considered if we were starting from scratch.

Dr. DEAKIN. I would say that the centers actually started out as a competitive program in the first round in 1987. Unfortunately, the competition was organized by federal region, and transpor-

tation excellence isn't necessarily distributed evenly by federal region, and so that wasn't purely competitive in the way I would think you would want to organize it.

If you look at the earmarked centers, they are a very mixed group. Some of them are top research universities. Two that come to mind immediately are Northwestern and Minnesota, either of whom would be able to compete very effectively for research dollars. Some of them are much more modest, local teching colleges that are not known particularly for research, and their research is modest, and I would actually leave it to their own State and local people to tell us whether they are producing the people that they need, because I see those as workforce development investments for those centers.

And I think RITA has encouraged that aspect of it, that they really try to make sure that they are measuring whether their people are ending up going into transportation jobs and being productive in those jobs. So looking at that dual role, that has certainly been an issue in this business.

One thing that I've thought about that might be a way to manage this process, I believe in competition. I think competition sharpens everybody up, makes us all work harder, think harder, try to get creative. It is good to get a push, so I don't mind having to compete. I think it is actually good for us, and if we got our comeuppance, I think it probably would teach us a lesson. So we would do better the next time. So I support competition.

One strategy that has been discussed and has operated in the past has been you got an earmark but then after a few years you are expected to compete, and there won't be as many centers as there are competitors or maybe new people can come in and compete as well. And I think that has actually worked pretty well, because it is removed from the process some centers that really weren't able to be productive and let other people who might not have either the political connections or the famous professors yet—

Chair WU. Uh-huh.

Dr. DEAKIN.—to get into that process, and some of those centers have really developed and become good research centers frankly, so—from the earmarked center. So I think we have seen the earmarks being productive in both producing people and producing research in at least some cases that would be competitive on any ground.

So I would say go for a process that encourages competition periodically after an initial period, even if there are earmarks, because that sharpens everybody back up. Let those centers that haven't been able to get their act together and perform be removed from the process in a rational way, and let other people take a chance and say, we want to do this, we think we can, and go for it.

Mr. BRUBAKER. Yes. I just—if I can add one additional thing, though, I want everybody to be really clear that the money that is designated for the UTC Program only represents a portion of the work that gets done. Obviously you have got the match issue, but frankly, most of the UTCs that I go to get, collect a lot of additional money from Federal Highway Administration, Federal Transit Administration, really the Department of Transportation, as well as

the private sector. They do privately-funded activity that builds on that foundation, whether it is an earmarked UTC or a competitive UTC.

So, I mean, they have sort of stood alone, for the most part they kind of stand alone and have their transportation credibility, if you will. You know, they are—and I think that is a relatively positive impact.

Now, there are other universities out there who are not UTCs at all who get millions of dollars in federal money from the Department of Transportation. I will give you a prime, you know, Virginia Tech is one, for example. They do a lot of great research, they get quite a lot of money from the Department of Transportation as well as the private sector, and operate outside of the UTC Program. The only issue that I have got with that is I don't have the same visibility into what goes on there as I do in the UTC Program as former RITA administrator.

Chair WU. Well, as we look at this issue I do want to capture the strengths of competition but recognize that we have different missions to perform, whether it is research or workforce development.

And also recognize that there are failed or imperfect markets or competitive environments. In a country like ours it is hard to criticize competition or merit review unless you look at the history of how some of these organizations or processes developed. And in the development of the science establishment after World War II, it was dominated by a few institutions, and into the '60s and '70s the peer review mechanism shall we say was just far from perfect, because people knew each other. People knew each other's work, so even in a blind analysis of publications or grant proposals, you knew whose proposals were coming through.

So, you know, any reconsideration of this has to take into account the realities of whether a merit review truly is blind or not, the multiplicity of functions ranging from personnel development to applied research to fundamental research, and sort of the shifting centers, the foci of research, you know, who would have thought that Wisconsin would be a biomedical research center 60 years ago. I am not sure that anyone would have thought of that.

Those things need to be taken into account as we consider this going forward.

I want to invite any of you who have any closing comments to make, you all have traveled a good long distance, if you have anything else to add to this process overall, I would like to invite that at this moment.

Mr. Saenz—and I want to apologize to you as someone whose name has been spelled out and mispronounced for a long time myself—

Mr. SAENZ. You pronounced it perfect.

Chair WU. Oh, my gosh. You are very generous. Thank you, sir. I think I have massacred it at least once or twice today.

Mr. SAENZ. Mr. Chair, I think just going back and just based on our prior topic about earmarks versus competition, we at Texas thrive on competition. We think competition brings the best of both the public sector and the private sector in trying to solve problems.

I think one of the things that starts, with all things, especially in the research program, is we need to have a national plan. This national plan can be there to solve for, not highway solutions or rail solutions or public transportation, but we need to look at it as a whole to try to identify how we solve those transportation issues. And it may be a rail project, it may be a highway project or an aviation project, inter-modal system, but we need to look at it as a whole, having that one focus, having that one goal, that one plan, and then be able to then look across lines and also at the same time be able to figure out how you measure success will lead to a better program.

Chair WU. Terrific. Thank you very much.

If there is nothing else for the good—Mr. Brubaker.

Mr. BRUBAKER. Just briefly for the good of the order here. I, first of all, I just want to commend you and the Ranking Minority Member for your leadership on this issue. I think this is really critical, and like I said in the opening, represents a real tipping pointing in our ability to transform the transportation infrastructure and make it more flexible and responsive to our needs.

The one thing that, and you know this, this goes without saying, and I don't want to minimize the complexity of this issue, but at the same time I have been in Washington long enough to know that when people use the word, complex, they really mean can't be done, don't bother doing it, don't bother breaking the rice bowls, don't bother breaking the stovepipes.

I firmly reject that. I think this is a very manageable situation. I think we just need to look at it from a high level. I think Mr. Saenz said it very well when he said, you know, we need that plan. We need that holistic plan.

For example, you know, if we are thinking about how to best move congestion at the ports, well, if you give that project to the Federal Highway Administration, they are going to give you a highway answer. You give it to Federal Rail Administration, they are going to give you a rail answer. But it needs to be some holistic answer, and I think the only organization within the Department of Transportation that has the ability to focus multi-modally and holistically is, in fact, RITA.

Lastly, I would just be remiss and as an ex-staffer I always loved to do this, I want to thank Meghan and Mike and Travis and Victoria for their help here, and as, and certainly Shep, and Shep, I know it is your last day. We are really going to miss you over at the Department, and really just appreciated your service here. So thank you.

Chair WU. You are good. You are good.

Anything else for the good of the order?

Well, I want to invite all of you to think—one topic I did not get into at all today, and it—we will save this for—as a topic of a future hearing, because it is a very big topic, and that is green transportation, green infrastructure, and better ways to plan and do things so that we are cognizant of the footprint that we leave both today and in the future and looking at our inputs as well as outputs.

And I want to commend that set of considerations to you all because I know that many of you, or all of you have been dedicated

to that already and will have suggestions for us as we go forward in considering the green transportation and green infrastructure issues and as we go forward in developing a research title for the Surface Transportation Bill.

I want to thank you all for appearing now this afternoon and thank you for coming a good decent distance. The record will remain open for additional statements from Members and for answers to any follow-up questions that the Committee may ask of you all. The witnesses are thanked and excused, and the hearing is now adjourned.

[Whereupon, at 12:15 p.m., the Subcommittee was adjourned.]

Appendix 1:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Paul R. Brubaker, Former Administrator, Research and Innovative Technology Administration, U.S. Department of Transportation

Questions submitted by Chair David Wu

Q1. You believe that a “holistic” approach to transportation research is needed. How does that differ from the current approach? What are the barriers that keep the Department of Transportation from utilizing this holistic approach?

A1. The current approach to transportation research is modal-centric and territorial. Research budgets are based on overall funding levels and historical funding levels rather than actual need or value to the overall transportation enterprise. This approach needs to be fundamentally re-thought and the approach must not only be much more multi-modal but must be integrated and enterprise-wide. That is, the Department should be approving research in the strategic context of what will add the most value to the national transportation system. Additionally, some portion of research should look to new and innovative approaches to transportation that do not fit nicely into one of the traditional modal stovepipes. For example, there should be a robust transportation-related alternative fuels component to research as well as intermodal and multi-modal modeling and simulation. While some of this activity exists within the modes today the activity is modal specific.

Fundamentally the barriers that exist that prevent taking this holistic approach are structural and cultural. The Department is organized around “modes” when in fact passengers and freight often use multiple modes to get from their origin to destination. We need to think of passenger and freight movement more holistically and begin to address challenges within the transportation system in this context. When commuters come into work they often drive or take a bus to a train station, board a train then may take a bus to their destination—involving multiple modes. When freight moves it often uses short sea shipping, rail and highways. Yet these multiple modes are hopelessly stovepiped and do not focus on the most efficient way to move people and freight in a holistic end-to-end manner.

This situation clarifies the notion that our national transportation system is really a system of systems that are poorly coordinated and are consequently not as efficient as they could be. There are also Congressional jurisdiction issues that come into play. For example, despite the fact that we move goods and people using multiple modes—the authorization does not take into account these multiple modes in an holistic manner. For example, if we could make tradeoffs between investment in high speed rail and airport investments in major cities it could result in obviating the need for building more airport capacity and replacing it with a more environmentally friendly high speed rail system—as well as result in taking a number of vehicles off of the road that travel between city pairs. Yet the separate authorizations between rail, air and road are not really set up to address this holistic view. Moreover, the tradition of using highway trust fund dollars to only support highway projects is antiquated. We must think of the entire transportation enterprise—whether it is the research program or the overall operation—much more holistically.

The lack of this holistic, system of systems approach has also resulted in missing some major issues and has perhaps even stifled innovation. For example, the transportation system is dependent on a cheap, abundant supply of energy. When the price of gasoline and diesel fuel jumped up over the past summer—the Department was caught completely off guard and unprepared. Naturally, vehicle miles traveled plummeted and suddenly congestion was reduced. However public transit ridership increased substantially and demand for Amtrak seats up and down the Northeast corridor was at capacity. There was no modeling and simulation capability within the department to even understand or predict what would happen. The devastating impact this situation had on the supply chain could have been entirely predictable if research and information gathering activity was directed in a manner that better understood the holistic condition of the passenger and freight movement system performance rather than focused on the traditional needs and narrow interests of the Department under its current modally focused research and information gathering structure.

Questions submitted by Representative Adrian Smith

Q1. You say in your testimony, “currently, there is no systematic or focused program, process, or set of activities that are driving innovations out of the laboratory and onto our nation’s roads, rails, runways or waterways.” In your opinion, what are

the current mechanisms for uptake of new transportation innovations? How could these mechanisms be improved? Does this assessment hold true for innovations in vehicle design and safety? If not, what are the differences between vehicle and infrastructure improvements?

A1. The Department and research community within the Department specifically has discussed technology transfer and many individuals have that role in their job descriptions. Additionally, many programs within the department like the Intelligent Transportation Systems Joint Program Office are required to consider technology transfer as part of its mission. Within RITA the RD&T program has a technology transfer role and the Federal Highway Administration, Federal Aviation Administration and other modes have key roles in driving innovation into the transportation system. However there is not well organized, systematic, enterprise-wide effort to drive innovation out of the laboratory and into the transportation system.

If you were to ask the research community about technology transfer they would suggest that the Transportation Research Board annual meeting represents a major technology transfer activity as does publishing research in peer reviewed journals. In my view, and this is based on a general familiarity with technology transfer and commercialization programs in major universities, research institutions and states, the Department and transportation community does not do a very good job of driving innovation into the transportation enterprise. This is mostly because transportation research has been an inside game—one that is managed and controlled by those with the biggest pockets who do not see anything wrong with the current system or the pace of innovation deployment.

Given the Department's almost \$1.2 billion investment in research each year, and by virtue of the fact that our economy requires rapid deployment of innovation to maintain its competitive edge in an increasingly competitive global economy—this somewhat casual approach does not seem to make sense. Based on my experience, I would advocate an office of technology transfer and commercialization be established within the Research and Innovative Technology Administration that is adequately resourced to monitor the research activity of the department and highlight the intellectual property that is being developed for opportunity to commercialize or transfer in a manner that would further the state of research in a particular area.

You asked if my assessment of weak mechanisms for uptake of new technology applies to vehicle design and safety innovation. The short answer is yes but not because the mechanisms don't exist or don't ultimately produce a result but rather because they are slow, excessively bureaucratic and cumbersome. To be sure, the National Highway Traffic Safety Administration (NHTSA) does a good job of collecting data and statistics to support their recommendations—its just the processes they employ and the timelines they find acceptable are inconsistent with technology development cycles and tend to stifle innovation and companies who desire to build, test and deploy safety-related technologies. For example, when I left the Department we were still waiting for NHTSA to validate that certain communications technologies were appropriate to use in safety applications. This is important work to be sure—but something we have been examining for the last four plus years and it was going to take NHTSA two years to complete its study. When technology improvement cycles follow 18 month timeframes—it is difficult to see how these processes can support timely and effective deployment of new safety technologies.

NHTSA does not like criticism. To be sure, they have presided over many beneficial safety regulations and requirements and there are people alive today thanks to the work of the agency. However, there is room for improving research and how technology transfer, innovation and commercialization in the vehicle safety area. However, any constructive criticism or attempt to influence research in the safety area generally results in turf warfare. Any attempt outside of NHTSA to suggest new opportunities or processes related to safety generally elicits a negative reaction—and the agency is great at working the office of the Secretary—at least this was true during the last administration—so that any criticism was met with the suggestion that any change these processes or procedures will compromise the safety of the American people. In other words, criticize the process you criticize safety—when in reality these processes—particularly the safety benefit validation processes—could be significantly improved to expedite innovations into the field.

It might interest you to know that NHTSA carved out an exemption from RITA oversight during the drafting of the Mineta Act. The argument, as I understand it, was that the safety research conducted by NHTSA was too important and critical to be subject to oversight by a centralized research oversight organization. Frankly, this exemption speaks to desire and ability of the agency to insulate itself from criticism, oversight and review by hiding behind the safety mission. Undoubtedly, the response from NHTSA will be that the roads are the safest they have ever been.

However, when more than 40,000 people die on the Nation's road each year—roughly the entire population of Grand Island, Nebraska—we should do whatever we can do ensure that the latest safety technologies are deployed as quickly as possible.

Certainly there are differences in vehicle and infrastructure research but they should not be artificially stovepiped as they both represent individual systems in the holistic system. We should begin looking at vehicles and infrastructure in a more integrated fashion—particularly with the development of next and future generation intelligent transportation systems when the vehicle and infrastructure will become significantly more integrated. Before I left, we launched the IntelliDrive initiative which envisions modern sensor and communication technologies enabling an entirely new safety paradigm that integrates vehicles with the infrastructure.

Q2. Do we need to produce a new, comprehensive strategy for our nation's highways? If so, should this strategy include other transportation modes? Who should be charged with developing such a strategy and how often should it be updated?

A2. We do need a comprehensive strategy for not only our nation's highways but an integrated strategy for the entire transportation system—including how we fuel the transportation system. This comprehensive strategy—I have called it holistic but I mean the same thing—should include all of the modes of transportation—ships, transit, highways, rail and air. The focus of the strategy should be on how both freight and people move across the system with a keen understanding and data regarding system performance. This would help us better understand how people and goods really move across the country and where the bottlenecks and safety issues are in the system.

This strategy should be fact-based and contain analysis, business cases and public benefit business cases outlining how projects and programs will measurably improve the performance and/or safety of the Nation's transportation system. This will require a robust and modernized ability to collect, analyze and disseminate transportation-related data. Currently, the Bureau of Transportation Statistics—which is inside of RITA, does not have an adequate or complete picture of all of the system and safety performance data that would be required to support such a strategy—mostly because it is grossly underfunded and does not have the data resources and personnel that would be needed to develop such a comprehensive view and analysis of the passenger and freight systems. In this same area, we also need to better understand how the system responds to externalities—like natural and man-made disasters, changing fuel prices and unexpected events. The Department should have an organic capability to conduct modeling and simulation around various policy, project or event scenarios.

The National Transportation System Strategy should be developed collectively although the Secretary of Transportation should be charged with developing the strategy and putting pen to paper. Congress could and should propose a restructuring of the Department along the lines suggested—although if nothing else could propose a commission to study and recommend a new structure that better reflects the way people and goods move across the country. I think this strategy should be developed every year and reflect a rolling five year vision of where we are going with the transportation system in this country—that lays out the very clear priorities of the Department and drives investment and alignment over the period. When I was at RITA we put together a forward looking document called “*Transportation Vision for 2030*” which from a thematic perspective could provide a useful construct—but the goals should be bolder and the strategy should provide tactical guidance in terms of organizational alignment and budget formulation and execution.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Elizabeth Deakin, Professor of City and Regional Planning; Director, University of California Transportation Center, University of California, Berkeley

Questions submitted by Chair David Wu

Q1. You recommended in your testimony that more research be subject to “arms-length” evaluations. Could you describe how many of these evaluations are currently done and how you believe they should be done? How would these evaluation processes be changed? How can this be encouraged either by the DOT or by legislation?

A1. Arms-length evaluations of research are important for credibility and can help target research dollars on the most cost-effective and creative topics. Independent evaluators can be asked to point out strengths and weaknesses in the research design, comment on the reasonableness of proposed expenditures, evaluate the qualifications of the researchers and their track records, estimate the contribution that the research is likely to make, and identify whether the proposed research is innovative or duplicates other past or ongoing research.

In the research community, peer review is the norm. Journals and some university transportation centers use either double-blind or confidential reviews and the reviewers are selected both for their subject area knowledge and for their ability to provide a dispassionate evaluation. In the most rigorously organized peer reviews, research collaborators, former students and former professors, and anyone with a close professional or financial interest in the outcome are disqualified from participating in a review.

Peer reviews are not perfect—for one thing, reviewers often know or can surmise the authors and vice versa, despite the removal of identifiers, and big names and big institutions may sometimes be given deference that the proposal might not actually deserve. Despite these flaws, most researchers agree that outside peer review is the best way we have devised for obtaining independent evaluations of research proposals and products and reducing biases in the evaluations.

On the other hand, there is also a desire research to be relevant to users, especially short-term, applied research that is expected to lead directly to a deployable product. For this reason reviews by outside researchers are often complemented by reviews or project oversight by practitioners, industrial partners, and others with a direct interest in the outcome. Such reviews and oversight are especially helpful in raising practical questions about the utility of a product, the size of the market for it, competing products and their pros and cons, etc.

In addition to peer review and end-user reviews, strategies for obtaining evaluations that can be of value in guiding research programs include:

- Using independent expert panels to generate research topics, review research proposals, oversee research as it proceeds, and review products. (This can be the same panel or different panels at each step.)
- Public agency and industry advisory committees, who can bring user and researcher viewpoints into the evaluation process while maintaining some intellectual distance. Independence of the reviewers can be built into this process. For example, some state DOTs enlist representatives of other state DOTs and universities outside the state to evaluate their research programs and major projects. Because panel members are not competing for the grants, they are more likely to be dispassionate than local reviewers might be.

NSF uses independent expert reviewers, and NAS committees evaluating research and research needs are typically independent expert panels. NCHRP and TCRP use stakeholder review panels to select and review projects. USDOT also uses these methods for some of its programs, but also does many reviews internally, in some cases because there's a lack of resources to bring in outside reviewers. Many states have research advisory committees, but for projects rely on internal staff review and (sometimes) project advisory committees composed of likely end users. The University Transportation Centers program calls for peer review of research proposals and products but does not provide much guidance on what qualifies as peer review.

Congress could mandate independent reviews by peers and end-users for all major research programs (as well as for field tests, demonstration projects, and other major projects) and provide funding for such reviews as part of program costs.

Q2. Please elaborate on your comment that other countries, like EU countries, Canada, and Australia, are ahead of the U.S. in terms of developing a strategic out-

come based plan for transportation research. What strategic outcome metrics do these countries use? What have been the impediments in the U.S. to utilizing a strategic outcome approach and what can the U.S. draw on the experiences of these other countries in developing its own national strategic transportation research plan?

A2. Transportation research would benefit from a mixed portfolio including some long-term, basic research whose application is uncertain as well as more applied research and development—some of which may nevertheless be years from application, and some of which could be implemented in the short-term and therefore should be coordinated with transportation plans and programs in order to move R&D results into implementation. Partnerships for implementation should extend not only to federal and State transportation agencies but also to the many other federal, State and local agencies, businesses and industries that have roles in implementation of transportation projects or products or are users of transportation products.

A study currently underway with funding from the Volvo Educational and Research Foundation, involving researchers from Leeds University in the UK as well as from UC–Berkeley, is examining the problem of moving research from studies to actual use by investigating how innovative cities and regions learn about innovations. Preliminary findings are that loose networks of professional acquaintances are a principal way for information on innovations to be transmitted among end users, and that professional meetings and short articles in publications are more valuable to professionals than are journals. Further, meetings that cross disciplinary boundaries are more effective in transmitting new ideas than are specialty conferences, which are better at developing expertise than at spreading new ideas. Researchers use both formal journals and their own networks to learn about new ideas and to share them. The work suggests that an important way to speed up knowledge transfer is to encourage participation in professional activities, especially ones that can attract participation from multiple disciplines and specialties.

In a related study just getting underway, UC–Berkeley researchers are looking at ways that transportation, urban development, and environmental agencies and foundations select and evaluate research and disseminate research findings. While the study is just getting underway, we have identified several good examples that could be adopted by U.S. transportation agencies. For example, Sweden uses international panels of experts to help evaluate its research agendas, assess research progress, and advise on action items.

A second study reviewing transportation policies in Canada, the UK, and Sweden, conducted by the Center for Global Metropolitan Studies at UC–Berkeley, offer examples of best practices in prioritizing projects, including research projects. The general approach is as follows:

- 1) **Adopt national goals and objectives, along with performance measures which track accomplishments.** Typical goals for transportation are improved access, efficient movement, economic growth, environmental quality, and social inclusion. For each goal, specific performance measures are identified and agencies must measure and report their achievements.
- 2) **Require horizontal and vertical policy integration:** National transport policies are required to be coordinated with policies for other infrastructure, housing and urban development (both urban redevelopment and new town programs), economic development, and the environment. In addition, local and regional policies are expected to be consistent with national policies. Inter-departmental and inter-governmental coordination mechanisms including joint committees and jointly funded programs have been established to help achieve this integration. In some countries policy integration is also being accomplished in part through institutional restructuring: Canada's and Sweden's national transport authorities lie within broader ministries, the Ministry of Transport, Infrastructure and Communities in Canada (created in 2006) and the Ministry of Enterprise, Energy and Communications in Sweden. The UK Department for Transport (DfT) is a stand-alone ministry but transport plans must align with the umbrella land use (spatial) plans at the local, regional and national level and local transport plans are reviewed by the DfT for adherence to the spatial plans and the DfT Smarter Choices campaign to lower carbon emissions.
- 3) **Align project selection criteria to national goals.** Project selection criteria are required to reflect the national goals, objectives, and performance measures.

- 4) **Provide information and incentives for government at all levels as well as citizens and businesses to support and help meet the goals.** Funding programs, tax policies, and pricing strategies have been revised to focus on achievement of national goals and objectives. Programs have been funded to encourage citizens and businesses to reduce their carbon emissions, for example. In the UK, nationally sponsored marketing programs are also underway to let people know what they can do to reduce emissions.
- 5) **Provide funding and create room for experimentation with innovative strategies.** For example, both the UK and Sweden have used pricing to manage congestion in their largest cities, London and Stockholm; in the Swedish case this experiment was led by the national government.
- 6) **Encourage public-private partnerships.** Canada recently established and funded an Office of Public Private Partnerships as a component of the \$33B multi-year Infrastructure Plan.

While these steps are largely aimed at aligning investment programs and projects with national goals, research agendas have been developed to help achieve the national goals and are being funded. In the U.S., such research agendas have sometimes been developed (e.g., the Transportation environmental research program requested by Congress) but there has been less consistency in connecting research expenditures to either the research agendas or to national policy directives.

Q3. If UTCs were competitively awarded, what are the criteria that should be used in the award and evaluation process?

A3. RITA currently requires that University Transportation Centers report on their products in research, education, human resources, and tech transfer. The specific criteria are:

- 1) the number of projects selected for funding
- 2) the amount budgeted for those projects
- 3) the number of research reports published
- 4) the number of research reports presented at academic/professional meetings
- 5) the number of transportation courses offered
- 6) the number of students participating in transportation research projects
- 7) the number of transportation degree programs offered
- 8) the numbers of students enrolled in those programs,
- 9) the number of transportation-related masters and Ph.D. degrees awarded
- 10) the number of seminars, symposia, and other activities conducted for transportation professionals and
- 11) the number of professionals participating in those events.

In addition, RITA requires centers to demonstrate the capacity to manage the grant effectively, both in terms of business services and in terms of a Principal Investigator who can provide appropriate intellectual leadership.

These are straightforward performance criteria that can be used to evaluate the productivity of the transportation centers or the capacity of prospective centers to perform well. The 11 criteria focus on inputs and outputs and hence are useful in measuring productivity. They are easily and objectively measured. Even so, the meaning of the numbers—what value to place on a high or low result—still requires interpretation.

In addition, university transportation centers could be evaluated based on **outcomes or accomplishments resulting from these activities**, including:

- 1) extent to which research results have opened up new research directions, led to new fields of study, and/or led to new or substantially improved practices, including systematic interdisciplinary approaches addressing emerging issues in science, technology and multi-agency, multi-jurisdictional, and/or public-private partnerships to improve implementation of research results
- 2) percent of graduates in last five or 10 years who are practicing in the field of transportation; number who have risen to leadership positions in the transportation field
- 3) extent to which professional practice has changed in notable ways as a result of technical assistance and tech transfer activities.

These latter criteria are harder to measure and are more subject to interpretation. However, they are the sorts of criteria often used to evaluate quality and outcome

changes. Independent peer review panels are a common way to implement evaluations using such criteria.

Nascent groups would be placed at a disadvantage compared to long-established centers of excellence if the focus is primarily on accomplishments and resources already in place, and so it may be useful to have separate criteria for new centers, such as the following:

- 1) a minimum of three regular/permanent (tenured or tenure-track) faculty members whose teaching and research is primarily in the field of transportation (or a university commitment to hire such faculty members during the first two years of the grant)
- 2) a university commitment to offer at least one degree program with a formal, university-approved specialization in transportation
- 3) transportation research funding of at least 20 percent of the amount of the grant on average over the past three years or a commitment of matching funds of at least 20 percent of the amount of the grant for the period of the grant
- 4) evidence of current or proposed collaboration (extant and planned) of major State, regional and/or local transportation agencies and private sector organizations with an interest in transportation, as evidenced by letters of support and commitments for matching funds.

These criteria would also be useful in sizing grants to institutional capacity.

Questions submitted by Representative Adrian Smith

Q1. Your testimony suggests that one reason for limited adoption of transportation technologies may be a lack of trust in the assessments that are available. Can you describe what factors limit the credibility of current assessments and can you give us an example of assessments, perhaps in other research areas, that have been successful? What actions would be required for transportation officials to restore their trust in these assessments?

A1. Trust in technology assessments, and more generally in assessments of the likely impacts of prospective investments, depends in large part on how accurate past assessments have been. Many studies have found that benefits have been overestimated and costs underestimated; the pattern of error is not random. Technology assessments, travel demand forecasts and cost estimates for new transportation investments (roads, tunnels, bridges, rail projects) have been the subject of considerable study in recent years, and scholars such as Bent Flyvbjerg and Daniel Kahneman (among many others) have examined why forecasts and other prospective assessments are inaccurate. Kahneman has identified psychological factors leading to “optimism bias” whereas Flyvbjerg believes that there is considerable “strategic misrepresentation.” Other factors including unforeseen changes or instabilities in factor prices (e.g., fuel price fluctuations) also have affected the accuracy of forecasts, of course, but these factors have been found to be insufficient to explain the gap between forecasts and results.

Strategies that have been recommended for overcoming these problems include:

- Use of independent peer review committees as evaluators. For example, both U.S. and EU universities call upon outside panels of experts to review university programs. Some transport programs in the EU also use peer reviews of this sort to take an independent look at the justification for proposed projects. While peer reviews are not perfect—especially if peers are drawn from a “club” of associates—awareness of their limitations has led to improvements in the design of peer review teams, often by including international experts, experts drawn from industry, and experts from a variety of disciplines as part of the assessment team: people with a bit more distance from the individuals and agencies being reviewed.
- Scenario testing is a method that acknowledges uncertainties in key factors that could shape future markets and opportunities. Scenario testing has been used in the U.S. by several states and Metropolitan Planning Organizations to assess alternative urban development and transportation investment packages and has been used by corporations such as Shell to investigate energy futures as a function of, among other things, public attitudes toward energy conservation and the environment. The development of the scenarios is typically done with multi-disciplinary expert panels, and in public settings, with public involvement.

- The UK Department of Transport has adopted a cost estimation procedure, reference class forecasting, that accounts for “optimism bias uplift” by adjusting costs upward and/or demand forecasts downward, based on past experience with similar projects. It is most easily applied when there are in fact similar projects, and is not as easy to apply to unique projects or new ideas that have not been examined before.
- Focus groups are used to test consumer responses to new products and options in relatively quick, inexpensive ways.
- Other market research techniques that can help assess technologies include stated preference surveys and consumer panels that participate in repeated surveys and/or focus groups over a period of time, sometimes several years.
- Demonstration projects and field tests are ways to further test markets but also to investigate implementation barriers and opportunities. Demonstrations and field tests often can be improved by including a wide range of stakeholders in the design (so that all the factors that might affect implementation are included). Third party, arms-length evaluation of demonstration projects can be valuable in reducing the danger of optimism bias (a risk if the evaluators of the demonstration are also the proponents of the demonstration) or too narrow a scope in the design and evaluation of the demos and field tests.
- Markets can offer a test of technology readiness, risks and opportunities: is there a business plan for implementation and are private investors interested in the opportunities presented?

Q2. Do we need to produce a new, comprehensive strategy for our nation's highways? If so, should this strategy include other transportation modes? Who should be charged with developing such a strategy and how often should it be updated?

A2. I see several reasons for a new, comprehensive plan for the U.S. transportation system that is multi-modal.

First, we need to find an effective way to pay for the transportation system. The highway trust fund is depleted, and changes in vehicle and fuel technologies seem likely to make the gas tax increasingly problematic. How to pay for both urban/metro and rural highways needs to be considered in terms of emerging energy futures and technology options. In metropolitan areas, how to pay for transit services also needs to be part of the discussion. New technologies can make paying for transportation fast, efficient, convenient, private, and flexible, and multi-modal applications could be made available.

Second, we need to pay more attention to freight movements, which are critical to the economy but also have high impact on the Nation's transport systems. Truck and rail freight systems must link to each other and to ports and airports more effectively. Better strategies are needed to manage the heavy and often concentrated traffic impacts that result from international trade through major ports. Freight movements are inextricably linked to security concerns and technology applications and better planning and management could yield major improvements. A plan to pay for freight improvements equitably is also needed.

Third, there are promising opportunities to reduce costs and improve performance by implementing new technologies for applications ranging from data collection to user fee collection to improved safety and security, but these options need evaluation in the context of ongoing investment programs and in comparison to more conventional approaches.

Fourth, we might be able to have better, cheaper, faster transportation services for both passengers and freight if we coordinate across modes better. For example, it's increasingly important to discuss whether we should be investing in truckways, moving more freight to rail, or finding new truck-rail combinations for freight movements. Opportunities for better service at lower cost could result if we plan for and coordinate urban transit, conventional passenger rail, and (in some cases) high speed rail with air travel modes; rail could not only serve as an airport access mode but could simultaneously serve a substitute for some short-haul air trips (as is happening in the Boston-Washington corridor), and a commute option in some markets.

MPOs currently prepare transportation plans that cover highways and transit, and increasingly address freight within their boundaries. Some states also have been developing strategic plans covering these critical topics. It would be timely to evaluate the performance of MPOs under the new responsibilities given them since ISTEA, to review State transport policy, planning, and investment strategies over the same period, and to look at how well states and MPOs are coordinating investments and evaluating projects. Such a critical review and assessment could be done in one to two years if mandated by Congress, and could provide valuable information on best practices and needed changes in practices. The resulting information

would be extremely valuable in shaping a new strategic plan for USDOT and the Nation, and might offer new ideas on how to restructure categorical grants, create incentives for cost-effective and high benefit investments, and make better use of new technologies in transportation.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Amadeo Saenz, Jr., Executive Director, Texas Department of Transportation

Questions submitted by Chair David Wu

Q1. In your testimony you described the benefits from the first Strategic Highway Research Program (SHRP). What benefits do you envision from SHRP-2?

A1. The Texas Department of Transportation (TxDOT) envisions that there will be benefits from all areas (Safety, Renewal, Reliability, and Capacity) of the SHRP-2 Program. All are very significant issues in Texas and around the country. I understand that an Implementation Committee with quite a few “high level” people involved in implementing technologies at their respective agencies has been established. Although I am not an expert on the report, I am aware that a Transportation Research Board Special Report 296, “*Implementing the Results of the Second Strategic Highway Research Program*” has been published. I am confident that Texas and the rest of the country will be able to use the results to improve safety and maximize the benefits of our transportation systems.

Q2. The Texas Department of Transportation (TxDOT) sets aside funds for implementation of its research projects. Would you recommend that the Federal Government consider an implementation set-aside for transportation R&D projects as well?

A2. TxDOT recommends that the Federal Government consider an implementation set-aside for transportation R&D projects. This set-aside could be used specifically for actual “demonstration projects” around the country. This would enable it to be used for activities such as training while capturing the additional costs associated with implementing new technologies. It is also necessary to provide assistance as needed and preparing implementation documents to maximize the R&D findings. Since a lot of money is spent on research, it is only responsible that we pursue cost effective implementation.

Q2a. What percentage of the TxDOT R&D budget goes towards implementation and do you find that this is sufficient to fully implement all successful research projects?

A2a. Roughly 15–20 percent of the TxDOT R&D budget is allocated towards specific implementation projects. We follow up only a small percentage of completed research projects with an implementation project since many do not require one. Implementation can consist of activities such as adopting a specification or new standard and incorporating recommendations into our operating procedures as appropriate. I feel the budget set aside specifically for the TxDOT implementation program is sufficient because we incorporate that into the R&D project. Many times the issues are overcoming other obstacles such as staffing and the time and training requirement to prepare for a new technology. This is “new” and most of our staff is already extremely busy dealing with issues of the day and week.

Q2b. Also, in your experience, what is required for successful implementation of R&D?

A2b. Successful implementation of research begins with conducting excellent research projects applicable to TxDOT. Most of our investment is applied research, meaning we have a specific problem we are trying to resolve. As TxDOT considers implementation of research results, we carefully monitor the research throughout the entire life of the project. We set up the project to receive deliverables needed. For example, if you need a specification, set up a specification as an actual required deliverable.

Deliverables should be provided in ready to use formats to increase the chance of successful implementation. Training may also be necessary for employees that will have to implement a new technology. Perhaps, one of the most important things we discovered is the agency has to “own” and “champion” the research. Within TxDOT, for example, the Division responsible for the research results would then have to incorporate them into their standards and operating procedures as appropriate. Of course, we need to have the people and resources to make this happen, which is one of the obstacles I addressed in my testimony.

Q3. In your testimony, you noted that the USDOT could help states, locals, and counties implement the results of research more quickly and effectively if infor-

mation and requirements for the new technologies were provided in a ready-to-use format. What do you mean by ready-to-use format?

A3. Ready-to-use format would mean an actual specification or standard that could easily be adopted by State and local agencies. Another example would be to distribute something similar to our Project Summary Reports (sample attached) with completed federal research projects.

Q3a. *What information do state and local transportation officials need for implementation?*

A3a. We believe that what would help State and local transportation officials with implementation is to make readily available a brief synopsis of completed research. For example, our Project Summary Reports are limited to two pages and include information about the following: (1) Background, (2) Research (3) Findings and (4) Conclusions. This makes it much easier to determine how they might use the research results. We also provide for our entire agency and local communities all of our Project Summary Reports on the Internet.

Q3b. *Why do you think the DOT does not already provide this type of information?*

A3b. The DOT does make this type of information available on some of the projects. It just does not appear to be a consistent practice. We are simply advocating the DOT have more consistent practices in Research and Development in order to have the findings available for the State and local communities.

Q3c. *Can you provide some specific examples where the lack of usable information slowed the deployment of new technologies?*

A3c. While I do not have any specific examples of lack of usable information slowing down the deployment of new technologies, there are research results from the DOT and other states that we have not implemented simply because we were not aware of the results and their utilization. This responsibility of course rests on the State and federal DOTs, lack of communication both ways can be improved. We need to do a better job of "scanning" the provided information, web pages and newsletters from TRB, RITA, FHWA, etc. While USDOT needs to do a better job of distributing information to the right State and local people.

Q4. *You mentioned that there was resistance by contractors towards new technologies. What types of incentives or aid did TxDOT use where TxDOT was able to convince contractors to use new technologies? Do you think a similar model would be successful at the federal level?*

A4. We can classify incentives or aids that TxDOT has used to convince contractors to implement new technologies and requirements into the following categories: bonus/penalty in specifications, measuring performance-related characteristics and giving contractors flexibility to achieve them, provide tools to allow contractors to lower their costs, and implement new quality monitoring programs to reduce impact. All of these strategies include education and cooperation with the contracting industry. There would be a significant advantage if a similar model would be used on a federal level. See specific examples below for benefits at a national level.

- **Bonus or Penalty in specifications**

- *Development and implementation of Quality Control/Quality Assurance Hot Mix Asphalt Concrete specifications.*

When we implemented QC/QA Hot Mix Asphalt Concrete specifications in the 1990's, we included bonuses and penalties for mixture characteristics that produce good performing hot mix. We require contractor testing for quality control and TxDOT testing for acceptance, all with certified technicians. We worked with the Texas Asphalt Pavement Association to develop certification courses to insure that all technicians, both contractor and TxDOT, were certified to perform the required testing.

- *Implementation of Ride Quality Specifications for Pavements.*

TxDOT conducted research to develop ride quality specifications in late 1980's and early 1990's. Research showed that the public's top interests were smooth roads and safe roads. Implementation of the current iteration of the TxDOT ride specification includes bonuses and penalties, giving contractors the incentive to produce smooth pavements. Additionally, specifications require certified profilers and operators. TxDOT worked the Texas Transportation Institute to develop and operate a certification program for profilers and profiler operators.

- **Measuring performance-related characteristics and giving contractors flexibility to achieve them**

- *Implementation of HMA specifications to address aggregate segregation, thermal segregation, and joint density.*

TxDOT originally developed specifications requiring specific pieces of equipment (usually costly shuttle buggies, etc.) to address these issues. These were met with resistance on the part of contractors. Resistance was reduced when we implemented testing to identify the problems, but allow contractors flexibility to develop “fixes” on their own without requiring specific pieces of equipment.

- *ASR Mitigation Options (Preventing Alkali-Silica Reaction and Delayed Ettringite Formation in New Concrete)*

Research enabled TxDOT to add an 8th mix design option and validated the previously existing seven ASR mitigation options in our concrete specification. It has been successfully implemented by giving the contractor any of eight options for concrete mix designs to choose from. Their choice is based on their local materials, experience, etc., and been widely accepted due to the flexibility given to the contractor combined with the extensive training/awareness campaign that we undertook.

- **Provide tools to allow contractors to lower their costs**

- *Low Coefficient of Thermal Expansion / Modulus of Elasticity.*

Continuously Reinforced Concrete Pavement Standard with reduced steel percentage (to address horizontal cracking in Portland cement concrete pavements). This process will begin to be used on projects by the end of the summer of 2009. It will be presented to the contractor as a cost-savings measure to utilize if the materials he is providing for the concrete pavement meet certain criteria.

- **Implement new quality monitoring programs to reduce impact.**

- *Implementation of the Superpave Performance Graded Asphalt Binder specifications for use in all Hot Mix.*

The Superpave Performance Graded Asphalt Binder Specifications, a result of the Strategic Highway Research Program (implemented by TxDOT in 1997) involved a significant education and training program. We used the FHWA, Asphalt Institute, Texas Asphalt Pavement Association, and newly formed User/Producer groups to educate contractors, asphalt suppliers, and TxDOT personnel. TxDOT developed a new binder approval program to address asphalt producers concerns that Performance Graded Binder testing took longer to complete. We now approve a binder supplier's production instead of individual tanks as in the past. We give monthly approval to ship product and perform “check sample” testing at least weekly to monitor production.

Questions submitted by Representative Adrian Smith

Q1. How are the research needs of State and local highway decision-makers transmitted to federal research agencies?

A1. The main and perhaps most formal way that State and local research needs are considered is through the various Cooperative Research Programs managed by the Transportation Research Board (TRB). Each State DOT is afforded this opportunity on an annual basis. At least some of the various TRB technical committees collect research needs from their committee members, who are from both State and local agencies. With regards to transmitting our research needs to the Federal Highway Administration, we are not aware of a formal mechanism.

Q1a. Alternately, how are the results of research performed with federal funding transmitted to these independent, local decision-makers?

A1a. All of our completed research reports are available on the Internet so if a local agency needs information, they may be able to access it through those means. The larger local agencies are typically more in tune to some of these activities so it is easier for them. They are also fairly familiar with our specifications and standards. The smaller local agencies have, of course, different needs. They would only be able to apply results from a small number of our research projects. Our local TxDOT dis-

strict employees have very good working relationships with these local officials and often assist them with some of their technical questions and needs.

Q1b. Do the research projects themselves need to be changed to meet the needs of the local officials, or do the results of these projects simply need to be communicated more efficiently?

A1b. We all need to do a better job of simply communicating the results more efficiently, and perhaps more importantly, making this information readily available and easy to find.

Q2. Do we need to produce a new, comprehensive strategy for our nation's highways? If so, should this strategy include other transportation modes? Who should be charged with developing such a strategy and how often should it be updated?

A2. Not only do we need a comprehensive strategy for our nation's highways, we desperately need a national transportation plan. This national plan should not be limited to the highways but should include all modes of transportation. We need to do more than mandate processes, we need to establish goals and meet them. States are looking for Congress to define a national strategy and provide the policy framework that empowers states to set these goals, make decisions, and deliver projects that implement the national strategy.

Transportation legislation should be consumer-focused and recognize that Americans expect congestion relief, cleaner air, improved economic opportunity, well maintained roads, and increased safety. Transportation systems should be evaluated based on improvements in performance standards and predictable travel times. Processes mandated by law should be streamlined and harmonized to enable the delivery of new transportation systems, not arrest their development. The national strategy should be reviewed every few years to make sure it is still viable and not just a place holder for transportation policy.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Robert E. Skinner, Jr., Executive Director, Transportation Research Board of the National Academies

Questions submitted by Chair David Wu

Q1. TRB will be issuing recommendations regarding research on climate change mitigation and adaptation.

A1. The TRB Executive Committee has been proactive about addressing transportation's role in climate change for some time. A self-initiated study in 1997 was designed to raise awareness about highway transportation's large and growing role in GHG emissions and to begin debate about mitigation options.¹ Another self-initiated study completed in early 2008 addressed the potential impacts of climate change on transportation; it includes recommendations for important initiatives, research, and standards revisions to facilitate adaptation.²

Q1a. What has prompted this new approach?

A1a. In reviewing the proposals being developed for surface transportation research last summer, the Executive Committee noted the absence of proposals addressing climate change mitigation and adaptation. Hence, it initiated a fast-track project to develop research program proposals for Congress to consider. The first drafts of the background papers commissioned for that project have been shared with your staff. This study is being conducted by a committee of experts, who will use the revised drafts of these papers, other relevant materials, and their own experience and judgment to develop their findings and recommendations. The report is expected to be complete in the August–September 2009 time frame.

Q1b. How much has FHWA spent to date on climate change issues?

A1b. FHWA provided an estimate that they have invested about \$6 million over the FY 1999 to FY 2006 time period on planning and environmental research directly related to climate change. The USDOT total share of the Federal Government-wide Global Change Research Program for 2007 to 2009 has ranged between \$0.7 and \$1.9 million, most of which is attributable to aviation research by the Federal Aviation Administration.³ Focusing only on FHWA R&D expenditures specific to climate change, however, is misleading. Important areas of ongoing research at FHWA are directly related to strategies for mitigating transportation greenhouse gases. For example, the results of ongoing traffic operations research, including ITS, to reduce congestion; programs to encourage and evaluate road pricing strategies; and improvements to regional travel and land use models will be quite helpful in informing future policy choices and operational strategies. FHWA research related to adaption will also be valuable. It has been investing in bridge hydraulics research to better understand and predict hazards from bridge scour, which may become more of a problem in areas that become more prone to flooding in the future.

Q2. TRB recommended that University Transportation Centers should be competitively awarded. What specific evaluation criteria does TRB suggest be used to evaluate and define a successful UTC?

A2. TRB has been involved in the UTC program since its inception, most directly in its early years. The Board convened peer review panels to assist USDOT in evaluating the initial applications of university consortia in the late 1980s, and, subsequently, to review the third and fourth year program plans of the centers. In 1993, TRB issued a report requested by USDOT to help them assess the quality of the centers.⁴ Much of the advice in that report remains relevant, even though the UTC

¹ Special Report 251, *Toward a Sustainable Future: Addressing the Long-Term Effects of Motor Vehicle Transportation on Climate and Ecology*. Transportation Research Board of the National Academies. Washington, D.C. 1997.

² Special Report 290, *Potential Impacts of Climate Change on U.S. Transportation*. Transportation Research Board of the National Academies. Washington, D.C. 2008.

³ *Our Changing Planet: The U.S. Climate Change Science Program for Fiscal Year 2009*, A Report of the Climate Change Science Program and the Subcommittee on Global Change Research: A Supplement to the President's Budget. p. 232. <http://www.usgcrp.gov/usgcrp/Library/ocp2009/ocp2009.pdf>

⁴ *Measuring Quality: A Review Process for the University Transportation Centers Program*. Transportation Research Board of the National Research Council. Washington, D.C. 1993.

program has grown from 10 to 60 centers and expanded its focus to include education and training.⁵

The committee convened to prepare *Measuring Quality* recommended a three-tiered review process: (a) a program-level review to evaluate the collective products of each center, (b) a center-level review to evaluate the performance of individual centers and (c) a project-level review to assess the quality of individual research projects and courses. The committee noted that measuring quality requires making subjective judgments about the value of programs and the quality of products. It recommended reliance on review panels made of academicians and professionals free of conflicts of interest. USDOT subsequently required regular peer review of UTCs. The committee also recommended the development of quantitative measures of output, such as the number of students supported by and graduated from UTC centers and the number of articles and the number papers on UTC-supported research published in peer-reviewed journals, conference proceedings, and other scholarly publications.

In its assessment of highway research, including the UTC program, the Research and Technology Coordinating Committee (RTCC) noted that a more useful output measure of the UTC educational mission than the number of students graduated would be the number placed in transportation agencies and firms.⁶ The RTCC also reiterated the value of reporting on peer-reviewed publications of research supported by UTC funds. It noted that, whereas the UTC program requires that centers be peer reviewed, these reviews are not shared beyond the center. RITA's UTC program managers, at least, should have access to such reviews as a basis of judging the quality of the centers funded with federal aid.

The intent of the committee's second question implies development of criteria for the selection of UTCs through a competitive process. Although most UTCs are not selected competitively currently, the UTC program does have competitions for the selection of the 20 Regional and Tier 1 centers. TRB has not been involved in these competitions in recent years, so we are less familiar with current practice. Presumably, the criteria in use derive from the goals of the UTC program (multi-disciplinary education; human resource development through undergraduate and graduate programs; diversity of student body and faculty; center process for research selection; ongoing program of basic and applied research; and technology transfer). Also important would be the strength of the UTC proposed strategic plan and multi-modal focus. Based on the work our committees, we would encourage consideration of output measures such as the success in placing students in transportation positions and track record of publishing peer-reviewed research, as well as the strength of center advisory committees. We would also stress the role of merit review involving peers in awarding funds to UTCs through a competitive process.

Q3. *TRB has consistently advocated that FHWA and DOT invest more in long-term, advanced research. What is your assessment of FHWA's Exploratory Advanced Research Program? Is this a model FHWA should follow? What lessons can be learned from the program?*

A3. The RTCC has, indeed, long advocated for more advanced research at FHWA. In Special Report 261 issued in 2001, the RTCC recommended that advanced research represent approximately 25 percent of FHWA's R&T portfolio.⁷ SAFETEA-LU authorized \$14 million annually for the Exploratory Advanced Research (EAR) Program. The RTCC has, subsequently, paid close attention to the implementation of this program. The committee is very pleased that Congress authorized and funded the program, and it views it as a genuine opportunity to expand federal investment in advanced highway research. The committee, however, is reserving judgment about whether the way FHWA has chosen to administer the program is the most effective approach to advanced research for the highway field.⁸

The RTCC is pleased with the first round of research solicitations through a Broad Area Announcement (BAA), which was wide open to good ideas from across the spectrum of highway research topics. It is also pleased that last year's technical corrections legislation changed the local matching requirement for EAR projects from 50 to 20 percent. In its 2008 report, *The Federal Investment in Highway Research*,

⁵ Eight centers are authorized in Title III of SAFETEA-LU (the transit title) and 52 are authorized in Title V.

⁶ Special Report 295: *The Federal Investment in Highway Research, 2006–2009: Strengths and Weaknesses*. Transportation Research Board of the National Academies. Transportation Research Board of the National Academies. 2009, p. 121.

⁷ Special Report 261: *The Federal Role in Highway Research and Technology*, Transportation Research Board of the National Academies, 2001.

⁸ Research and Technology Coordinating Committee, Letter Report of September 18, 2007. http://gulliver.trb.org/admin/blurb/blurb_detail.asp?id=8152

2006–2009, the RTCC expressed some concern about the narrowing of topics in the second round of solicitations and the share of funding for advanced research projects devoted to intramural research (23 percent of the funding allocated through 2008).⁹ Based on funds committed through 2008, the committee prefers that a larger share of the funds be devoted to extramural research. (Subsequent projects may have been selected and funded by the program, which the RTCC has not yet reviewed, so the share to intramural may have declined.)

The administration and conduct of an advanced research program is something new and exciting for the highway community, but it is one that will take some time to develop and mature. Advanced research requires a different approach than the highway research community is accustomed to for research administration, stakeholder involvement, research partnering, requests for proposals, contracting (statements of work, deliverables), merit review, and tolerance for risk of failure. FHWA, and the highway research community more broadly, is learning about these features as the EAR program proceeds. The good signs so far are a growing list of intriguing and promising projects, a much higher proportion of research conducted by universities than is true for the FHWA program in general, a new set of research partners adept at advanced research, and FHWA's outreach to scientists and experts in other federal agencies to assist it in merit review. Because the highly applied, short-term research model is so well established in the mind set of the highway research community, signs to watch out for are whether the program becomes too focused on near-term deliverable products and reliance on research organizations that have proven track records in applied research but less so in advanced research. The RTCC hopes that the EAR program will succeed and bring new understanding and breakthroughs, but it is premature to judge whether the program's current approach is the best model for the future.

Q4. TRB emphasized the need for performance-based metrics for transportation R&D. Specifically, what should those metrics be?

A4. My written testimony mentions performance-based metrics only in the context of the administration of the highway program, in which I was attempting to point out the data issues that would arise from adoption of a performance-based highway program,

“Proposals already circulating that address reauthorization of the surface transportation program, including the reports of both SAFETEA–LU commissions, recommend that the federal aid program become performance based. A true system of performance measures will create enormous new demand for better data on inventory condition and value, real-time system performance, safety, environmental protection, and other performance metrics.”

This comment was meant to support the RTCC report recommendation for additional support for data collection.

TRB has, and has had, committees providing peer review of the research programs of FHWA, FTA, and FRA and for peer reviews of USDOT strategic planning for research during the Bush and Clinton Administrations. From this experience, we have become somewhat circumspect about the prospects of developing and implementing successful empirical performance measures of research and development outcomes. It is, of course, relatively easy to develop and implement output performance measures for short-term, highly applied research, such as progress against milestones. This is widely done in both government and industry and in programs managed by TRB, as described in more detail below. We strongly endorse, however, the recommendation of a National Academy panel convened to address the question of evaluating R&D in response to the Government Performance Results Act (GPRA),

“The most effective means of evaluating federally funded research programs is expert review. Expert review—which includes quality review, relevance review, and benchmarking—should be used to assess both basic and applied research programs.”¹⁰

Our committees have tended to be circumspect about research outcome performance measures for a variety of reasons: the need to have different expectations across different areas of research, such as policy, materials, ITS, safety; the long lead-time for basic research results to find their way into products, technologies, and practices; and the difficulty crediting individual research projects for outcomes influ-

⁹ See pages 91–92 of Special Report 295.

¹⁰ *Evaluating Federal Research Programs: Research and the Government Performance and Results Act*. Committee on Science, Engineering, and Public Policy. National Academy of Sciences, National Academy of Engineering, Institute of Medicine. National Academy Press, 1999, p. 5.

enced by other research and other factors. It is much easier to measure the impact of a materials research project that leads to a new specification than for a policy research project that leads to new understanding about travel behavior, but both outputs are important for the advancement of the field. As a result, committees of the National Academies have tended to place more emphasis on getting processes right—appropriate stakeholder involvement, merit review, and peer review of both projects and programs that help ensure achievement of the desired outcomes.

Q4a. What are the performance metrics TRB uses for the Strategic Highway Research Program (SHRP), SHRP-2, and any other research that it funds?

A4a. Most projects undertaken in the cooperative research programs, the original SHRP, or SHRP-2 are expected to yield products that will find application in transportation practice, consequently TRB relies upon review of the research it manages at both the project and the program levels by committees that include practitioners as well as subject matter experts. For SHRP-2 and the cooperative research programs, every project is overseen by a panel of researchers and practitioners. Each panel prepares requests for proposals, conducts a merit review of the proposals received, and monitors the progress and outcomes of each project. We rely upon these panels for quality review of individual projects. Although the research reports prepared through the SHRP-2 and cooperative research programs appear under the name of the authors of the research, the results are only published by TRB if the panels so recommend. These panel determinations are based upon such considerations as whether the authors have been responsive to the statement of task of the RFP and whether the quality of the work meets standard practice. During the course of the research, the contractors are required to report to the panel on progress against milestones, including schedules.

At the program level, an ongoing review is provided by the committees that oversee the research programs that TRB manages. For example, the National Cooperative Highway Research Program (NCHRP) is funded each year by the voluntary contributions of each member state of the American Association of State Highway and Transportation Officials (AASHTO). The projects are selected by AASHTO's Standing Committee on Research (SCOR), which also makes the funding allocation decisions. At the semi-annual meetings of SCOR, they are briefed on projects completed and published, progress against milestones of individual projects, and other metrics, including implementation, or usage, of report results (see Appendix 1). NCHRP tracks the adoption of AASHTO standards, specifications, and guidance that are based on NCHRP research results.¹¹ Also, the panels of completed projects are surveyed every four years to find out about applications of the research they oversaw.¹² In addition, TRB monitors the diversity of contractors selected. In 2008, NCHRP was subject of a benchmarking analysis conducted by directors of State and FHWA research programs.

The funding and governance models vary from NCHRP in the Transit and Airport Cooperative Research Programs (TCRP and ACRP), because Congress authorizes these programs and appropriates the funds. The governance of the programs, however, mirrors that of the NCHRP program. A special committee of the American Public Transportation Association (APTA) allocates funds and picks TCRP projects and a committee appointed by the Secretary of Transportation provides the same functions for ACRP. These governance committees also provide ongoing program reviews. As does NCHRP, in addition to reporting on program and project statuses, TCRP briefs its oversight committee on products adopted by APTA members and others (see Appendix 1 for examples) and reports on periodic surveys of transit industry users of TCRP reports.

The Strategic Highway Research Program 2 is yet a different model. Although AASHTO supported authorization of the program in SAFETEA-LU, and the states agreed to fund it through Title I as a percentage take-down of their federal aid for capital and maintenance, as directed by Congress the oversight committee was appointed by TRB's administrative parent organization, the National Research Council (NRC). (The NRC is the operating arm of the National Academies.) This oversight committee is made up of representatives of State DOTs, researchers, environmental and safety groups, and other highway research stakeholders. As a fairly "young" program, SHRP-2 has few products to review to date. So far, the oversight committee has been briefed on program and project status. Moreover, in authorizing

¹¹ *Leveraging Resources for Better Transportation*. National Cooperative Highway Research Program. Transportation Research Board of the National Academies. 2002. See page 3 for a listing of the 40 AASHTO specifications, guides, and other documents based on NCHRP research over the previous decade. <http://www.trb.org/NotesDocs/NCHRPBrochure.pdf>

¹² <http://www.trb.org/NotesDocs/NCHRPSurveyResults.pdf>

this program in SAFETEA-LU, Congress chose to have it evaluated by the Government Accountability Office.

We believe that the determination of the relevance of the research managed by TRB is built into the structure of these programs. The decisions about what research to conduct is made by the oversight committees themselves. The relevance of individual projects is further ensured by having panels that include practitioners oversee each project. In research programs such as these, another important measure of relevance is the ongoing satisfaction of the organizations that requested that TRB manage the research in the first place. NCHRP, for example, has been in existence for over 40 years, and the states have demonstrated their commitment to it through their annual, voluntary contributions to fund the program. In all these years, only one state has ever opted out, and it did so for only one year. The other cooperative programs are much younger, and are funded through a different mechanism, but both APTA and Airports Council International–North America (ACI-NA), along with FTA and FAA, have demonstrated strong support.

In response to a follow up question to your staff, we were asked to indicate how TRB decides to begin or terminate research projects. As indicated above, the oversight committees of the cooperative research programs and SHRP-2 make all the decisions about project initiation. Projects are occasionally terminated if the project panel overseeing the project concludes that the contractor is not addressing the commitments made in the agency's proposal or not providing quality work. In the case of SHRP-2, contracts for higher-risk research generally contain "go/no go" gateways which require the researchers to formally demonstrate the feasibility and or the utility of the research at an early stage in order to receive continued funding. The decision to continue or terminate is made by the oversight committee.

Q5. How does TRB disseminate the results of the research it funds to standards development organizations (SDOs)?

A5. As described above, the products of the SHRP and cooperative research programs are expected to be applied in transportation practice. Such application, however, is constrained if standards that agencies can reference for design and contracting do not exist. Therefore, the volunteer expert groups overseeing projects encourage the research contractors to deliver materials that will directly enable SDO development of new standards or the revision of existing standards. For example, Superpave, a major product of the first SHRP now in use throughout North America, is the systematic amalgamation of 26 different AASHTO standard specifications, test methods, and practices. The initial data used for development of these standards was supplied by the original SHRP research teams. Similarly the Load Resistance Factor Design (LRFD) guideline for bridge design adopted by AASHTO several years ago was preceded by a series of NCHRP projects addressing a variety of different technical concerns of AASHTO's subcommittee on bridges and structures. The Mechanistic–Empirical Design guidelines for pavements, which has been endorsed by AASHTO and is being adopted by states, was developed in the same manner. In both these cases, SCOR embarked on a deliberate program of research to revise and modernize these design guidelines. TCRP has also funded projects that have resulted in transit standards, for example a TCRP project provided technical information and resources that helped result in the adoption of many IEEE electric rail passenger vehicle standards for system and subsystem interfaces.¹³ TCRP also provided information to ASME that led to ASME standards on light-rail vehicle crash-worthiness.

The cooperative programs often include members or liaisons from SDOs when conducting a project that will provide information that may be of use to the SDO that has responsibility for a standard. For example, NCHRP panels have addressed issues such as traffic signal visibility requirements and maintenance practices for LED traffic signals, and have involved ITE members and staff in doing so because ITE is the SDO for traffic signal heads.

While AASHTO, APTA, and ACI-NA have strong influence in selecting TRB projects, other organizations also develop standards applied in transportation. To ensure these organizations also have access to TRB information that supports standards development, all reports of the Cooperative Research Programs and SHRP-2 are posted on TRB's website for free download. Completed reports are announced in TRB's weekly e-Newsletter, which reaches more than 30,000 recipients.

TRB's Technical Activities Division has about 200 standing committees made up of 4,000 individual practitioners and researchers. This standing committee structure

¹³TCRP Research Results Digest 44: Consensus Standards for the Rail Transit Industry. Transportation Research Board of the National Academies. http://onlinepubs.trb.org/Onlinepubs/trcp/trcp_rrd_44.pdf

functions much like a professional society. The mission of the standing committees is to bring practitioners and researchers together to identify research needs, stimulate needed research, provide input on research priorities and procedures, facilitate the adoption of appropriate research findings into practice, and provide a mechanism for mutual exchange of information on social, economic, and technological developments within transportation. The committees organize workshops, conferences, and the sessions of TRB's Annual Meeting, which attracts over 10,000 participants. Many of the members of these committees serve on the standards committees of organizations such as the ITE, American Concrete Institute, AASHTO, APTA, IEEE, ASME and similar organizations. The TRB's Annual Meeting is the world's largest meeting designed for the sharing and dissemination of research information. Much of it finds its way into the hands of SDOs.

Questions submitted by Representative Adrian Smith

Q1. Do we need to produce a new, comprehensive strategy for our nation's highways? If so, should this strategy include other transportation modes? Who should be charged with developing such a strategy and how often should it be updated?

A1. There has not been a Transportation Research Board (TRB) report addressing Mr. Smith's important questions. SAFETEA-LU did call for two major commissions to provide guidance to Congress on the future of the highway program, particularly with regard to how it should be funded. Both Commissions have prepared extensive and reports to Congress; The National Surface Transportation Policy and Revenue Commission provides recommendations for a comprehensive, multi-modal strategy, and well as recommending how such a strategy should be funded.¹ The National Surface Transportation Infrastructure Financing Commission provides recommendations regarding funding the highway program.² Funding issues will likely be paramount in Congressional debates about reauthorizing SAFETEA-LU, which expires at the end of September of this year, as the authorized funding from the Highway Trust Fund in 2008 and 2009 exceeds available user tax revenues.

If a TRB committee was charged to address Mr. Smith's question about developing a new, comprehensive strategy for our nation's highways, it would need to consider the character of the current highway program and whether it is meeting the Nation's needs as currently structured. The federal highway program began in 1916 with the first authorizing legislation and has been reauthorized and reshaped from time to time over the last nine decades. Although the program has evolved, particularly with the federal emphasis on the Interstate program in the middle of the last century, it has retained a federalist structure in which the Federal Government provides a share of the cost of new and rehabilitated highways, while the states, and to a lesser extent metropolitan areas, make the decisions about where and how funds should be invested to serve urban, rural, and inter-city passenger and freight travel demand. The states are also primarily responsible for maintenance, enforcement, and safety and develop the standards by which highway infrastructure is designed, constructed, and operated. The federal program is a user financed system that is almost completely funded by taxes on highway gasoline and diesel sales and through commercial vehicle excise taxes. Authorizing legislation also pursues federal environmental, safety, equity, and mobility goals through provisions in the law; moreover the law provides and allows for expenditures of about 15–20 percent of all user taxes paid by motorists and motor carriers into the Highway Trust Fund for investments in new transit capital. As noted in my original written testimony, the federal investment in highway research and development is an absolutely critical component of the innovation process.

Because federal highway funding as currently structured operates something like a block grant to the states, there is no comprehensively stated strategy per se, even though the law addresses many important federal goals through its requirements and program funding categories. For example, in addition to pursuing the goals listed above, the law requires and helps fund metropolitan planning organizations to ensure adequate investment in highway and transit programs within urbanized areas. Thus, it is fair to say that whereas there is no single strategy for the current program, there are many federal, State, and metropolitan transportation and environmental strategies accomplished through current legislation.

¹National Surface Transportation Policy and Revenue Commission Report, <http://transportationfortomorrow.org/>

²National Surface Transportation Infrastructure Financing Commission, <http://financecommission.dot.gov/>

I provide this background in part to address the question of who should be charged with developing a new, comprehensive strategy and how often it should be updated. Clearly one option would be for the U.S. Department of Transportation (USDOT) to assume a leadership role in any such an endeavor in concert with states, metropolitan areas, and highway and transit users. The USDOT has prepared such policy guidance in the past in the form of major reports, often as a prelude to reauthorization.³ The commission model is another option. Mr. Smith may find that the report of the National Surface Transportation Policy and Revenue Commission provides the comprehensive strategy he seeks. Because the current program serves so many goals and has evolved over decades to balance federal, State, metropolitan, highway and transit and environmental interests, development of a new comprehensive strategy would no small undertaking. It would not only reconsider transportation goals, it would have to include reconsideration the current intergovernmental institutional structure for carrying out current highway and transit programs.

Mr. Smith also asks about whether a strategy should be multi-modal. As noted, Congress has already incorporated transit into the highway program by taxing highway users to pay the federal share for new transit capital investments and by requiring and funding comprehensive planning for urbanized areas. An open question is whether other surface modes should be financed in this manner. We have not addressed inter-city passenger rail for some time, but in a 1991 report, our study committee concluded that subsidies for high-speed rail could be justified in some corridors, but progress in doing so was stymied by lack any dedicated mechanism for funding these subsidies.⁴ Current highway and aviation trust fund legislation preclude subsidies for inter-city rail.

³ See, for example, the last such report prepared by USDOT, *The Changing Face of Transportation*. http://www.bts.gov/publications/the_changing_face_of_transportation/

⁴ *In Pursuit of Speed: New Options for Inter-city Passenger Transport*. Special Report 233. Transportation Research Board, National Research Council. Washington, D.C. 1991. http://trb.org/news/blurbs_detail.asp?id=2690

Appendix: Examples of Usage of TCRP and NCHRP Reports

TRANSIT COOPERATIVE RESEARCH PROGRAM

- **Transit Capacity and Quality of Service Manual:** TCRP Project A-15, produced a *First Edition, Transit Capacity and Quality of Service Manual*, that was initially available as a CD-ROM and on the TRB website as TCRP Web Document 6. In late 2003, TCRP Report 100, *Transit Capacity and Quality of Service Manual: Second Edition* was issued, updating and adding to the material provided in the first edition. Report 100 is a fundamental reference document for public transportation practitioners that contains quantitative techniques for calculating the capacity of bus, rail, and ferry services, and transit stops, stations, and terminals. It also provides a framework for measuring transit availability and quality from the passenger point of view. TRB established a Task Force on Transit Capacity and Quality of Service that will manage the transit manual much as a TRB standing committee has long overseen revisions and expansions of the *Highway Capacity Manual*. The University of Arizona, University of Idaho, Massachusetts Institute of Technology, Portland State University, and the Queensland University of Technology all report incorporating the manual into transportation education programs. In addition, all Metropolitan Planning Organizations in Florida, at the request of the Florida Department of Transportation, are assessing their transit systems using the quality of service concepts outlined in the manual. Transit agencies in Atlanta, Birmingham, Broward County (FL), DuPage County (IL), San Antonio, New Orleans, Seattle, Washington (DC), San Francisco, MTA New York City Transit, Adelaide (Australia), and Dublin (Ireland) also report using the manual for transit planning processes and quality of service evaluations. AC Transit in Oakland reports that its Board of Directors is currently reviewing the quality of their services as they relate to the quality of service parameters in TCRP Report 100. The National Transit Institute offers a course on the material in the manual.

The Institute of Transportation Engineers (ITE) reports that it is using material from TCRP Report 100 in a new textbook that they are developing, titled *Professional Transportation Planner (PTP) Certification Program Refresher Course Handbook*.

- **Transit Vehicles and Maintenance:** TCRP Report 29, *Closing the Knowledge Gap for Transit Maintenance Employees: a Systems Approach*, addresses the maintenance skill supply, the skill needs and effective training methods. It is very popular with maintenance personnel, because it is “down to Earth” and squarely addresses the technology, diagnostic, and skill development issues mechanics are facing. The Transit Authority of River City in Louisville, Kentucky, has given copies to all of its maintenance personnel, and uses the report as a basis for staff meetings and maintenance services delivery. Pierce Transit in Tacoma, Washington, also used the report as part of their maintenance team concept. It provides ideas for skills utilization and performance measurement that are being incorporated, with union support, into skills-based career ladders. The National Transit Institute selected Report 29 for a very successful teleconference seminar that featured prominent maintenance managers in a call-in radio format.
- TCRP Report 43, *Understanding and Applying Advanced On-Board Bus Electronics*, is being used by Pierce Transit in Tacoma, Washington, and other transit agencies to give staff a better understanding of multiplex wiring and intelligent fleet systems. A comment received on the APTA TCRP website states, “this is a great report; a terrific help to understanding what is going on, written at the level of the intelligent layman/engineer.” This report has become a basic primer for bus on-board electronics.
- Pierce Transit also reports that TCRP Report 25, *Bus Operator Workstation Evaluation and Design Guidelines*, was used to change the specifications for new coaches. Specifically, they ordered smaller steering wheels and air-ride seats to reduce driver fatigue. Also, a major North American bus manufacturer advertises that its new driver workstation “is ergonomically designed to meet TCRP recommendations,” indicating that Report 25 and its comprehensive companion, Web Document 1, were used in the redesign of the bus.

- *TCRP Synthesis 2, "Low-Floor Transit Buses,"* described the technology and issues associated with low-floor transit buses as of January 1994. TCRP Report 41 updates information on the current market for low-floor buses, and provides a summary of operating experiences on the basis of discussions with transit agencies and low-floor bus manufacturers. Many transit systems have used this material in their evaluations of low-floor vehicles for bus purchasing decisions.
- TCRP Projects C-12, *Configuration Options Supplement to Standard Purchase Specifications for Transit Buses*, and C-13, *30-Foot, Heavy Duty Bus Technical Specifications* developed standard bus specifications for different types of heavy-duty transit buses using an industry consensus process administered by the American Public Transportation Administration (APTA). Specifications were prepared for the following buses: (1) 35/40-foot, heavy-duty, diesel, low-floor; (2) 35/40-foot, heavy-duty, compressed natural gas, low-floor; and (3) 30-foot, heavy-duty, diesel, low-floor. In addition, generic specifications for the bus operator workstation and on-board bus electronics have been completed, and incorporated in the bus specifications described above. These specifications are available through APTA. Many transit systems are incorporating the standard specifications in their bus procurement processes.
- TCRP Report 61, *Analyzing the Costs of Operating Small Transit Vehicles*, provides a User's Guide that explains an accompanying Small Transit Vehicle Economics (STVe) computer-based model. STVe is a tool designed for transit planners and others making decisions about the purchase of small transit vehicles for different services and operating environments. The STVe is based on the principles of engineering economics and allows the user to assess whether it makes economic sense to invest in a particular type of vehicle, based on user-defined inputs. The User's Guide describes how to run the model and interpret the results. It also explores non-financial aspects that may influence the vehicle purchasing decision. A number of transit systems have indicated the use of the report and its tool in their bus purchasing decisions.
- **Bus Stop Location/Design:** TCRP Report 19, *Guidelines for the Location and Design of Bus Stops*, provides guidelines for locating and designing bus stops in various operating environments. The Central Contra Costa Transit Authority reports that it uses this report to assist them in making recommendations for the location of bus stops to their member jurisdictions.
- **Pedestrian Safety:** TCRP/NCHRP Report 112/562, *Improving Pedestrian Safety at Unsignalized Crossings* was approved by the National Committee of the MUTCD. As a result, the next version of the MUTCD will include changes in the area of Pedestrian Beacon and Pedestrian Signal Warrant.
- **Standardized Railcar Systems:** Transit rail operators could save as much as \$120 million as a result of the development of uniform technical standards for rail vehicle systems and subsystems. Through TCRP Project G-4, an Institute of Electrical and Electronics Engineers (IEEE) Rail Transit Vehicle Interface Standards Committee was formed as part of the standards-development process. The Committee formed 15 working groups to prepare standards for specific interfaces. In addition, an American Society of Mechanical Engineers (ASME) Committee was formed to develop mechanical standards for railcars. This ASME Committee focused on the structural strength and crash-worthiness of light rail and rapid transit cars. The standards, which should lower the cost of transit railcars and replacement parts, reduce parts inventories, and simplify maintenance, evolved through a consensus-building process. The project involved significant in-kind contributions by the transit industry, leveraging the TCRP investment by a ratio of approximately eight to one. Under the TCRP project, nine standards were formally published by the IEEE, and a number of others were in various stages of production in 2002, when the process was transitioned to APTA sponsorship. It has been reported that SEPTA used a draft version of a standard outlining communications-based train control (CBTC) performance and functional requirements in its CBTC procurement document for its light rail tunnel. The MTA NYCT has indicated that the standards have helped them finalize technical specifications for the procurement of more than 2,000 new subway cars. In addition, New Jersey Transit reported that it would save approximately \$420,000 per year as a result of the use of the IEEE standard for communications protocols aboard trains developed by this effort. To date, the standards have been cited

in specifications issued by the Chicago Transit Authority, Massachusetts Bay Transportation Authority, MTA Long Island Railroad, MTA New York City Transit, New Jersey Transit, Washington Metropolitan Area Transit Authority, and the Southeastern Pennsylvania Transportation Authority. The Illinois Department of Transportation also cited the standards in their positive train control procurement project.

- **Rail Infrastructure Research:** TCRP Report 57, *Track Design Handbook for Light Rail Transit*, provides guidelines for the design of various types of light rail transit track. Track structure types include ballasted, direct fixation ("ballastless"), and embedded track. The components of the various track types are discussed in detail. The handbook includes chapters on vehicles, alignment, track structures, track components, special track work, aerial structures/bridges, corrosion control, noise and vibration, signals, and traction power. These chapters provide insight into considerations that affect track design and require interface coordination. A consultant reported that he had used the handbook on LRT design projects in Baltimore and Tampa. In addition, the Charlotte Area Transit System reported that it used the report to review the design aspects of its planned light rail system as they were developed by the system's consultants. The Denver RTD also reported that the handbook was used as the basis for designing its light rail extension. AREMA Committee 12 is currently updating Chapter 12 of the AREMA track standards for transit application. The committee is drawing heavily from TCRP Report 57.
- **Fare Structures, Systems, and Technologies:** TCRP Report 80, *A Toolkit for Self-Service, Barrier-Free Fare Collection*, addresses the full range of issues and parameters that an agency must consider in determining the applicability of self-service fare collection systems, including those related to policy and enforcement issues, operational issues, and capital and equipment issues. The Charlotte Area Transit System (CATS) reports that this TCRP publication served as the centerpiece for recommendations associated with establishing regulations to address fare evaders, and other safety/security matters associated with operating the barrier-free fare collection system proposed for their light rail system.
- **Track Sharing:** TCRP Report 52, *Joint Operation of Light Rail Transit or Diesel Multiple Unit Vehicles with Railroads*, identifies and discusses issues associated with the joint operation of light rail transit (LRT) or lightweight diesel multiple unit (DMU) vehicles with freight and/or passenger railroads. For the purposes of this report, joint operation is defined as co-mingled, simultaneous train operation on shared track by railroad trains (freight and/or passenger) and rail transit vehicles that are not fully compliant with current Federal Railroad Administration (FRA) regulations. The report identifies and discusses issues associated with such joint operation, focusing on the current regulatory and institutional environment, railroad and rail transit operations, infrastructure, and rolling stock. In addition, substantial information concerning joint operation overseas is presented and discussed. This report has been a primary source of information to assist in the debate on the issue of track sharing in the United States.
- **Public Transportation to Airports:** TCRP Report 62, *Improving Public Transportation Access to Large Airports*, presents available data on the use of public transportation at large U.S. airports and selected international airports, as well as related evolving trends. The report provides examples of successful airport access systems from around the world; presents key factors affecting the use of public transportation by airline passengers and employees; identifies new and emerging technologies that have the potential to improve public transportation services at airports; and describes the institutional environment and factors affecting public transportation at large U.S. airports, including airport structure, funding for airports, and agreements with airlines. This report has been useful to several transit agencies investigating potential rail links to airports in their service areas.
- **Evaluating Fuel Options for Buses:** TCRP Report 38, *Guidebook for evaluating, Selecting and Implementing Fuel Choices for Transit Bus Operations* (C-8), provides information on the performance, cost, safety, and facility requirements of five transit bus fuels: diesel (baseline for comparison), compressed natural gas, liquefied natural gas, methanol, ethanol and liquefied petroleum gas. An accompanying cost model spreadsheet, *FuelCost 1.0*, en-

ables users to estimate and compare the cost impacts of fuel choices. VIA Transit in San Antonio used the software to aid them in selecting an alternative fuel and in justifying the decision to their management and Board of Directors.

- **Rural Transit:** TCRP Report 54, *Management Toolkit for Rural and Small Urban Transportation Systems*, identifies an array of management principles and techniques, for use by small urban and rural public transportation providers, to assist in managing their transportation services more effectively. The toolkit has two parts: a guidebook and a self-assessment tool. The guidebook introduces the idea of customer-driven transit service attributes and includes general management philosophies. Included in the guidebook are exemplary practices and “how to” instructions for some topics. Additional sections describing “rules of thumb” or “things to avoid” are included for some management processes. A self-assessment computer-based tool on disk accompanies the report. The tool is designed to give the user a baseline or current picture of the status of the transit system. The West Virginia Division of Public Transit distributed copies of this report to all of the rural operators in the state and also brought in the consultant who produced the report to give a training session. The Division of Public Transit indicates that the report, and its accompanying tool, have been very useful to the rural operators in West Virginia.
 - TCRP Report 70, *Change and Innovation at Rural and Small Urban Transit Systems*, addresses the culture for change and innovation, and presents more than 40 initiatives and innovations implemented by an array of organizations including public and nonprofit transit systems, regional planning agencies, State transit associations, and State departments of transportation. The Southeast Missouri Transportation Service reports that the report “. . . has been a valuable resource in improving our service.” They have used the report to “. . . define our corporate culture, and focus on our values, attitudes and beliefs for the process of change.” Also, “. . . this report has challenged us to be the best we can be and view challenges as opportunities for new ways of doing things.”
- **Bus Rapid Transit:** TCRP Report 90, *Bus Rapid Transit*, a two-volume set, identifies the potential range of bus rapid transit applications through 26 case studies, and provides planning and implementation guidelines for bus rapid transit. The Charlotte Area Transit System reports that they found the case studies in Report 90, Volume 1 very helpful as they were preparing information on bus rapid transit to share with their board. The Fairfax County (Virginia) Department of Transportation reports that it has used Report 90 extensively in the planning for a BRT system in the Richmond Highway corridor of the county.
 - TCRP Report 118, *Bus Rapid Transit Practitioner's Guide*, provides information on the costs, impacts, and effectiveness of implementing selected bus rapid transit (BRT) components. It includes practical information that can be readily used by transit professionals and policy-makers in planning and decision-making related to implementing different components of BRT systems. This report updates some of the information presented in TCRP Report 90: *Bus Rapid Transit* and presents the latest developments and research results related to the costs and impacts of implementing various BRT components and their effectiveness. The California Department of Transportation (CALTRANS) indicated that they use TCRP Report 118 as the basis for a course for CALTRANS personnel, particularly highway/traffic engineers. Purdue University notes that the material in Report 118 is used in a course covering bus rapid transit.
- **Transit Operator Fatigue:** TCRP Report 81, *Toolkit for Transit Operator Fatigue*, documents principles, techniques, and strategies that can be used in the development of fatigue-mitigation plans. The Toolbox includes a “how to” component on the design, implementation, and evaluation of fatigue-mitigation plans. An accompanying CD-ROM provides specific tools, such as posters for operator rooms, that address fatigue issues. The National Transit Institute (NTI) prepared a one-day course on the report, and offered it at eight locations throughout the country in the first half of 2003. The Santa Clara Valley Regional Transportation Authority (VTA) in San Jose, California reports that it has implemented many of the tools in the report that were taught at the NTI training classes.

- **The Image of Transit:** TCRP Report 63, *Enhancing the Image and Visibility of Transit in the United States and Canada*, assists professionals at the local, regional, and national levels interested in improving the visibility and image of transit in the United States and Canada through the implementation of image campaigns. The report documents and presents how the image of transit can be strengthened by building on existing positive perceptions. The research provides a communications strategy to guide national, regional, and local efforts to enhance the image and visibility of transit in order to create a more positive and supportive environment. The results of this effort are being used in APTA's Public Transportation Partnership for Tomorrow (PT)2 program. It has also been reported that the results were used in the development of marketing campaigns in Arizona and Pennsylvania. Funding assistance for the Canadian element of the research was provided, in part, by Transport Canada through the Canadian Urban Transit Association.
- **Professional Capacity Building:** Universities and State departments of transportation have requested TCRP materials, and sometimes the author, in support of training courses. The New York State Department of Transportation requested copies of TCRP Synthesis 22, *Monitoring of Bus Maintenance Performance*, for use in state-level training. The Pennsylvania Transportation Institute used copies of *Measuring Customer Satisfaction and Service Quality: A Handbook for the Transit Industry* in a course on customer service. The tools from that report were utilized in Pennsylvania. Minnesota DOT reported that Synthesis 30, *ADA Paratransit Eligibility Practices*, was beneficial to the DOT staff and was frequently requested by transit agencies in Minnesota. The author of TCRP Synthesis 8, *Retrofit of Buses to Meet Clean Air Regulations*, conducted six workshops on the subject at the request of agencies striving to comply with the complex regulations. He also conducted workshops for Florida DOT based on Synthesis 12, *Transit Bus Service Line Cleaning Functions*.

The Civil Engineering Department at the University of Nevada, Las Vegas developed a graduate course in transportation using TCRP Reports 16, 27, 30, 33, 35, 36, and the CD-ROM on Transit Capacity and Quality of Service as source materials.

Rutgers University is using TCRP Report 30, *Transit Scheduling: Basic and Advanced Manuals*, and TCRP Report 100, *Transit Capacity and Quality of Service Manual: Second Edition* in a course entitled Transit Management and Planning. The course is part of the Master's program at Rutgers University Bloustein School of Planning and Public Policy.

Two products are especially useful to travel demand forecasters:

—TCRP Report 95, *Traveler Response to Transportation Systems Changes: Third Edition* will be published as a 19-volume report, updating a handbook last published in 1981. This handbook will equip members of the transportation profession with a comprehensive, readily accessible, interpretive documentation of results and experience observed across the United States and elsewhere of traveler responses to different types of transportation system changes. To date, the first thirteen volumes of this report have been published—Chapter 2, *HOV Facilities*; Chapter 3, *Park-and-Ride/Pool*; Chapter 5, *Vanpools and Buspools*; Chapter 6, *Demand Responsive/ADA*; Chapter 9, *Transit Scheduling and Frequency*; Chapter 10, *Bus Routing and Coverage*; Chapter 11, *Transit Information and Promotion*; Chapter 12, *Transit Pricing and Fares*; Chapter 13, *Parking Pricing and Fees*; Chapter 14, *Road Value Pricing*; Chapter 15, *Land Use and Site Design*; Chapter 17, *Transit Oriented Development*; and Chapter 18, *Parking Management and Supply*. Remaining chapters will be published throughout the remainder of 2008 as they become available. The Metropolitan Atlanta Rapid Transit Authority reports that it used Chapter 11 in the development of its 2005 Marketing Action Plan. Bloomington (IN) Transit reports using Chapter 3 in discussing commuter parking lot impacts with adjacent community groups. The University of Florida reports that Chapter 15, *Land Use and Site Design*, has been incorporated in a course being offered.

—TCRP Report 73, *Characteristics of Urban Transportation Demand*, examines macro transportation characteristics such as daily trips per capita, daily trips by mode, average trip length, vehicle miles of travel per household, trip chaining, and parking ratios by type of work site. The final report

provides a compendium of multi-modal information for transportation planners, provided in both printed and electronic form.

The Southeastern Pennsylvania Transportation Authority (SEPTA) human resources department indicates that they use the following TCRP publications, among others, in their on-going training programs:

- (1) TCRP Report 27, *Building Transit Ridership: An Exploration of Transit's Market Share and the Public Policies That Influence It*
- (2) TCRP Report 28, *Transit Markets of the Future: The Challenge of Change*
- (3) TCRP Report 77, *Managing Transit's Workforce in the New Millennium*
- (4) TCRP Report 88, *A Guidebook for Developing a Transit Performance Measurement System*
- (5) TRB Special Report 257, *Making Transit Work: Insight from Western Europe, Canada, and the United States* (funded through TCRP)
- (6) TCRP Synthesis 16, *Changing Roles and Practices of Bus Field Supervisors*
- (7) TCRP Synthesis 40, *A Challenging Employment System: Hiring, Training, Performance Evaluation, and Retention of Bus Operators*
- (8) TCRP Synthesis 45, *Customer Focused Transit*
- (9) TCRP Synthesis 47, *Corporate Culture as the Driver of Transit Leadership*

The American Planning Association is incorporating material from several chapters of TCRP Report 102, *Transit Oriented Development in the United States: Experiences, Challenges, and Prospects* in their Transit Oriented Development Planners Training Service course.

The Commonwealth of Puerto Rico, Highway and Transportation Authority, Department of Public Works, Oversight Systems Safety Manager, incorporates TCRP publications for training at Tren Urbano.

- **Workforce Development Initiative.** Two TCRP reports have served as key inputs to APTA's Workforce Development Initiative. *TCRP Research Results Digest 45*, "Identification of the Critical Workforce Development Issues in the Transit Industry," provides a scoping study that identifies: the most important challenges that the transit industry faces in workforce development; current innovative approaches to workforce development on the part of both transit agencies and external "benchmarks"; the most useful potential products of the Workforce Development Initiative; and the next steps that should be taken to help the transit industry address workforce development on an effective, ongoing basis.

TCRP Report 77, *Managing Transit's Workforce in the New Millennium*, assesses the transit industry's workforce needs and prospects for the coming decades. Further, the report provides guidelines to enable employers to assess their own workforce needs, describes best practices for recruiting and retaining employees, and identifies ways to enhance or establish partnerships between management and labor for attracting, training, and maintaining a qualified workforce.

- **Transit Scheduling:** Scheduling is one of the basic skills in the transit industry. TCRP Report 30, *Transit Scheduling: Basic and Advanced Manuals*, updates a 50-year-old predecessor, providing step-by-step instructions in trip building, blocking, run-cutting, and rostering. The report is written in the form of a training manual, and has proved very popular. The Metropolitan Transit Development Board in San Diego requested copies for the scheduling staff. University and state DOT staff have also requested multiple copies for use in graduate level courses and for training staff: Institute for Transportation Research and Education, North Carolina State University; the National Center for Advanced Transportation Technology, the University of Idaho; and the Oregon Department of Transportation. SunTran (Ocala, FL) reports using Report 30 to train their schedulers.
- **Software for Transit Risk Managers:** Identification of risk exposure is the cornerstone of the risk-management process, because the other elements of risk management rest on the accuracy and completeness of this process. TCRP project G-3 developed risk management software and a User's Guide tailored to the needs of transit risk managers. The software was dem-

onstrated at the 1996 APTA Risk Management Seminar and at the 1996 APTA Annual Meeting. Copies were also distributed by the usual J-1 distribution method. Through the TCRP J-1 project, APTA prepared the product for distribution, professionally packaged like commercial software. Two companion Research Results Digests cover identification of risk exposure, risk assessment, loss control programs, and guidelines for consistent collection of loss data. The Hillsborough Area Regional Transit Authority reported that they have used the software extensively to help identify potential risks.

- **Technology Transfer from International Experience.** TCRP Project J-3, International Transit Studies Program: The International Transit Studies Program is a leadership development program intended to foster a multi-modal-mobility-manager approach to urban transportation. Participants in the program bring innovative ideas from overseas to transportation agencies in the United States. The Massachusetts Bay Transportation Authority reported three major operational changes as a result of staff exposure to new ideas from abroad. The Blue Line was converted to single-person train operation, saving over \$1 million per year. Opponents of the change were won over by the extensive documentation of European cities that made successful conversions to single-person train operation, by installing CCTV cameras on platforms as observed in Vienna, and by engaging in a public outreach campaign. The MBTA also introduced low-floor light rail cars and accelerated the change to a new station management system supported by the integration of automated fare collection equipment and security systems based, in part, on the observations of the modernization of older European transport systems to much safer, more secure, customer friendly station environments. NJ Transit reported that information gathered by staff who participated in a study mission greatly increased NJ Transit's confidence in low-floor light rail cars and helped support the decision to purchase low-floor cars. Also information on transit's contribution to livable communities in Europe was used as part of a transit-friendly land use initiative in New Jersey. NJ Transit also reported that information obtained in Europe about contactless smart cards was evaluated for possible application in New Jersey. At that time, European applications had gone beyond testing to implementation. Riverside Transit reported that information about integrated school and public transportation in Europe assisted them with an initiative in the Los Angeles area to demonstrate the feasibility of such integrated service. She also reported that information about corridor preservation, the use of art in transit, and strategies to improve livability of cities were applicable to issues she was facing at home. The London Docklands LRT is using moving block signal technology, and American transit agencies that are considering this technology found it reassuring to see that it works in practice as well as in theory. Participants were also impressed with improved transportation efficiencies achieved in Britain through increased use of private contractors and increased competition.
- **Low-Floor Light Rail Vehicles:** A number of transit systems, e.g., NJ Transit, SEPTA, and Santa Clara County, have used a TCRP database on available low-floor light rail vehicle (LFLRV) technologies and their characteristics as input into the development of potential LFLRV specifications. The project demonstrated, according to reports from Santa Clara County, that LRVs with 70 percent of the floor area in low-floor configuration minimize the risks associated with new rail car design, because they use traditional trucks, but still provide the advantages of a low floor for ADA compliance. This influenced their decision to plan for low floor LRVs. Santa Clara County staff estimated savings on the order of \$20 million, attributable to not building expensive ramps for access by the disabled. Low-floor vehicles accommodate disabled persons, please the general public because the ramps would have detracted from the architectural aesthetics of a downtown transit mall, and save money. This was a win-win decision.
- **Alternative Fuel Safety:** NJ Transit and several bus manufacturers reported that they used TCRP Synthesis No. 1, Safe Operating Procedures for Alternative Fuel Buses, as a planning tool. One bus manufacturer reported that it made copies available to staff to inform them of safe handling procedures. At two conferences in Pennsylvania on alternative fuel buses, sponsored by the Rural Transportation Assistance Program (RTAP), most of the 35 to 40 attendees reportedly had this document with them or had read it. The majority of knowledge that these operations personnel had about alternative fuels at this point reportedly came from TCRP Synthesis No. 1. Fuels

like methanol, compressed natural gas, and liquefied natural gas have characteristics very different from diesel fuel or gasoline and are dangerous if handled incorrectly. This synthesis provided information on safe procedures for handling alternative fuels.

- **Operational Savings:** TCRP Report 4, *Aids for Rail Car Side-Door Operation*, provides guidance on the safest ways for the operator to observe door operation, thereby making it possible to eliminate conductors in some circumstances. This report was a key information resource for the Massachusetts Bay Transportation Authority (MBTA) during the conversion of the Blue Line to a single-person train operation in 1996, saving \$1 million annually. The report was submitted to the Massachusetts State Legislature and the state regulatory agency during public hearings concerning the initiative.
- **Standardized Light Rail Signaling for Improved Safety:** A draft version of a new light rail chapter for the Manual on Uniform Traffic Control Devices (MUTCD) was prepared as part of TCRP Project A-5, *Integration of Light Rail Transit into City Streets*. The TCRP contractor worked closely with the LRT Subcommittee of the MUTCD Committee on Railroad-Highway Grade Crossings to incorporate a new LRT chapter into the Millennium version of the MUTCD. The MUTCD is the document that contains nationally accepted standards for roadway signing and signaling, a critical element of traffic safety.
- **Track Maintenance Safety:** A National Transportation Safety Board (NTSB) report that was released in January 2008 referred to track-worker alert technology in its report on how to prevent future track-worker incidents. That track worker alert technology that NTSB referred to was developed and tested in TCRP IDEA Project 55, "*Warning Device for Rail Rapid Transit Personnel for Approaching Trains*," and NTSB demonstrated that technology at their public board meeting. The IDEA project included testing of the technology at MTA New York City Transit and the Greater Cleveland Regional Transit Authority.
- **Reduced Visual Impact of Overhead Wire:** The Greater Cleveland RTA used the results of TCRP Project D-4, *Visual Impact of Overhead Contact Systems for Electric Transit Vehicles*, in planning an RTA extension. The findings of this project were particularly significant, because citizen opposition to overhead wire is one of the primary roadblocks to LRT acceptance.
- **Transit Performance Measures:** The Wisconsin DOT reported that two TCRP publications were very useful in reviewing transit performance measures and their use in allocation formulas: TCRP Synthesis No. 6, *The Role of Performance-Based Measures in Allocating Funding for Transit Operations*, and *The Quality Journey: A TQM Roadmap for Public Transportation*. The experiences of other states were found to be particularly helpful. TRB documents were reported to be of value in developing a long-range statewide transportation plan and in providing guidance to the Metropolitan Planning Organizations in the state. The Greater Cleveland RTA reported that it used TCRP Report 88, *A Guidebook for Developing a Transit Performance-Measurement System*, to assist in a review of their performance-measurement system. In addition, LYNX in Orlando, Florida indicated that it used TCRP Report 88 during its 2004 strategic planning process.
- **Public Transportation Boards:** TCRP Report 104, *Public Transportation Board Effectiveness: A Self-Assessment Handbook*, provides a self-assessment process and tools to measure public transportation board effectiveness and provides references on how board characteristics can be changed to improve board effectiveness in various areas. The handbook also identifies the characteristics of public transportation boards that influence transit system performance. A number of transit agencies, including the Dallas Area Rapid Transit (DART), indicated that they implemented the board self-assessment process developed in the report. The Small Urban & Rural Transit Center reports that it is using Report 104 as part of a 2.5 hour presentation on the roles and responsibilities of transit board members at the 2007 Dakota Transit Association Conference.
- **Application of Artificial Intelligence To Railcar Maintenance:** A potentially cost-effective use of artificial intelligence technology was identified to assist railcar maintenance personnel in their diagnosis of railcar propulsion system maintenance problems. TCRP Report 1, *Artificial Intelligence For*

Transit Railcar Diagnostics, recommended testing the technology on the propulsion system, because the potential for savings is the greatest. The project was continued in order to conduct an operational test of the concept. A successful demonstration was completed at the Washington Metropolitan Area Transit Authority. The results of the demonstration are summarized in TCRP Report 44.

- **Commuter Benefits Programs:** TCRP Reports 87, *Strategies for Increasing the Effectiveness of Commuter Benefits Programs*, and 107, *Assessing the Costs and Benefits of Commuter Benefits Programs*, provide significant information and guidance regarding the implementation of commuter benefits programs. The U.S. Environmental Protection Agency (EPA) has indicated that information from these publications is being used to document some of the impacts that might result from the EPA's Best Workplaces for Commuters Program. In addition, the contractors for Report 107 were presented with the 2005 Transportation Demand Management Institute Research Excellence Award. This award is presented annually to the research project noted for its substantial contribution to the field of transportation demand management.
- **Transit Security:** The Cambria County Transit Authority (CamTran) in Johnstown, Pennsylvania reports that it used the revised final report for Project J-10D, *Security Planning Tools for Rural, Small Urban, and Community-Based Public Transportation Operations* (to be published as Report 86/ Volume 10 in early 2006) to assist them in the development of an Emergency and Security Plan that was required from the Department of Homeland Security to receive security funds for their Johnstown Inclined Plane. CamTran reported ". . . the TCRP document has been invaluable to us in providing structure and direction in what we need to get it done properly . . . We have looked at many other agency plans and we have looked at what FTA and FEMA has to offer and it is just overwhelming. This TCRP document kept us on track and focused on what we needed."

SEPTA in Philadelphia reports extensively using TCRP Report 86, Volume 8, *Continuity of Operations (COOP) Planning Guidelines for Transportation Agencies*, as a valuable resource in developing their internal continuity of operations plan. The City of College Station, Texas, is using material from this report to develop its COOP plan.

Florida DOT reports that it hired the principal investigator of TCRP Report 86, Volume 10, *Hazard and Security Plan Workshop: Instructor Guide*, to offer the workshop in several locations statewide. Mississippi DOT has also made the course available for its transit systems, both pre- and post-Hurricane Katrina. The Texas DOT is conducting four workshops around the state that are based on this TCRP report and its CD-ROM. At one of the workshops, a participant indicated ". . . the things addressed were instantly applicable to our operation at Citibus and for the first time since I got the responsibility of our security plan, I felt like I learned strategies that I could suggest for implementation."

The Coast Guard reports that it is incorporating material from TCRP Report 86, Volume 11, *Security Measures for Ferry Systems*, in its training for new terminal pilots. The general security measures (GSM) evaluation and selection tool included in the report will also be included in a Coast Guard Navigation and Vessel Inspection Circular (NVIC). Material from the revised final report was also incorporated into internal Coast Guard documents for its operational commanders.

The California Office of Homeland Security used material from the TCRP Report 86 public transportation security series (Volumes 1-12) in developing its internal policies and procedures.

The Chicago Transit Authority reports that it has frequently turned to reports from TCRP when analyzing security issues and policies. They indicate that TRB is the first source turned to when looking for reports on useful transportation security practices.

NATIONAL COOPERATIVE RESEARCH PROGRAM

See the following which gives examples of the impact of NCHRP reports on practice. A series of such reports can be reviewed at this link to NCHRP section of the TRB website: <http://www.trb.org/CRP/NCHRP/NCHRPImpacts.asp>

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Impacts on Practice—NCHRP Report 422

Quality assurance for the maintenance world

State DOTs expend tremendous resources to maintain their highways, bridges and other facilities. Many states use Maintenance Management Systems to plan and budget maintenance activities, but until recently DOTs' quality assurance programs were largely limited to the realm of construction.



Documenting field conditions

Responding to this need, NCHRP initiated Project 14-12, "Highway Maintenance Quality Assurance," to expand the use of QA programs in highway maintenance. The project's goal was to create a template for an MQA program that could be implemented by any state DOT. A program like this allows agencies to make educated decisions about where to invest limited maintenance resources, and to assess the benefits of investing in one type of asset over another.

The program template took the form of NCHRP Report 422, *Maintenance QA Program Implementation Manual*. Published in 1999, the report lays the groundwork for developing and implementing an MQA program, including guidelines for a Level of Service rating system and for field inspections, analysis and reporting.

"I can't imagine trying to start the program without this report."

Building a program from scratch

For Wisconsin DOT, Report 422 was a key factor in the 2001 launch of the department's ambitious maintenance quality assurance program, called Compass.

"I can't imagine trying to start the program without this report," says Alison Lebwahl.

former Compass program manager. "We had our pilot launched in six months, and I don't think we could have done it without having this step-by-step guide."

Tennessee DOT also put Report 422 to use in developing its Maintenance Rating Index, including program details such as TDOT's inspection form and the weighting factors assigned to roadway characteristics.

More thorough inspections

Before TDOT developed the Maintenance Rating Index, Tennessee county supervisors evaluated roadway conditions using a traditional "windshield inspection"—rating highway segments while driving.

"Overall it's been a very positive program for us," says Chris Harris, an operations specialist with TDOT. "Inspectors like it because it gives them an opportunity to see more within their county than if they were just doing a windshield inspection."

Bringing MQA to practitioners

A unique aspect of Project 14-12 was its aggressive approach to technology transfer. The project included funding for six workshops that brought the manual's principles to state DOT managers and maintenance professionals across the country.

"We walked them through it," says Marshall Stivers, the project's co-principal investigator and formerly ERES Consultants' director of maintenance systems. "We took them out in the field and let them evaluate the quality of a highway segment. It was interesting—there were lots of variations in what people saw."

Lee Smithson, former deputy director of the maintenance division at Iowa DOT and a workshop attendee, said the workshops had a great deal of practical value.

"The workshops demonstrated how to use condition ratings as a target—how to go to policy makers and say 'Here's where we are, and here's how much money or staff it will take to get to that next level,'" Smithson says.

"The report was a real steppingstone to advancing the national trend toward maintenance quality assurance."

Interest builds nationwide

The workshops helped expand awareness of the new NCHRP manual and of the MQA concept, which was in its infancy when the manual was published in 1999. By the time Wisconsin DOT and the University of Wisconsin held a Maintenance Quality Assurance Peer Exchange five years later in 2004, participation was very strong, with staff from more than 35 agencies attending the event.

"The report was a real steppingstone to advancing the national trend toward maintenance quality assurance," Lebwahl says.

NCHRP Report 422 is available for purchase from the TRB Bookstore at <http://www.trb.org/bookstore/>. A related report, Web Document 8, is available online at <http://www.nap.edu/catalog/6346.html>.



Winter performance measures

NCHRP—Transportation research that works

Objective national highway research since 1962 • Focused on practical problems of state DOTs • Contract researchers competitively selected • Overseen by balanced panels of technical experts • Reviewed by TRB highway specialists

ACKNOWLEDGEMENT OF SPONSORSHIP Work was sponsored by the American Association of State Highway and Transportation Officials, in cooperation with the Federal Highway Administration, and was conducted in the National Cooperative Highway Research Program, which is administered by the Transportation Research Board of the National Academies.

DISCLAIMER The opinions and conclusions expressed or implied in reports are those of the research agencies. They are not necessarily those of the Transportation Research Board, the National Academies, or the program sponsors.

Delivering value across a transportation agency

Bill Temple, chief engineer of the Louisiana Department of Transportation and Development, can name off the top of his head a dozen NCHRP research reports that his office uses on a regular basis to get its work done. Topics range from Superpave testing to pavement drainage issues, from access management to design-build contracting. However, when Temple did some asking around Louisiana DOTD, he found that his list was just the tip of the iceberg.



NCHRP research contributed to the accelerated design and construction of the new I-10 Twin Spans Bridge.

Serving Louisiana DOTD's engineers

To get a broader picture of how Louisiana DOTD uses NCHRP research, Temple asked division heads throughout the agency to identify NCHRP research products that they commonly rely upon. He received an impressive response, with some 150 reports cited by the Engineering Office alone, and 40 more by other areas of the agency.

Each part of the Engineering Office—spanning research, project development, construction, systems engineering, and traffic engineering—has examples to share. For instance, Project Development makes extensive use of NCHRP's load and resistance factor design research for bridge and structural design. Discussing recent rebuilding efforts on the Interstate 10 Twin Spans Bridge, Skip Paul, the director of the Louisiana Transportation Research Center, says, "The agency's design team never could have completed this work without relying on NCHRP research."

Systems Engineering is another frequent user of NCHRP research, calling upon many studies to support its mechanistic-empirical testing of state pavement materials and implementation of new design strategies. And NCHRP research studies are a standard reference for Pavement and Geotechnical Services' life cycle cost analyses. The list goes on.

Benefits across the agency

NCHRP's impact reaches beyond engineering and into virtually all areas of the agency. To name just a few:

- Highway Safety relies on NCHRP 500 Series guides for safety implementation and for data collection and analysis.
- Intelligent Transportation Systems has incorporated NCHRP research on traffic management centers into its statewide plans.
- Legal commonly uses NCHRP research on data management resources.

Small investment, large return

Louisiana DOTD enjoys a wide range of benefits from what Temple describes as a "flow of NCHRP material that arrives at our agency all year long." He estimates that Louisiana's annual voluntary contribution to NCHRP could by itself fund only a few research studies of a similar scope and magnitude. Pointing to all these NCHRP projects, Temple notes, "NCHRP is an extremely smart way for our department to leverage our research funding." Complementing the

"The agency's design team never could have completed this work without relying on NCHRP research."

program's full-scale research projects is a variety of other research products cited by Louisiana DOTD division heads, including NCHRP synthesis reports, series 20-07 "quick response" studies, and Innovations Deserving Exploratory Analysis reports.

Growing intellectual capacity

Beyond practical guidance, NCHRP research delivers additional benefits to Louisiana DOTD. "NCHRP assembles the best and brightest around the table when investigating a topic," says chief engineer Temple. Louisiana DOTD actively encourages employees to participate on Transportation Research Board technical committees and on NCHRP research project panels. Says research director Paul, "This not only helps us address areas of concern, but we also build a network of contacts among experts and grow our intellectual capacity to be worldwide leaders in our field."

"NCHRP is an extremely smart way for our department to leverage our research funding."



Skip Paul (left), research director for Louisiana DOTD, is one of many users of NCHRP research reporting to Bill Temple (right), the agency's chief engineer.

NCHRP—Transportation research that works

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www.trb.org/CRP/NCHRP/NCHRPImpacts.asp

ANSWERS TO POST-HEARING QUESTIONS

Responses by David J. Wise, Acting Director, Physical Infrastructure Issues, U.S. Government Accountability Office

Question submitted by Chair David Wu

Q1. What would GAO consider to be adequate performance measures for evaluating the impact of the DOT RD&T investment?

A1. RITA's primary responsibilities include reviewing DOT's research activities to ensure that research throughout DOT has been evaluated according to best practices, thereby demonstrating the effectiveness of RD&T investment. We recommended that RITA develop an overall strategy, evaluation plan, and performance goals and measures for this and its other coordination and facilitation responsibilities. RITA has taken some steps to do so, but still lacks an overall strategy, evaluation plan, and performance measures for its review responsibilities.

While evaluating RD&T impact is not an easy undertaking, it does not have to be solely focused on gauging outcomes—since the outcomes of RD&T often cannot be quantified in advance. The National Academies and our previous work echoed that setting clear RD&T goals and measuring their progress, using expert review to evaluate the quality of research and outcomes, and reporting periodically in evaluation results can help agencies systematically evaluate RD&T outcomes.¹ One approach that has been used in this area is to measure technology transfer. For example, key experts and stakeholders told us that one way that the Office of Pipeline Safety's RD&T program could be measured is by the degree to which new technologies developed by the program were actually used by pipeline operators. Similarly, according to a RITA official, the Federal Railroad Administration measures the performance of its RD&T activities by how many times RD&T programs are used in real world applications.

Questions submitted by Representative Adrian Smith

Q1. Your report states that RITA has taken steps to develop appropriate performance measures, including gathering information of the operating administrations on their performance measures through the RD&T Planning Team. You further state that RITA officials will determine what measures could be adopted after all of the operating administrations have had input. Do you know when RITA began these meetings of the Planning Team and how often the Team meets? Has DOT moved expeditiously to meet this requirement?

A1. In 2006, we recommended that RITA work with the operating administrations to develop common performance measures for the department's RD&T activities.² RITA has taken some steps to do so. According to a RITA official, in November 2008, the agency began gathering information from the operating administrations on performance measures during RD&T Planning Team meetings. The Planning Team is required to meet quarterly, but has met more frequently. In 2008, the Planning Team met 13 times, and the team has met twice thus far in 2009. A RITA official told us that they have finished the process of gathering information on performance measures, and are analyzing the information for commonalities and to determine whether any of the measures could be adopted for the department's RD&T activities. We will continue to monitor RITA's progress in developing and implementing performance measures.

Q2. Overall, does GAO believe that RITA can successfully plan and coordinate transportation R&D projects in-house and across the Department? Is the RPIC process as currently operating sufficient for these purposes? For instance, does RITA have access to data on the budget and performance of all R&D at the Department?

¹The National Academies. *Evaluating Research Efficiency in the U.S. Environmental Protection Agency*, Committee on Evaluating the Efficiency of Research and Development Programs at the U.S. Environmental Protection Agency (2008) and GAO, *Pipeline Safety: Systematic Process Needed to Evaluate Outcomes of Research and Development Program*, GAO-03-746 (Washington, D.C.: June 30, 2003).

²GAO, *Transportation Research: Opportunities for Improving the Oversight of DOT's Research Programs and User Satisfaction with Transportation Statistics*, GAO-06-917 (Washington, D.C.: Aug. 15, 2006).

A2. The RPIC process began in fiscal year 2009 and has not been in place long enough to assess whether it will enable RITA to successfully coordinate, facilitate, and review the department's RD&T activities, or enable RITA to develop an overall strategy. A RITA official told us that they have begun the RPIC process using fiscal year 2009 planned budget information (they do not have performance information at this time) and plan to compare planned budget information to actual budget information once the budget is enacted. While the RPIC process seems like a step in the right direction, DOT has not yet documented this new process or explained how it complements or replaces its existing coordination and review strategies. According to a RITA official, RITA is planning to develop a detailed description of the RPIC process and hopes to have this completed by late spring. In our 2006 report, we recommended that RITA develop an evaluation plan for its own activities, so it could better assess whether its activities and process, including RPIC, are meeting intended goals. RITA has not yet developed such an evaluation plan.

Q3. *Do we need to produce a new, comprehensive strategy for our nation's highways? If so, should this strategy include other transportation modes? Who should be charged with developing such a strategy and how often should it be updated?*

A3. We have reported that surface transportation programs need to be re-examined, especially given the Nation's financial crisis and growing congestion and travel demand.³ Since federal financing for the interstate highway system was established in 1956 because of the national interest in interstate mobility, the federal role in surface transportation has expanded to include broader goals, more programs, and a variety of program structures. To incorporate additional transportation, environmental and societal goals, federal surface transportation programs have grown in number and complexity. However, the federal highway program's financing and delivery mechanisms have not substantially changed and their continued relevance in the 21st century is unclear.

Many of these programs are not effective at addressing key transportation challenges such as increasing congestion and growing freight demand because federal goals and roles are unclear, many programs lack links to needs or performance, and the programs in some areas do not employ the best tools and approaches to ensure effective investment decisions. For example, most highway funds are distributed through formulas that have only an indirect relationship to needs and no relationship to performance or outcomes.

We have called for a fundamental re-examination of the Nation's surface transportation policies. We identified a number of principles that could help drive reexamination of federal surface transportation programs and an assessment of options for restructuring the federal surface transportation program. These principles include: (1) ensuring goals are well defined and focused on the federal interest, (2) ensuring the federal role in achieving each goal is clearly defined, (3) ensuring accountability for results by entities receiving federal funds, (4) employing the best tools and approaches to emphasize return on targeted federal investment, and (5) ensuring fiscal sustainability.

With the sustainability and performance issues of current programs, it is an opportune time for Congress to more clearly define the federal role in transportation and improve progress toward specific, nationally-defined outcomes. Given the scope of needed transformation, it may be necessary to shift policies and programs incrementally or on a pilot basis to gain practical lessons for a coherent, sustainable, and effective national program and financing structure to best serve the Nation for the 21st century.

³GAO, *Surface Transportation: Restructured Federal Approach Needed for More Focused, Performance-Based, and Sustainable Programs*, GAO-08-400 (Washington, D.C.: March 6, 2008).

Appendix 2:

ADDITIONAL MATERIAL FOR THE RECORD

STATEMENT OF LAWRENCE H. ORCUTT
CHIEF, DIVISION OF RESEARCH AND INNOVATION
CALIFORNIA DEPARTMENT OF TRANSPORTATION

This testimony is intended to address the following four questions posed to the Division of Research and Innovation, California Department of Transportation (Caltrans):

1. *How has the federal investment in R&D through the UTCs, NCHRP, SHRP II, etc. impacted current infrastructure construction practice?*
2. *What barriers prevent adoption of new techniques or applications?*
3. *How can the Federal Government ensure that State, county, and city decision-makers make informed decisions (i.e., LTAP)?*
4. *Is the current workforce capable of implementing advanced highway technologies?*

INTRODUCTION

Mr. Chairman, Members of the Subcommittee:

My name is Lawrence Orcutt. I am the Chief of the Division of Research and Innovation for the California Department of Transportation, also known as Caltrans. Thank you for the opportunity to provide you with this written testimony.

The Division of Research and Innovation (DRI) receives \$10–15 million per year from the Federal Highway Administration (FHWA) to fund the State Planning and Research Program, Part 2. In addition, in 2008 Caltrans was notified of receiving \$10–15 million in federal grants through various competitive processes that include Safe Trip-21: Connected Traveler (Research and Innovative Technology Administration), Vehicle Assist and Automation (sponsored by Federal Transit Administration), Augmented Speed Enforcement (sponsored by the Rural Safety Initiative-FHWA), and a Truck Parking Initiative grant to fund a project along the Interstate 5 (I-5) Corridor (sponsored by FHWA).

I serve on the Transportation Research Board's (TRB) Strategic Highway Research Program 2 (SHRP 2) Safety Technical Coordinating Committee, and I am the Co-Chair for the TRB Technology Transfer Committee. I also serve on the Research and Technology Coordinating Committee (RTCC) that serves as an independent advisor to FHWA and other research organizations on national and federal highway research that has been supported by FHWA.

Innovation is one of the four core values that guide and shape Caltrans, and staff is empowered to seek creative solutions and take intelligent risks. Caltrans has the largest and one of the most vigorous research programs in the Nation. Mr. Randell H. Iwasaki, Chief Deputy Director for Caltrans, provided testimony to your subcommittee in June 2008 about some of the nationally significant infrastructure-related technologies that Caltrans has developed such as, long-life pavement rehabilitation strategies, and rapid rehabilitation strategies (Construction Analysis for Pavement Rehabilitation Strategies). I will be providing more detailed information about these two innovations later in my testimony.

Caltrans has been focused on deploying research results to achieve true innovation so that research becomes reality. Through the guidance of the Caltrans Research and Deployment Steering Committee and by establishing a deployment group that is responsible for developing and implementing research deployment strategies, Caltrans has become a leader in transportation research deployment. Examples of some of the challenges and solutions to research deployment are included in my testimony.

One of the most significant issues facing California and the Nation is the need to develop and implement transportation innovations. In the *Safe, Accountable, Flexible, Efficient Transportation Equity Act—A Legacy for Users* (SAFETEA-LU), Congress recognized the importance of innovation per the Principles for Research based on Title V:

“The federal portfolio should cover the full innovation cycle, including the following:

- Agenda setting,
- Conduct of research,
- Support of research and technology transfer by the states,
- Sharing of results, and
- Deployment (including education and training).”

In the *Research and Technology Coordinating Committee, TRB Special Report 295* it is recommended that:

“Adequate resources should be provided to FHWA to support a robust program for dissemination of research results to states, local governments, and private vendors.”

Congress had the excellent foresight to require an implementation report for SHRP 2. “As part of SHRP 2 authorization, Congress requested that a report be delivered in early 2009 concerning promising results from the research and how they could be implemented most effectively. In response to this request, the TRB’s report *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life* outlines what it will take to implement the results of the program and reap the benefits it promises.”

The recommendations listed in the report are very consistent with the Caltrans focus on deploying research results to achieve innovation: “A SHRP 2 implementation program should be established and stable and predictable funding should be provided over several years to support SHRP 2 implementation activities.”

The legislative recommendations from the American Association of State Highway and Transportation Officials (AASHTO) developed by the Standing Committee on Research also requests resources for research deployment:

“Legislative Recommendations Summary: Initiation of a new Research Deployment Program, funded at \$5 million annually.

Policy Issue Discussion/Background:

Research products are difficult to deploy into practice. Many reasons contribute to this, and many are documented in the NCHRP Report 442, *Systems Approach to Evaluating Innovations for Integration into Highway Practice*. One of the most significant reasons hindering the deployment of a research product is a lack of a focused national program with resources to identify and share the most successful research deployments.

A program should be established that facilitates the deployment of successful research products. This program should be multi-modal and conducted under the guidance of stakeholders who are the ultimate users of the research. The program would develop and implement project deployment plans, communications, and demonstration activities. The program should be able to advise and assist stakeholders with unique implementation problems, such as intellectual property, feasibility studies, cost benefit analysis, and ease of implementation.”

The Federal Investment in Highway Research, 2006–2009: Strengths and Weaknesses—Special Report 295 makes an excellent argument for implementing innovation:

“The challenges facing the highway system cannot be addressed simply by spending more money, even if doing so were possible. Funding for highways is currently constrained by the sharp draw-down in the federal highway trust fund and a general unwillingness to raise fees or taxes that support transportation infrastructure. Successfully addressing many of the challenges discussed above will require new and more efficient ways of doing things—new materials, better and faster construction techniques, safer designs, better information for drivers, new financing mechanisms, options for pricing use of the system, and many more. This is the role that research, development, deployment, and training must fill.”

QUESTION 1. How has the federal investment in R&D through the UTCs, NCHRP, SHRP II, etc. impacted current infrastructure construction practice?

OVERVIEW

The California Department of Transportation (Caltrans) built and oversees a 78,000 lane-kilometers (lane-km, or one lane, one kilometer) State highway system. Much of that system needs repair. Rebuilding our transportation infrastructure affects all Californians as well as our national economy and global commerce. Much of our problem focuses on meeting the challenge of how to rebuild deteriorating highways economically, safely, and with minimal impacts and inconvenience to the public.

Cutting-edge pavement research at Caltrans and the University of California has been helping find ways to rebuild our highways. Pavement research methods and findings have potential use on other projects. For example, results from traffic stud-

ies in work zones are available for research and deployment of Intelligent Transportation Systems (ITS). Also, results may help improve pavements at ports and railheads. The state-of-the-art research tools are also adaptable to local agencies to use in improving city streets and county roads. In this way, results from Caltrans research are better able to produce benefits for all Californians and all Americans.

BACKGROUND LONG LIFE PAVEMENT REHABILITATION STRATEGIES (LLPRS)

The three examples I will describe, all stem from the Caltrans Long-Life Pavement Rehabilitation Strategies (LLPRS) Program which began in 1998. The goal of the LLPRS program is to rebuild approximately 2,800 lane-km of high-volume urban freeway with pavements that are designed to last more than 30 years with minimal maintenance. LLPRS also addresses the State's need for cost-effective approaches for rebuilding the aging pavements in its urban highway networks. The LLPRS program will reduce the need for future repair projects and ultimately save public resources for future generations of road users.

LLPRS candidate projects were selected from among highways that experience minimum volume demands of 150,000 Average Daily Traffic or 15,000 Average Daily Truck Traffic, and that have poor structural pavement condition and ride quality. Most LLPRS candidate sections are Portland Cement Concrete (PCC) pavements on Interstate freeways in urban networks, 80 percent of which are within the Los Angeles Basin, and 15 percent of which are in the San Francisco Bay Area.

Caltrans has been working with the Partnered Pavement Research Center (at the University of California, Berkeley) since 1994 using the Heavy Vehicle Simulator (HVS) and Accelerated Pavement Testing to develop new pavement products for infrastructure improvements. In 2005, Caltrans approved an issue memo titled, "Adoption of Mechanistic-Empirical (ME) Pavement Design Method," which calls for the adoption of ME pavement design methodology to replace existing pavement design methods which have been in place since the early 1960s. Since 2000, the University of California Pavement Research Center (UCPRC) has been supporting the Caltrans effort to adopt ME pavement design by using a wide array of tools, including HVS full-scale pavement tests. This work is under the technical guidance of the Caltrans Pavement Standards Team. One of the Team's tasks is to develop and calibrate ME flexible pavement design and models for new pavements and rehabilitation. These models have been incorporated into a draft software program called *CalME*. The validation and calibration of the models in *CalME* was first performed using performance data from HVS tests completed by the UCPRC between 1995 and 2004. Calibration of *CalME* models also has been achieved using WesTrack performance data.

The following are three Caltrans LLPRS projects:

1. LLPRS Pilot Project: Interstate 10 Concrete Rehabilitation in Pomona

In February 2000, a 20-lane-km rehabilitation project on Interstate 10 near Los Angeles, California, was successfully completed. Fast setting hydraulic cement concrete was applied because it reached traffic opening strength in only four hours after its placement. The project required one weekend closure to complete 2.8 lane-km and repeated seven and ten-hour nighttime closures for the remaining distance. The rehabilitation project consisted of replacing the existing 230 millimeter concrete slab with new concrete, dowels, and tie bars. The contractor used a concurrent working method in which demolition and concrete paving occurred simultaneously and only a single lane was removed and replaced.

The delivery and discharge of concrete controlled the overall progress. The 55-hour weekend closure proceeded at a rate 54 percent faster than the average of nighttime closures, as measured by number of slabs replaced per hour. A comprehensive traffic management strategy helped to reduce the volume of traffic during the weekend closure and minimize the traffic delay through the construction work zone.

This "proof of concept" LLPRS project, which used concrete material, was followed by another project using asphalt materials.

2. LLPRS Demonstration Project: Interstate 710 Asphalt Concrete Rehabilitation in Long Beach

Caltrans successfully rebuilt a 4.4-km stretch of Interstate 710 in Long Beach, California, by adopting a fast-track construction approach that included around-the-clock (24/7) operations. The project proved that fast-track rehabilitation with 55-hour weekend closures is effective to drastically shorten overall construction time and lessen the negative effects of construction in an urban area. This eased

congestion for the public, as well as freight moving to and from the ports of Long Beach (the second busiest port in the United States) and Los Angeles.

The project proved that asphalt concrete pavement designed to provide a 30+ year design life can be constructed in a series of weekend closures even on the most heavily loaded truck route in the state. This long-life asphalt concrete pavement rehabilitation project occurred during the summer of 2003. On this project, either 230 millimeters of asphalt concrete overlay or 325 millimeters of full-depth asphalt concrete replacement were applied during eight 55-hour weekend closures. After five years of monitoring, the pavement is performing as predicted by research and pavement tests conducted for Caltrans by the UCPRC.

3. LLPRS Implementation Project: Interstate 15 Concrete Rehabilitation in Devore

Fast-track rehabilitation and reconstruction innovations have been researched and deployed in California. One example is the heavily traveled Interstate 15 corridor in Devore, California. A 4.5-km stretch of badly damaged concrete truck lanes was rebuilt in only two 210-hour (about nine days), extended closures using counter-flow traffic and 24-hour operations. The same project would have taken ten months using traditional nighttime closures.

Compared to traditional ten-hour nighttime closures, the extended closure had about 80 percent less total closure time, about 30 percent less road user cost due to traffic delay, and about 25 percent less Caltrans cost (about \$6 million savings) for construction and traffic control.

Specific innovations adopted for this groundbreaking "Rapid Rehab" project include the following:

- **Automated Work Zone Information Systems** to update travelers with real-time travel information
- **Quickchange Movable Barrier** system with a dynamic lane configuration to minimize traffic disruption
- **Incentive/disincentive provisions** to encourage the contractor to complete the closures on time
- **Multifaceted outreach program and web-based information systems** for disseminating project updates and getting input from the public
- **Mix design of rapid strength concrete** to enable the project to be opened to traffic 12 hours after placement.

RAPID REHAB

One significant R&D product that is changing planning and management of highway construction across the country, specifically pavement rehabilitation projects, is Rapid Rehab. Rapid Rehab, also known as *Construction Analysis for Pavement Rehabilitation Strategies*, or CA4PRS, is a software package that was developed by the UCPRC with funding from DRI. CA4PRS aids engineers and contractors in selecting economical highway rehabilitation strategies that minimize disruptions to drivers and to the surrounding community. It identifies optimal construction management strategies that balance construction schedules with traveler inconvenience while minimizing agency costs by considering "what if" scenarios for variables such as construction time windows, number of lanes to be closed, material selection, and site access for construction vehicles (16).

Rapid Rehab Development, Testing, and Implementation Progress

CA4PRS was developed outside of the normal Caltrans Information Technology (CIT) development process using a Transportation Pooled Fund project with the States of Washington, Minnesota, and Texas participating in the pooled fund effort.

CA4PRS was first tested in 1999 in a construction project along a stretch of Interstate 10 near Pomona, east of Los Angeles, California. Data from that project validated CA4PRS simulated production rates and impacts on traffic. Before the work began, the contractor's estimate for a 55-hour weekend production rate was 3.5 lane-km. CA4PRS' estimate was 2.9 lane-km. Actual performance came to 2.8 lane-km (17).

The second major construction project was on Interstate 710 near Long Beach in Southern California in 2002. The original construction plan called for ten 55-hour weekend closures. However, encouraged by an incentive provision of \$100,000 for each weekend closure eliminated, the contractor used CA4PRS and finished the job in eight consecutive closures instead of ten and claimed a \$200,000 bonus (18).

The third major project was in 2004 along a 4.5-km stretch of Interstate 15 near Devore in Southern California. Original construction schedule called for 10-month nighttime-only closures. However, using CA4PRS proposed scenario, this badly damaged concrete stretch was rebuilt in two single-roadbed continuous closures (also called “extended closures”) totaling 210 hours, using counter-flow traffic (opposite direction to the main traffic flow) and 24-hour-per-day construction operations (17).

The AASHTO Technology Implementation Group in 2006 designated CA4PRS as a “priority technology” because CA4PRS proved to be a valuable time and money saving innovation.

In 2007, CA4PRS was nominated and earned the International Road Federation Global Road Achievement Award for the Research Category. CA4PRS is also included on the FHWA Priority Market-Ready Technology list. During a recent ceremony with the Director of Caltrans, the question was asked, “Why aren’t we using this tool on all of our projects?” Caltrans is working to make CA4PRS part of the standard design practices for all projects.

At the national level, Caltrans has been working with FHWA to assist other State Departments of Transportation in the purchase of the licensing rights through the *Highways for Life Program*. The University of California has established a cost of \$150,000 for all states to be allowed exclusive rights to use CA4PRS. The current cost for a state to purchase a CA4PRS enterprise license is \$5,000, which is relatively inexpensive.

Conclusion

Through partnering with University of California researchers, Caltrans used innovative technologies to begin rebuilding California’s infrastructure. These examples show pavement improvements being made in California that both improve how pavements are designed and built, and also help to manage the construction impacts to traffic by considering work windows that allow contractors get the work done quicker, cheaper, and with better quality. The overall construction cost savings total more than \$20 million for the LLPRS program using the new technologies developed by this research program. Rebuilding America’s infrastructure will require new methods and technologies similar to those developed in California using federal research funding to develop products that will improve our transportation products and services.

QUESTION 2. What barriers prevent adoption of new techniques or applications?

INTRODUCTION

In the transportation world of the 21st century, many challenges are created by inadequate resources needed to address today’s massive transportation problems of congestion, failing infrastructure and environmental impacts of transportation, most notably worsening air quality and climate change. Innovation should, and could lead to improving the performance, efficiency, and quality of the transportation system as well as reducing their environmental impacts.

Innovation is much needed to manage the enormity and complexity of transportation system. As noted in the TRB Special Report 261, “*complexity of the transportation challenges underscores the need for new ways of looking at problems and for innovative solutions, offering significant research opportunities in all facets of the highway sector*” (1).

COMMON BARRIERS TO INNOVATION

Different types of innovations face different obstacles. The more radical or disruptive an innovation is, the more challenges will accompany its acceptance and implementation. A thorough literature search (particularly the 2001 TRB Special Report 261) (1) helped the department to identify six major barriers to innovation in transportation as summarized below.

1. System Diversity and Complexity

The United States Transportation system is diverse, decentralized, and multifaceted. Conflicting public and private sector incentives add to such complexity (1). Fragmentation, disagreement among public works constituencies, and competition among public works categories for scarce resources have combined to constrain innovation (7).

2. Intellectual Property and Procurement Restrictions

The public sector procurement practices impose constraints on innovation (1). Public sector procurement activity is driven by low-bid process based on speci-

fications and procedures established to satisfy the need for open competition and accountability (7). Competitive bidding requirements represent a core problem because often certain innovations are offered by a single company. Conflict between open public bidding processes and private Intellectual Property (IP) rights can hamper deployment of innovative products (9). Excluding evaluation contractors from implementation contracts can limit competition at the deployment stage (8).

3. Risk Aversion

There is notable low tolerance for risk in the public sector (1). Public sector decision-makers work in an environment that does not reward risk taking. If public officials are uneducated about or unfamiliar with the potential of innovative technology or uncertain of its merits, they are reluctant to adopt it (7).

4. Resistance or Inability to Change

Organizations limit and resist change (1). "When optimal resolution of a product or process performance problem demands a very different set of knowledge than a firm has accumulated, it may very well stumble" (10). Lack of training and unskilled employees often inhibits technological change (8).

5. Lack of Profit Motives

Public sector innovation is not subject to the profit motive that stimulates commercial innovation (7). Disruptive technologies are "initially embraced by the least-profitable customers in a market" (10). Companies that let customers identify only new products that promise greater profitability and growth "are rarely able to build a case for investing in disruptive technologies until it is too late" (10).

6. Lack of Product Evaluation Criteria

It is often difficult to characterize and predict system and component performance of new innovative products (1). New product evaluation guidelines are slow to develop and are often under-resourced (8). Evaluation requirements are sometimes unclear or not defined (9). At the Caltrans it is particularly difficult to get business cases for Information Technology products approved through the extensive and cumbersome Feasibility Study Report process imposed by other regulatory agencies (8).

THREE MAJOR CALIFORNIA CASE STUDIES

Recently, Caltrans completed research and development of three technological innovations the implementation of which covers a wide spectrum of barriers in encountered in new transportation technologies.

- I. Sensys™ is a revolutionary traffic sensing innovation that combines latest communications in roads and highways technologies that was implemented in an evolutionary manner.
- II. Rapid Rehab (also known as *Construction Analysis for Pavement Rehabilitation Strategies*, CA4PRS), is a strategic and tactical planning, and control software innovation that is being implemented in an evolutionary fashion.
- III. Balsi Beam is an evolutionary safety hardware innovation that needed revolutionary approach to implementation.

Although these innovations promised significant return on investment, deployment of each faced numerous and significant challenges that delayed implementation.

I. SENSYS™ CASE STUDY

Sensys™ is a compact, self-contained, easy-to-install, highly reliable, low cost wireless traffic sensor system that can replace traditional, more expensive inductive loops. The Sensys concept originated through the Partners for Advanced Transit and Highways (PATH) Program, at the University of California, Berkeley (UC–Berkeley) through a special research program in 2002 dedicated to exploring new ideas. Through Caltrans' DRI, the program provided up to \$25,000 for one-year research proposals strictly intended to test or demonstrate new ideas and concepts.

The \$25,000 Sensys proposal was to investigate the potential use of a new wireless detector that could collect similar traffic data collected by wired inductive loops that have been in use since 1960. The research proposed to investigate the use of micro electro-mechanical systems (MEMS) acoustic sensors, a prototype of which was developed earlier in the Department of Electrical Engineering and Computer Science at UC–Berkeley under a previously sponsored Defense Advanced Research

Project Agency (DARPA) project. Researchers proposed to test how well the MEMS sensor network would detect traffic in urban streets and parking lots and determine how effectively these sensors can operate in an urban traffic environment, and how much spatial and temporal resolution can be achieved (11).

The Sensys research proposal was approved and Caltrans, which allowed the researchers to explore and test the concept within one year, provided, seed money. During the research, the researchers switched from the initial detection technology (acoustical sensors) to magneto-resistive sensor. They also redesigned the system's protocol to increase communications efficiency and reduce energy consumption (12). The first Sensys prototype was ready for testing in 2003.

SensysTM Roadblocks

Two of the main barriers that the implementation of the new Sensys system faced emerged at the testing stage. There was no funding allocated for testing and there were no criteria with which to evaluate its effectiveness. Other roadblocks faced by Caltrans include:

1. Lack of Funding to Explore Brand New Concepts

To mitigate this barrier, DRI created a small (\$25,000) and limited (one-year) research grants to investigate and test new ideas.

2. Lack of Functional Requirements, Specifications, and Evaluation Criteria

To mitigate this barrier, DRI commissioned the California Center for Innovative Transportation (CCIT) at UC–Berkeley to perform an evaluation and that also performed a supplemental evaluation using comparable criteria.

3. Lack of Provider Credibility

To mitigate this barrier, DRI assured end-users that Sensys was a reliable product backed not only by the manufacture but also approved by Caltrans.

4. Resistance to Change and Risk Aversion

To mitigate this barrier, proactive communication was pursued through reports and informal discussions. DRI recruited champions at Caltrans' Division of Traffic Operations who sanctioned the testing.

5. Sole-sourcing Contracts

To mitigate this barrier, DRI had relied on performance-based specifications.

Lessons Learned

Caltrans has learned several important lessons in this case.

1. Logical Evaluation Criteria must be established in a Timely Fashion to Evaluate New Products.

Customer-approved key performance indicators must be identified and performance must be measured with reasonable resources. It was learned that, in order to establish credibility, testing performance standards for new products should be as rigorous as or more rigorous than performance standards for existing products.

2. Using a Systems Engineering Approach is Necessary.

Using principles of systems engineering, functional requirements should have been specified and used instead of promotional product descriptions. In all cases, a company trying to meet the client's requirements must clearly understand the process for getting the product approved for use by the client (12).

3. Intellectual Property (IP) can be Handled through the University System.

Intellectual property was not an issue with this innovation because the IP was handled through the University of California's IP licensing process. Nonetheless, this required a substantial effort by Caltrans to get the approval of the California Department of General Services to allow the University to own the IP developed by the University research that was funded by Caltrans.

4. Innovation needs Champions.

The importance of innovation champions was a critical factor for the successful deployment of Sensys. Professor Varaiya, inventor of Sensys at UC–Berkeley, believes that acceptance of Sensys in California by Caltrans will establish confidence in Sensys and pave the way for other markets to deploy the product (15).

II. RAPID REHAB (CA4PRS) CASE STUDY

Rapid Rehab is described previously under Question 1 as part of the LLPRS program.

CA4PRS Roadblocks

The AASHTO Technology Implementation Group in 2006 designated CA4PRS as a "priority technology." Despite this and the fact that CA4PRS proved to be a valuable time and money saving innovation, it had its share of roadblocks. CA4PRS was developed outside of the normal Caltrans Information Technology (IT) development process using a Transportation Pooled Fund project with the States of Washington, Minnesota, and Texas participating in the pooled fund effort.

1. **Compliance with Caltrans IT Standards.** In order for CA4PRS to be accepted and allowed by Caltrans IT to become standard Caltrans software (and for Caltrans users to install it on their computers), an extensive benefit-cost analysis justifying the acquisition of the software for Caltrans had to be conducted and an extensive and cumbersome Feasibility Study Report (FSR) had to be completed. Completing the FSR for CA4PRS was extremely time-consuming, complicated, difficult, and frustrating process.

Soon after the CA4PRS FSR was completed and after CA4PRS was incorporated into Caltrans Technology Standards list, a new deployment roadblock emerged. CA4PRS software needs to be installed on each engineer's computer individually. According to Caltrans IT protocols, individual installation of software requires the work to be performed by Caltrans IT staff. Caltrans' IT staff was not able to perform the installation work in a timely manner for the many users. As a result, many engineers gave up on using CA4PRS altogether.

2. **Need to Learn How to Market New Technologies.** Marketing of technology is critical for its success because often the information is available, but it requires too much effort to find. Marketing successful results of research by going out to the customers is a proactive approach that Caltrans has used to "push" this technology out to users. Caltrans has learned that producing a report that resides on a web page or in a library is not an effective way to deploy innovation.
3. **Resistance to Change and Breakdown in Bottom-up Communications.** Public institutions prefer stability and routine and are resistant to change. Caltrans had to be proactive in pushing the new technology. DRI used champions at staff and management levels throughout all stages of deployment to demonstrate the merit of this software. Briefings were provided to key decision-makers to support this innovation.
4. **Lack of Profit Motive.** It was necessary to demonstrate the concrete benefits of Rapid Rehab to Caltrans staff as well as private contractors. Establishing the savings in support costs is very important to Capital Outlay Support managers, and this information helped make decisions that supported the use of CA4PRS. Construction and traveler delay cost and savings were documented and shown to benefit Caltrans, the contractors, and the general public.
5. **Risk Aversion and the Need to Establish Credibility for New Products.** Seeking national and international recognition for innovative research is a strategy that DRI has used to build credibility for CA4PRS within Caltrans at management and staff levels. In 2007, CA4PRS was nominated and earned the International Road Federation Global Road Achievement Award for the Research Category. CA4PRS is also included on the FHWA Priority Market-Ready Technology list. DRI used CA4PRS in pilot studies that demonstrated its success. DRI won credibility for CA4PRS through winning national and international recognition.
6. **Software Licensing Issues.** The University of California has established a cost of \$150,000 for all states to be allowed exclusive rights to use CA4PRS. The current cost for a state to purchase a CA4PRS enterprise license is \$5,000, which is relatively inexpensive. Nonetheless, many states were unable to get the approval from their own IT departments to acquire the software for reasons similar to the Caltrans experience. To alleviate the financial burden that other states may have in acquiring CA4PRS, Caltrans took the initiative and has been working with FHWA to assist other State DOTs in the purchase of the licensing rights through the *Highways for Life Program*.
7. **Need for User Training.** Finally, lack of training is an impediment to using CA4PRS. Therefore, Caltrans, in cooperation with UC-Berkeley, has established a training curriculum. So far over 700 people have been trained to use CA4PRS. This includes approximately 100 users from other states.

Lessons Learned

The most important lesson learned includes the needs to do each of the following:

1. **Be flexible and resourceful.** Although the FSR was difficult to do, DRI used it to as a way to document the benefits and costs of CA4PRS.
2. **Manage product licensing.**
3. **Demonstrate the value of innovation.**
4. **Have innovation champions.**
5. **Minimize implementation cost.** Caltrans used *Highways for Life Program* to help other states purchase CA4PRS.
6. **Train users professionally.** It was learned that without a curriculum and training plan, this innovation would not be used.

III. BALSİ BEAM CASE STUDY

Protecting the safety of construction and maintenance field crews and motorists on roadways has long been a top priority for Caltrans. More than 40,000 people are injured each year in the United States of America as a result of motor vehicle crashes in work zones. Fatalities from work zone crashes have increased by more than 50 percent between 1999 and 2004 (19). In 2004, the cost of a fatality was estimated to be \$1,011,000. The cost of a critical injury was estimated to be \$858,000 (20).

Balsi Beam is an innovative mobile work zone protection system that was envisioned by Caltrans Division of Maintenance staff. The Balsi Beam is named after Mark Balsi, a Caltrans landscape worker who suffered major injuries when he was working along Interstate 280 in Santa Clara County, California in January 2001.

The Balsi Beam system is basically a tractor-trailer combination, with a specialized trailer that extends into a thirty-foot long work space in between the rear axles and tractor, shielded on one side with two steel beams" (21). The trailer provides an extendable steel barrier to protect workers on traffic-exposed flank of a work zone.

The Balsi Beam was designed and built by Caltrans' Division of Equipment. The Caltrans bridge crews utilized the Balsi Beam to protect their workers. The Balsi Beam would not be deployed today without the support of the bridge crew from Caltrans district staff Marysville, California.

Balsi Beam Roadblocks

The deployment of Balsi Beam has faced several technical, logistical, and institutional roadblocks that included the following:

1. **Lack of an Established Evaluation Criteria and Customers' Uncertainty about the Effectiveness of Balsi Beam.** It is difficult to get maintenance crews to use a new product like the Balsi Beam. In the opinion of the inventor, Balsi Beam is not ready for national deployment because it is still a prototype. In her opinion, Balsi Beam will prove its effectiveness when it is actually hit and saves lives (22).
2. **Customers' Lack of Familiarity with Balsi Beam Capabilities.** The complex logistics of introducing a new tool into existing processes at Caltrans made the deployment of this innovation difficult. Demonstrations by the crew using the Balsi Beam helped get the word out to the maintenance community. Having champions at all levels to support the Balsi Beam is critical for the success of implementing this innovation. Training needs to be developed by maintenance personnel as hands-on training for crews to be able to operate the Balsi Beam.
3. **Lack of a Business Case for Commercializing Balsi Beam.** Balsi Beam has strong business (and safety) case but documenting such an innovation case for commercialization was a new process for Caltrans. Documenting the business case for the Balsi Beam was essential for getting additional resources to purchase additional units through the Budget Change Proposal process at Caltrans. Documenting the business case not only yielded a solid and presentable business case, but also during the process itself, stronger links were established between champions at all levels for this innovative system from regular highway maintenance workers to the Chief for the Division of Maintenance at Caltrans, District Director for District 3 (in Sacramento), and Caltrans Chief Deputy Director. This made the case stronger to implement the Balsi Beam. Establishing the business case using worker safety data and in-field evaluations helped to overcome the institutional issues. DRI commissioned CCIT to perform an evaluation. Finally,

DRI funded research at UC–Davis to perform benefit-cost analysis and risk evaluation study.

A consultant was hired to help DRI establish a process to sell the licenses to vendors to produce units for other states. Two goals of commercializing the Balsi Beam were to improve the product design and to reduce the costs and time to produce the units.

4. **Legal Restrictions.** One way for Caltrans to share this innovation with other states would have been to “gift” the license to other states or vendors. However, California law prohibits Caltrans from doing so. Article XVI § 6 of California Constitution prohibits any public agency from making “any gift of any public money or thing of value to any individual, municipal or other corporation whatever” (23). As a result, DRI has developed licenses to allow other states to purchase the right to use Balsi Beam through license agreements. DRI will be issuing an RFP to sell Balsi Beam licenses to multiple qualified vendors.
5. **High Capital Cost.** A major obstacle for getting the approval to deploy additional Balsi Beam units has been its high capital cost. The capital cost of the original prototype unit was \$257,000. Capital cost for a new, fully operational unit is estimated to be as high as \$600,000–700,000. Increases in the price of steel, complex system requirements, and potential liabilities are behind the cost increases. High capital cost has become a barrier to deploying Balsi Beam at Caltrans and to marketing it to other State DOTs. DRI is using commercialization to reduce capital cost by improving the design and optimizing manufacturing procedures as well as mass-producing the units to domestic and international customers. Concerned about its high cost, the California Department of Finance asked Caltrans to evaluate other less expensive mobile work zone protection devices. Caltrans will purchase an additional three Balsi Beams units and three ArmorGuard™ units. This study suggests that one way to reduce the high capital cost is to optimize Balsi Beam design and its manufacturing processes. Another way is to mass-produce the system, which spreads the fixed manufacturing costs over larger number of units by marketing it to other State agencies and overseas.
6. **Intellectual Property Constraints.** The patent and resulting Intellectual Property license for the Balsi Beam is an important discussion point that relates to implementing innovation. Almost all states have competitive bidding requirements to assure that they get the lowest price for the products they buy. CCIT conducted a study to analyze problems related to intellectual property and licensing of the Balsi Beam and concluded that Caltrans may have hampered the marketing of Balsi Beam by patenting it (12). This same study concluded that if a patent or licensed product requires exclusive, non-competitive bid, government entities might not be able to purchase the product because of the restrictions placed on non-competitive bids.
7. **Uncertainty about a Fair Market Value for Balsi Beam.** Uncertainty in determining a fair market value for Balsi Beam has been a financial stumbling block facing the implementation of this innovation. An agreement with the State of New York was held up for about one year waiting for the license to be developed and approved. In an effort to solve this problem, DRI commissioned CCIT in 2007 to conduct a study to estimate a market value for Balsi Beam license. CCIT concluded that a fair market value for the license would be \$2.6 million. The study further assumed that there is demand for 136 units that could be marketed eventually. Thus, the license cost per unit would \$19,000 per unit (12). Fair market value is critical for establishing that Caltrans gets a reasonable compensation for the Intellectual Property and for complying with the State Constitution that prevents gifts of public resources.

Lessons Learned

This case study illustrates the importance of several lessons learned including the need for all of the following:

1. **Creating champions at all levels of the organization from the crew level to top management.** Getting to this stage in the deployment of innovation has taken considerable time and dedication on part of champions at all levels in the organization.
2. **Carefully Managing Intellectual Property Rights.** Intellectual Property was a significant issue with the deployment of the Balsi Beam. It is different than the other two case studies because Caltrans owns the patent for the Balsi Beam.

Developing standard license agreements for use by other states and providing a market assessment were effective in overcoming the IP roadblocks. Caltrans is very close to issuing RFP to sell the licenses to vendors who will allow other potential customers to purchase Balsi Beam through commercial channels.

3. **Optimizing Manufacturing and Production of Balsi Beam.** Commercialization should optimize Balsi Beam design and manufacturing process and lower production cost. Mass production is also expected to lower unit cost.
4. **Marketing.** Marketing the Balsi Beam across the country has helped to gain credibility within California by proving that this technology is unique for the purpose of obtaining resources to purchase additional units. In June 2004, Caltrans sent the Balsi Beam across the Nation on a multi-state tour with the final destination being a demonstration for the AASHTO Standing Committee on Maintenance. Caltrans also marketed the Balsi Beam through many FHWA publications and by adding the Balsi Beam to the AASHTO Technology Implementation Group (TIG).

QUESTION 3. How can the Federal Government ensure that State, county, and city decision-makers make informed decisions (i.e., Local Technical Assistance Program, LTAP)?

Need to Train Next Generation Workforce

Over the next 10 years, nearly half the current transportation workforce will be eligible to retire—it's even more crucial than ever that we provide technical assistance and training programs. Tomorrow's decision-makers are likely today's young professionals. If they stop learning when they leave college, their training may be 20 years behind them by the time they are leading their agency. As technology and processes change, we need to ensure today's decision-makers are using today's tools, not what they learned in school 20 years ago.

LTAP Centers (the California center and 58 other centers across the country) already support the Federal Government objectives by getting training and information out to State, regional, local agencies in the following ways:

- Over the past 10 years, LTAP/TTAP centers have provided training to over 200,000 State DOT employees, helping to increase their knowledge and proficiency. More than half of this training is focused on Highway and Worker Safety.
- Each year more than 40,000 DOT staff use the LTAP/TTAP technical newsletters as a source of timely transportation related information.
- LTAP Centers are assisting in the Strategic Highway Safety Improvement Plan development process through their participation on many statewide advisory committees including Roadway Safety, Bike/Pedestrian, Work Zone Safety and Driver Behavior committees.
- Partnerships between State DOTs, the Federal Highway Administration, and the Local Technical Assistance Program have developed Safety Circuit Rider programs to help reduce the number of fatalities on rural roads.
- LTAP Centers are administering their State High Risk Rural Road Programs, including conducting the field reviews for local agencies.
- LTAP Centers are conducting the Safe Routes to School Educational Outreach programs.
- LTAP Center staff has coordinated national, regional, and statewide transportation conferences including the Transportation Asset Management Conference, the AASHTO Research Advisory Committee Meetings, Winter Maintenance Symposia, Pavement Preservation Conferences, Rail Corridor Safety Conferences, and many others.
- Partnerships with State DOTs on new local road safety programs have helped to provide training, technical assistance and funding for local road improvement projects.
- State Transportation Librarians, working closely with LTAP Librarians, have created customized search tools using Google that include all State DOTs and all university transportation center libraries and provided materials to State and local agencies that those employees would not otherwise have access to.
- LTAP Centers are vital for delivering critical training to county engineers, highway superintendents and local road professionals in each state. Over the past 10 years, over 1.5 million local transportation professionals attended the LTAP/TTAP training.

LTAP Accomplishments and Training Statistics

"It would be hard to find a program in the Federal Government that touches as many people and fosters such success as LTAP and TTAP" says Joe Toole, former FHWA's Associate Administrator for the Office of Professional and Corporate Development and now Associate Administrator for FHWA's Office of Safety.

Over the past 10 years, LTAP Centers have:

- Conducted more than 60,000 training events,
- Provided more than nine million hours of training,
- Reached over 1.5 transportation professionals/practitioners in those classrooms, nearly half of all training content relates to highway and worker safety,
- Distributed over two million technical publications, and
- Saved local transportation agencies an estimated \$8 for every \$1 LTAP spent on information and training.

National Cooperative Highway Research Program

The National Cooperative Highway Research Program (NCHRP) was created as a means to conduct research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide. NCHRP is a voluntary program created by agreement between AASHTO, FHWA, and member States and administered by the TRB.

Caltrans values the research produced through the NCHRP program. Caltrans contributes \$3.5 million each year to NCHRP. In 2008, 54 projects were selected for funding of which 37 were a high priority for Caltrans. Of the 171 projects selected over the past three years, Caltrans has over 50 members serving on project panels guiding the research. The strength of the NCHRP research projects is in how they are developed and supported, usually by TRB or AASHTO committees, and how the research is pursued through panels that represent the users/customers to make sure the research is meaningful. This model is very similar to how the SHRP 2 was developed through direct involvement from transportation stakeholders and practitioners. A recent TRB project *Communicating the Value of Research* objective to develop a guide for successfully communicating the value of transportation research projects and programs is a good example of the type of research that is pursued at the request of the transportation community.

QUESTION 4. Is the current workforce capable of implementing advanced highway technologies?

The challenge of implementing advanced highway technologies is more an institutional issue. The employees of today are very capable of taking on the new challenges of advanced highway technologies. What they are lacking are the tools to bring new technologies into their environments to make changes that will improve the products and services that are provided to the transportation system customers.

In order for the workforce to implement innovations they need to have the "right stuff" to overcome the many institutional and organizational barriers. One basic requirement that most advanced technologies have difficulty overcoming is to establish a business case that can be approved through the financial institutions. Providing product specifications and training are requirements that often are not met. The innovation system is designed to create new ideas, not to implement them. At Caltrans, we have dedicated resources to deploying research results by forming a four-member deployment branch. We have also established the California Center for Innovative Transportation to assist with deployment of research products and services.

Innovation Survey

Transportation innovation information can help provide insights into what our current staff thinks about innovation and what we should do to encourage them to innovate. DRI conducted a pilot survey in an attempt to help answer the following research innovation questions. The following survey was sent to 150 transportation research professionals in California, research executives in the other 49 State DOTs, and some in Canada:

1. Should focus be on sustaining (evolutionary) or disrupting (revolutionary) innovation?
2. What are the most common roadblocks facing the implementation of innovation in transportation?
3. What are most common enablers of the innovation process?

4. Prioritize the importance of innovation in safety, performance, cost-effectiveness, quality, and environmental protection.
5. How can we facilitate the process of implementing innovation at Caltrans and other State DOTs?

Survey Instrument

The survey consisted of ten questions used to test our assumptions “hypothesis” regarding the existence of the above barriers and enablers. Respondents completed 109 “usable” surveys. The survey asked respondents the following:

- Rate the importance of each roadblock and enabler.
- State if they prefer sustaining or disruptive technologies.
- Prioritize which innovations, safety, performance, cost-effectiveness, quality, and environmental protection, are most important.
- Provide their suggestions for improving the innovation process.

Survey Results

1. About 79 percent of respondents indicated that innovation is “very important,” 20 percent indicated it is “important.”
2. About 62 percent of respondents thought “sustaining” (evolutionary) technologies are more important than “disruptive” (revolutionary) technologies. However, 73 percent of academic respondents believed the other way around.
3. Safety was the top priority for non-academic respondents with an average score of 4.1/5.0.
4. Academic researchers indicated they are most interested in performance innovations, followed by quality.
5. About 63 percent of respondents considered themselves innovation champions.
6. About 42 percent of respondents are decision-makers.
7. About 40 percent of respondents are potential implementers of technological innovations.
8. “*Resistance to Change*” was voted by both Caltrans practitioners and academic researchers as the most serious roadblock to innovation (researchers scored it 4.8/5.0, Caltrans participants scored it 4.6/5.0).
9. Innovation enablers “Product matches user needs” received a score of 4.6/5.0; “User/customer participation” received a score of 4.5/5.0; and “Successful pilot projects” received a score of 4.4/5.0.
10. Both Caltrans practitioners and academic researchers view “lack of political will to take on challenge” as the most serious institutional barrier to innovation, with researchers thinking it is more serious and rating this barrier 4.7 on average as compared with Caltrans group, who rated it 4.3 on average.

IMPROVING TRANSPORTATION INNOVATION IMPLEMENTATION

1. Establish clear direction and procedures for the innovation process

A vast number of respondent comments focused on the need to establish clear direction and procedures for the innovation process, including clear objectives and precise performance measures to evaluate success.

One respondent stressed the importance to define what is “new” and what is “innovative.” Another said clear procedures should be created for implementations and marketing, and some respondents recommended to make pilot projects part of the implementation process. Frustration with bureaucracy was evident. The innovation process should be streamlined so that there are fewer barriers holding up innovation. “The FSR [Feasibility Study Report] required for implementation of innovations at Caltrans] process and requirements are mind-boggling and in need of streamlining as well.” Executive leaders must “institutionalize” the culture of encouraging innovation by integrating it into work plans and incorporating it into the regular performance evaluations of the organization and its managers. One respondent’s experience is that most innovations stop at the recommendations level in government and there are not good implementation plans to carry out the recommendations make them permanent or institutional. The same respondent further cautioned that “Too often things are attached to a per-

son and when that person moves on and so does the innovation." The implementation of innovation should be mandated in order to carry innovation to fruition.

2. Improve communications

One respondent emphasized "Communicate, communicate, and communicate." Make sure that everyone with an interest in the potential innovation gets a chance to provide input and to question. A university research executive suggested connecting the organization [say Caltrans] more closely with researchers and innovators. A project manager would mandate customer participation in project progress and meetings.

3. Secure executive sponsorship and management support

There was a universal consensus that strong management support for innovation is indispensable. "There is no substitute for leadership with vision and practical, focused follow-through," one respondent wrote. Innovation begins with executive-level commitment and development of a work environment that embraces innovation. Upper management support and encouragement is required. Innovation needs strong executive support & successful pilots/demos. There is a need for strong executive mandate and adequate funding of demonstration programs. While executive-level support is important, they need to leave the implementation to the experts. Leaders should lead, not manage. Finally, top leadership has to make innovation a priority and then hold people accountable.

4. Empower people and find champions for each innovative idea/project

Innovation champions are needed in the innovation policy and procedures area. Otherwise, innovations will fall flat or will not reach full potential. Many respondents suggested that research staff "needs to be empowered to accomplish innovation." It is necessary to have champions at high-levels in order to create a culture for innovation in an organization as well as product-level champions to overcome resistance to change. A university professor and a director of a university transportation center said: "Give people some freedom to try new things". A Caltrans project manager suggested giving ownership of each innovation project to a small team with management backing. One respondent pointed out the role of the individual in innovation and cautioned that, "if the person who is championing the change is not liked in the organization, the change may be overlooked."

5. Create incentives for innovators

Many respondents argued for increasing opportunities for innovative ideas. Both university researchers and project managers advocated creating incentives. "More ideas portend higher probability of innovation which may be implemented," said a university researcher. A senior electronics engineer would reward innovators and reward those in management who are willing to take reasonable risk when the potential advance is significant. A senior transportation engineer would encourage more innovative research work by staff by reducing administrative workload demands.

6. Demonstrate the benefits of innovation

Many respondents emphasized the importance of ensuring that end-users have clear understanding of the advantage of innovation. The benefits of the concept must be proven to satisfy the real user needs. Innovation advocates and end-users must have clear understanding of the problem and value added by innovation. The importance of an innovation must be clarified up front to all stakeholders. Case studies should be used to show how other State agencies have implemented an innovation and show how it has improved their business.

7. Manage risk and change

Surprisingly, many respondents with executive authority confronted the need to take reasonable risk head on. One asked to "demystify risk" because sometimes "it is riskier not to act." Another said one must "accept certain amount of risk to compensate for high payoff." One acknowledged that the core issue is the "risk-averse culture," the general lack of positive reinforcement to try something new, and the "penalties" if you break the mold and fail. One executive cautioned, however, to be realistic and not expect the organization to always absorb the cost/effort to innovate. One respondent believed that people, users, and even institutions that normally are reluctant to change would eventually welcome "good" changes that make life easier.

CONCLUSIONS AND RECOMMENDATIONS

Respondents recommended seven major actions to develop a workforce that can implement innovations that will make new or advanced technologies a commonplace reality:

1. Establish clear direction and procedures for the innovation process,
2. Improve communications,
3. Secure executive sponsorship and management support,
4. Empower employees and find champions for each innovation,
5. Create incentives for innovators,
6. Demonstrate the benefits of innovation, and
7. Manage risk and change.

Finally, the research showed that “resistance to change” and “lack of political will” are among the most serious barriers to innovation. The highest-rated enabler of innovation was “product matched user need.” It was also evident that innovation, whether disruptive or sustaining, requires champions of innovation at all levels of the organization to be successful. It was evident that managing risk and change is critical for the success of innovation. In the public sector, most failures are highly publicized and criticized. A single innovation failure can outstand, outtalk, and overshadow dozens of successful ones. Therefore, creating the ability to take calculated reasonable risks is required at all public agencies in the transportation sector.

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An Overview of Transportation Research and Development: Priorities for Reauthorization

The American Society of Civil Engineers (ASCE)¹ is pleased to submit this Statement for the Record of the February 12 hearing held by the United States House of Representatives, Subcommittee on Technology and Innovation, Committee on Science and Technology: *An Overview of Transportation Research and Development: Priorities for Reauthorization*.

America's surface transportation system is broken. ASCE's 2009 *Report Card for America's Infrastructure*, released in January, graded the Nation's *Roads* a D-; *Bridges* a C; *Transit* a D; and *Rail* a grade of C-.

Among the key findings are the following. In 2007, 41,059 people were killed in motor vehicle crashes and 2,491,000 were injured. Motor vehicle crashes cost the U.S. \$230 billion per year—\$819 for each resident in medical costs, lost productivity and travel delays. Americans spend 4.2 billion hours a year stuck in traffic at a cost of \$78.2 billion a year—\$710 per motorist. Roadway conditions are a significant factor in about one-third of traffic fatalities and poor road conditions cost U.S. motorists \$67 billion a year in repairs and operating costs—\$333 per motorist. One-third of America's major roads are in poor or mediocre condition and 36 percent of the Nation's major urban highways are congested.

More than 26 percent of the Nation's bridges are either structurally deficient or functionally obsolete and the number of deficient bridges in urban areas is on the rise. While demand for public transit is increasing, only about half of American households have access to bus or rail transit and only 25 percent consider it to be a good option. Because freight and passenger rail generally share the same network, any significant increase in passenger rail demand will exacerbate freight railroad capacity challenges.

To compete in the global economy, improve our quality of life, and raise our standard of living, we must rebuild and update America's surface transportation infrastructure. America's 21st century surface transportation system must be founded on a new paradigm based on a comprehensive, holistic, multi-modal approach utilizing integrated, effective, inter-modal, sustainable, cost effective solutions. Only then will America have a surface transportation system that is unparalleled in its safety, security, efficiency and effectiveness.

As Congress works to develop the 2009 Authorization of the Surface Transportation Program, it must remain cognizant that it can no longer focus only on the movement of cars and trucks from one place to another. Rather, the new paradigm must be based on moving people, goods and services across the country. This new vision must be inter-modal and deal with the possible effects of climate change; land use, sustainability, and the anticipated changes in the population's demographics, particularly age and urbanization.

ASCE supports the vision of a national inter-modal transportation system which is economically efficient, environmentally sound, provides the foundation for U.S. businesses to compete globally and moves people and freight in an efficient manner. Developing and deploying new technologies and cutting-edge solutions will require input from stakeholders in the public, private, and academic sectors, and accomplishing a truly inter-modal system will require partnerships among Federal, State, local and regional government authorities as well as citizen groups and the private sector.

Research and technology (R&T) are critical to achieving transportation goals in: infrastructure performance and preservation; safety; quality of life; economic prosperity; environmental impacts; and sustainability and security . . . and technology transfer activities are critical to the successful implementation of research results. While we understand that in the current economic environment it may be difficult to increase surface transportation research and development funding, at a minimum, current R&T funding levels must be maintained and public-private partnerships, where appropriate, should be fostered.

¹ ASCE was founded in 1852 and is the country's oldest national civil engineering organization. It represents more than 146,000 civil engineers individually in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE is a non-profit educational and professional society organized under Part 1.501(c) (3) of the Internal Revenue Code.

The Highway Trust Fund (HTF) has been an essential source of funding for surface transportation research and technology for decades, and research results have led to many benefits including: materials that improved the performance of pavements and structures; design methods that reduce scour (and the consequent threat of collapse) of bridges; intelligent transportation systems technologies that improve safety and reduce travel delay; methods and materials that radically improve our ability to keep roads safely open in severe winter weather; innovative management approaches that reduce environmental impacts and improve the cultural aspects of transportation facilities; and many more.

One way to reduce the investment gap, that is, the difference between HTF revenues and the funding needed to improve the surface transportation system, is through research, as research outcomes can improve the performance and durability of our transportation infrastructure, resulting in reduced operations and maintenance costs and less frequent replacement of infrastructure elements. The Exploratory Research Program, funded in SAFETEA-LU, has the potential to be the lead program in providing improved materials, designs, and processes that can transform the performance of our surface transportation infrastructure.

The ability of the HTF to continue to serve as a major funding source for transportation R&T is dependent upon the continued capability of the Highway Trust Fund revenue sources to generate adequate levels of funding. The latest projections indicate that Highway Trust Fund revenues will be insufficient to continue the 2009 SAFETEA-LU authorized levels of funding in 2010. The result will be not only reduced investment in highway and transit infrastructure, but also reduced investment in research. To avoid reduced investment, Congress will need to address this problem by September 30, 2009. While in the short-term, an increase in user fees is clearly necessary, our national surface transportation policy must—in the longer-term—move toward a system that more directly aligns fees that a user is charged with the benefits that the user derives. Appropriate policy research can help identify solutions to the funding issue and what methods and technologies are best to provide revenue to the HTF. This type of research needs to be funded in the new authorization.

Other research programs that can continue to contribute to the improvement of the highway system include the Federal Highway Administration's (FHWA) program, the National Cooperative Highway Research Program (NCHRP) and State department of transportation programs funded largely through State Planning and Research (SPR) funds. In the transit area, the main programs are those of the Federal Transit Administration (FTA) and the Transit Cooperative Research Program (TCRP). ASCE believes that the University Transportation Centers (UTC) program provides valuable research across most transportation modes.

Designated programs and earmarks in SAFETEA-LU resulted in an over designation of funding in the research title. As a result, the FHWA has no discretionary research funding, causing some research products and services previously provided by FHWA to either be absorbed by State programs or to be discontinued altogether. Some of the earmarks also placed additional burdens on State research programs when these programs were identified as sources of matching funds for the earmarks. Therefore, as we go forward, we recommend that there be minimal earmarking and that free and open competition among non-federal entities performing research utilizing federal funds be promoted.

Within the context of the general principles set out above, ASCE supports the following actions regarding specific R&T programs:

- The research and technology portion of the State Planning and Research (SPR) program should be maintained to help support state-specific activities while continuing to encourage the states to pool these resources to address matters of more general concern.
- University research should continue to be supported through the University Transportation Centers (UTC) program using a competitive selection process that guarantees quality participants and fairness in the allocation of funds.
- The Federal Highway Administration's (FHWA) program should be strengthened by giving it sufficient funding and flexibility to implement the recommendations of TRB Special Report 261, *The Federal Role in Highway Research and Technology*, to focus on fundamental, long-term research; to perform research on emerging national issues and on areas not addressed by others; to engage stakeholders more consistently in their program; and to employ open competition, merit review, and systematic evaluation of outcomes.
- A continuation of the Strategic Highway Research Program SHRP II beyond the life of SAFETEA-LU, ensuring that critical research will be continued in key areas of surface transportation.

- The Federal Transit Administration's (FTA) research program should be given sufficient funding and flexibility to work with its stakeholders to develop and pursue national transit research priorities.
- The new Research and Innovative Technology Administration (RITA) should have a well-defined scope and responsibility and appropriate funding, in addition to currently authorized research funding, so that it may supplement and support the R&T programs of the modal administrations.

We also encourage the Subcommittee to review the findings and recommendations of TRB Special Report 295, *"The Federal Investment in Highway Research 2006–2009, Strengths and Weaknesses."*

While the Federal Government plays a relatively minor role in the ownership and operations of the Nation's highways, it plays a critical and indispensable role in the research and innovation process, providing about two-thirds of the total amount spent on highway research and technology projects. It also plays a major role in training and technology transfer, and has traditionally been the sole source for higher-risk, potentially higher pay-off research.

To bolster the U.S. Department of Transportation's (DOT) capabilities to improve research, development, technology coordination and evaluation, in 2004, Congress created DOT's Research and Innovative Technology Administration (RITA), to coordinate and review the Department's programs for purposes of reducing research duplication, enhancing opportunities for joint efforts and ensuring that research, development and technology activities are meeting their objectives. In 2006, the U.S. Government Accountability Office (GAO) reported that while RITA had made progress toward these ends, more needed to be done. Specifically, GAO noted that RITA has not yet developed an overall strategy, evaluation plan, or performance measures which delineate how its activities ensure the effectiveness of the Department's research, development, technology investment. As a cost-effective coordinated research, development and technology program is vital to creating a world class, 21st century surface transportation program, we urge Congress to continue to monitor RITA's progress towards achieving these goals to ensure that the public receives a maximum return on every dollar invested.

Rebuilding America's transportation infrastructure is a critical part of rebuilding our economy. And there can be little doubt that a highly focused and well coordinated R&T surface transportation investment program is necessary if we are to build a surface transportation system that is unparalleled in its safety, security, efficiency and effectiveness, one which provides long-term benefits and reinforces the economic foundation of our nation.

ASCE looks forward to working with the Committee to create a strong transportation research program in the next surface transportation authorization bill.

**THE ROLE OF RESEARCH IN ADDRESSING
CLIMATE IN TRANSPORTATION INFRA-
STRUCTURE**

TUESDAY, MARCH 31, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION,
COMMITTEE ON SCIENCE AND TECHNOLOGY
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. David Wu [Chair of the Subcommittee] presiding.

**SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

**The Role of Research in Addressing
Climate in Transportation Infrastructure**

TUESDAY, MARCH 31, 2009
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

I. Purpose

On Tuesday, March 31, 2009, the Subcommittee on Technology and Innovation will convene a hearing to address the research agenda required to mitigate the environmental impact of the transportation infrastructure on the environment, with an emphasis on climate change. Witnesses will address the components of such an agenda and possible implementation strategies.

II. Witnesses

Mr. David Matsuda is the Acting Assistant Secretary for Transportation Policy at the U.S. Department of Transportation.

Ms. Catherine Ciarlo is the Transportation Director at the Office of Mayor Sam Adams.

Dr. Laurence Rilett is the Keith W. Klaasmeyer Chair in Engineering and Technology and the Director of the Nebraska Transportation Center at the University of Nebraska—Lincoln.

Mr. Steven Winkelman is the Director of Transportation and Adaptation Programs at the Center for Clean Air Policy.

Mr. Mike Acott is the President of the National Asphalt Pavement Association.

III. Issues and Concerns

The transportation sector has major impacts on the environment, contributing 28 percent of the total U.S. carbon emissions. Eighty-two percent of that arises from highway travel alone. The focus of mitigation efforts has largely focused on vehicle technologies and alternative fuels. However, the potential carbon-savings and other potential environmental benefits from changes and improvements to the transportation infrastructure have received less attention. Planning and design elements in surface transportation infrastructure can influence congestion, the number of vehicle miles traveled (VMT), and the amount of energy embodied in the system from the materials, like concrete and asphalt, used to build roads. In the same vein, these planning and design factors for transportation infrastructure also impact water quality from changes to watersheds, air quality and human health, and the ecology of the natural environment.

As climate has risen in importance, many are suggesting it is imperative to reduce the environmental burden of the transportation sector, including making infrastructure changes. The American Association of State Highway Transportation Officials (AASHTO), for instance, notes that to address climate change, the transportation sector will need to reduce the growth in transportation demand and improve the efficiency of the system. They further recommend that appropriate methodologies need to be developed for accounting for greenhouse gas emissions from the surface transportation system, which would enable the development of greenhouse gas reduction performance measures for surface transportation. As noted by the Center for Clean Air Policy, the Transportation Research Board, and others, there is relatively little data and modeling capability to support such an effort.

Other infrastructure based strategies include encouraging changes in traveler behavior. Decision-makers are hindered in their efforts to choose and implement many of these strategies, however, by a lack of usable information on the benefits and costs (both monetary and environmental) and traveler reaction.

Research strategies to reduce the impact of the transportation sector cut across many disciplines within transportation, from modeling and planning to materials and intelligent transportation systems. The DOT has long funded research in many of these areas (see below) but the impetus to address climate change and other environmental issues is relatively new. The following broad research categories would support efforts to create infrastructure solutions to reduce carbon emissions from transportation:

- *Forecasting and Analytical Tools to Support State and Local Global Warming Studies.* Transportation planners need data and models to understand the impact of their systems on climate. They also need measurable indicators to know if planning choices are meeting goals of reducing carbon emissions.
- *Tools to Assess System Performance.* Currently, transportation planners have no methods and tools to choose the best infrastructure alternatives (for instance, high-occupancy vehicle lanes versus increased access to public transit).
- *Traveler Behavior.* Research could help understand the conditions and circumstances under which travelers would make more sustainable transportation choices.
- *Demand Management.* Demand management strategies promote alternative modes of transportation and reduce the number and length of trips. Improved metropolitan travel forecasting data models would aid planners in spending transportation dollars in the most effective ways to both meet public demand and reduce environmental impact.
- *Congestion.* The Texas Transportation Institute estimated that traffic congestion in the United States resulted in 2.9 billion gallons of wasted fuel in 2007. Intelligent Transportation Systems technologies could be used in improving traffic flow, be it through better signal timing or inducing real-time changes in traveler behavior. However, there is little data available to support the efficacy of many of these Smart technologies on reducing congestion.
- *Energy Use in Materials.* Reducing the amount of energy and materials used in transportation infrastructure reduces the overall burden of roads, bridges, and other elements of the built environment. Many new materials and technologies show promise in mitigating the life cycle environmental costs. These include warm-mix asphalt, the use of industrial by-products in cement, and the use of recycled (ripped-up) pavement in new pavement. Research is needed to further characterize the performance of these materials and to enable their adoption.

IV. Background

DOT Activities Related to Climate Change

The Center for Climate Change at the USDOT is a “virtual organization” that receives funds, staff, and technical expertise from nine modal agencies. According to the USDOT, the Center serves as the DOT’s central point for information and technical expertise on transportation and climate change, and coordinating related research and policy. Established originally in 1999 as the Center for Climate Change and Environmental Forecasting, the Center predominately focused on providing information to State and local officials on the vulnerabilities of transportation infrastructure to extreme weather patterns, rising sea levels, and other climate change impacts. Toward this goal, the Center funded approximately 20 studies and reports, such as *Surface Transportation Safety and Operations: the Impacts of Weather within the Context of Climate Change*. The Center’s current focus will be on both mitigation and adaptation to climate change for the transportation sector.

The DOT also funds research in many areas that touch on some of the issues and research categories identified above. However, only a small portion of the overall research budget is specifically environmentally related. In fiscal year (FY) 2009, the Federal Highway Administration (FHWA) funded a total of \$196 million in research, development, and deployment activities. Nineteen and a half million dollars in FY 2009 supported planning and environmental research. The largest research program at FHWA is devoted to infrastructure, funded at \$66.4 million. Developing more durable infrastructure reduces the need for rebuilding and repairs can mitigate congestion and result in less energy use.

Surface Transportation Environment and Cooperative Research Program (STEP) is the primary source of funding to conduct all FHWA research on planning and environmental issues. Approximately \$1.4 million in FY 2009 was devoted to Air Quality and Climate Change. The goals of this funding were to better understand the

contribution of transportation to air pollution and climate change, to develop and assess analytical methods to adequately identify and reduce transportation emissions; to identify cost-effective mitigation strategies to reduce transportation emissions; and to develop information, guidance and communication strategies to provide useful technical assistance and training to State and local partners and stakeholders.

Past Committee Activities

The Subcommittee on Technology and Innovation held two hearings on transportation and the environment in the 110th Congress. The first, *Green Transportation Infrastructure: Challenges to Access and Implementation*, in May of 2007, focused on environmentally sustainable methods of managing storm water runoff from roads. Witnesses discussed both the research needs to improve these technology and the regulatory and knowledge barriers to adopting environmentally sustainable storm water runoff practices. H.R. 5161, the *Green Transportation Infrastructure Research and Technology Transfer Act*, introduced last Congress, directed the DOT to use the capacity of the UTC system to perform research to remove the barriers to using green transportation infrastructure.

The second, *Sustainable, Energy-Efficient Transportation Infrastructure*, in June of 2008, focused on the energy used to build transportation infrastructure, and the fuel that is wasted due to congestion or poorly planned and managed systems. The witnesses addressed R&D, policy, and technology transfer needs to increase the adoption of energy saving strategies, such as the use of industrial by-products in cement, and better controlled traffic signals.

Chair Wu. This hearing will now come to order.

Good morning. Welcome, everyone, to today's hearing, which is the third in a series of hearings that this subcommittee has convened on the impact of our transportation system on our environment. The first hearing addressed regulatory barriers to the utilization of green technologies that mitigate surface water runoff from our roadways and parking areas. As a result, the Subcommittee reported H.R. 5161, the *Green Transportation Research and Development Act*, in the last Congress to address that issue. Our second hearing explored the R&D agenda required to improve energy efficiency and to lessen the environmental effects of the pavements used in our transportation infrastructure.

The focus of today's hearing is to examine the R&D that is required to help mitigate the impact of our transportation infrastructure on our climate. Efforts to limit the climate impact of cars and trucks stretch back to 1973 when we began to phase out lead-based additives to gasoline although a total ban on these additives did not take effect until 1996. In 1976, the use of catalytic converters was mandated to reduce the toxic emissions of cars. In 2007, Congress adjusted CAFE (Corporate Average Fuel Economy) standards for the first time in more than 30 years.

These changes were the low-hanging fruit that helped us to begin minimizing the impact of our transportation system on our atmosphere and on climate. Even now, climate change mitigation efforts largely focus on improving our current fuel sources and developing alternative fuels.

But today there is an opportunity to think more broadly about the impact of our transportation infrastructure on the climate environment and what research is needed to begin minimizing our impact in more far-reaching ways.

We need to think about improving the energy efficiency of our transportation system as a whole and not just the cars and trucks on it, although I do note that I think the split between the cars and the system is about 80 percent, 20 percent roughly. For example, what are the modeling tools that would help communities develop an effective mixed-use transportation system of cars, buses, light rail, trolleys and bikes like we have in Portland, Oregon? If we are serious about congestion mitigation and traffic management, what is required to realize these goals? What tools would help us eliminate or reduce the need to commute in the first place?

I want to thank our witnesses for appearing before the Subcommittee and for assisting the Subcommittee in formulating the R&D needs that should be included in a surface transportation R&D authorization bill.

[The prepared statement of Chair Wu follows:]

PREPARED STATEMENT OF CHAIR DAVID WU

Good morning. I want to welcome everyone to this morning's hearing.

This is the third in a series of hearings that the Subcommittee has convened on the impact of our transportation system on the environment. The first addressed regulatory barriers to the utilization of green technologies that mitigate surface water runoff from our roadways and parking areas. As a result, the Subcommittee reported H.R. 5161, the *Green Transportation Infrastructure Research and Development Act*, in the 110th Congress to address this issue.

Our second hearing explored the R&D agenda required to improve energy efficiency and lessen the environmental impact of the pavements used in our transportation infrastructure.

The focus of today's hearing is to examine the R&D that is required to help mitigate the impact of our transportation infrastructure on the climate.

Efforts to limit the climate impact of cars and trucks stretch back to 1973, when we began to phase out lead-based additives to gasoline, although a total ban on these additives did not take effect until 1996. In 1976, the use of catalytic converters was mandated to reduce the toxic emissions of cars. And in 2007, Congress adjusted CAFE standards for the first time in more than 30 years.

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Today there is an opportunity to think more broadly about the impact of our transportation infrastructure on the climate and what research is needed to begin minimizing our impact in more far-reaching ways.

We need to think about improving the energy efficiency of our transportation system, not just the cars and trucks on it. For example, what are the modeling tools that would help communities develop an effective mixed-use transportation system of cars, buses, light rail, trolleys, and bikes like we have in Portland, Oregon? If we are serious about congestion mitigation and traffic management, what's required to realize these goals?

I want to thank our witnesses for appearing before the Subcommittee and for assisting the Subcommittee in formulating the R&D needs that should be included in a surface transportation R&D authorization bill.

Chair WU. Now I would like to recognize Representative Smith, the gentleman from Nebraska, for his opening statement.

Mr. SMITH. Thank you, Mr. Chair. Thank you for holding this hearing today on climate-related transportation research and our second hearing on this topic as we work toward developing an R&D title of the highway bill later this spring. I appreciate the opportunity that you have taken in providing the Committee an opportunity to examine these issues in depth. I know it will ultimately help us craft a better bill and increase our impact on the overall highway bill as it moves forward.

I also want to offer a warm welcome to Dr. Larry Rilett from the University of Nebraska-Lincoln. I appreciate your willingness to appear before the Subcommittee today to discuss these important issues, and I am grateful for the quality of research you are performing at the University, and I thank the rest of the witnesses as well.

As we discussed in our last hearing on this issue, the transportation challenges we face are significant and diverse and there is general agreement that technological advancement is key to addressing nearly all of them from aging infrastructure, growing congestion to ongoing safety issues. Part of our task then is to endeavor to ensure that the roughly \$600 million in Department of Transportation research that we oversee is spent as effectively as possible. A former DOT official recommended at our last hearing to start with development of an overarching transportation research agenda that establishes and aligns the key objectives and desired outcomes of our transportation system and in that prioritize research programs to meet those objectives. This makes sense to me, and I hope to explore this further as we do move forward.

We are here this morning to discuss one potential item of such a research agenda, climate change, and how best to reduce CO₂ emissions from the transportation system. This is obviously an area of major policy interest for President Obama and the Demo-

crat leadership as evidenced by the call for establishment of a cap-and-trade regime to regulate energy use across our economy. I am hesitant about a cap-and-trade policy because it could ration energy and then tax folks who want to use more of it. As the President and his advisors have readily acknowledged, the proposal would increase energy prices for consumers and businesses and result in at least \$600 billion in new taxes on the American people over the next 10 years. While the costs of cap-and-trade to our economy are clear, any environmental benefits in the form of reduced temperature growth are highly uncertain and maybe immeasurable, especially when one considers that China and India alone are expected to add 300 million vehicles to the roads in the next 20 years.

While I want to be clear about my skepticism to cap-and-trade, I also want to be clear that I am not opposed to supporting transportation research aimed at reducing CO₂ emissions, especially when it advances additional goals such as reduced congestion or improved highway durability. However, as we consider climate-related transportation research, I think it is important to do so as part of the overarching transportation research agenda that I mentioned earlier while all research needs are systematically prioritized under department-wide transportation goals and R&D objectives. So I hope to learn more today about climate-related research needs and how they should fit into an overall transportation research agenda.

Before I close, I want to comment on two specific aspects of transportation policy that relate to the topic of today's hearing. One, the notion of vehicle-miles-traveled-based financing mechanisms to transition away from the gas tax and institute greater traffic management controls, and two, the notion of smart growth and land-use planning policies to reduce traffic congestion and urban sprawl. Both of these policy areas appear to be receiving strong consideration from the committees of primary jurisdiction in the House and the Senate and both are in need of significant additional research and data collection to better inform policy-makers on their respective advantages and disadvantages, especially as they relate to the social, behavioral and economic impacts on citizens affected by such changes. For example, I am concerned that transition to a VMT-based highway tax may unfairly penalize citizens in my State of Nebraska where people tend to drive longer distances to work and shop. Similarly, with respect to reducing urban sprawl, I think there is a need to better understand the tradeoffs associated with policies aimed at reducing urban sprawl, particularly how land-use restrictions impact housing affordability and limit choice. I hope this is something we can address and I certainly look forward to hearing from the witnesses today as to their opinions of research needs and policy tradeoffs in these areas.

Thank you, Mr. Chair.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF REPRESENTATIVE ADRIAN SMITH

Mr. Chair, thank you for holding this hearing today on climate-related transportation research, our second hearing on this topic as we work toward developing the R&D title of the highway bill later this spring. I appreciate the approach that you have taken in providing the Committee an opportunity to examine these issues in-

depth. I know it will ultimately help us craft a better bill and increase our impact on the overall highway bill as it moves forward.

I want to also offer a warm welcome to Dr. Larry Rilett, from the University of Nebraska-Lincoln, which is located in my home state and also happens to be my alma mater. I sincerely appreciate your willingness to appear before the Subcommittee today to discuss these important issues and am grateful for the quality of research you are performing at the University.

As we discussed in our last hearing on this issue, the transportation challenges we face are significant and diverse, and there is general agreement that technological advancement is key to addressing nearly all of them, from aging infrastructure to growing congestion to ongoing safety issues. Part of our task then is to endeavor to ensure that the roughly \$600 million in Department of Transportation research that we oversee is spent as effectively as possible. A former DOT official recommended at our last hearing that this start with development of an overarching transportation research agenda that establishes and aligns the key objectives and desired outcomes of our transportation system, and then maps and prioritizes research programs to meet those objectives. This makes sense to me and I hope to explore this route further as we go forward.

We are here this morning to discuss one potential element of such a research agenda: climate change, and how best to reduce CO₂ emissions from the transportation system. This is obviously an area of major policy interest for President Obama and the Democrat leadership, as evidenced by their call for establishment of a "cap-and-trade" regime to regulate energy use across our economy.

I am critical of a cap-and-trade policy because it would ration energy and then tax those that want to use more of it. As the President and his advisors have readily acknowledged, the proposal would increase energy prices for consumers and businesses and result in at least \$600 billion in new taxes on the American people over the next ten years. While the costs of cap-and-trade to our economy are clear, any environmental benefits in the form of reduced temperature growth are highly uncertain, and may be immeasurable, especially when one considers that China and India alone are expected to add 300 million vehicles to the roads in the next 20 years.

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Before I close I want to comment on two specific aspects of transportation policy that relate to the topic of today's hearing: (1) the notion of vehicle miles traveled-based financing mechanisms to transition away from the gas tax and institute greater traffic management controls; and (2) the notion of "smart growth" and land use planning policies to reduce traffic congestion and "urban sprawl."

Both of these policy areas appear to be receiving strong consideration from the committees of primary jurisdiction in the House and Senate, and both are in need of significant additional research and data collection to better inform policy-makers on their respective advantages and disadvantages, especially as they relate to the social, behavioral, and economic impacts on citizens affected by such changes.

For example, I am concerned that transition to a VMT-based highway tax may unfairly penalize citizens in my State of Nebraska, where people tend to drive longer distances to work and shop. Similarly, with respect to reducing urban sprawl, I think there is a need to better understand the tradeoffs associated with policies aimed at reducing urban sprawl, particularly how land use restrictions impact housing affordability and limit choice. I hope this is something we can address and I look forward to hearing from the witnesses today as to their opinion of research needs and policy tradeoffs in these areas.

Thank you, Mr. Chair.

Chair Wu. I thank the gentleman.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

Now it is my pleasure to introduce our witnesses today. Mr. David Matsuda is the Acting Assistant Secretary for Transportation Policy at the United States Department of Transportation,

and Mr. Matsuda informs me that he has been on the job for what feels like a very long 15 days. Ms. Catherine Ciarlo is the Transportation Director at the Office of the Mayor of Portland, Oregon, and takes care of my highways and byways at home. Dr. Laurence Rilett is the Keith W. Klaasmeyer Chair in Engineering and Technology and the Director of the Nebraska Transportation Center at the University of Nebraska–Lincoln. Mr. Steven Winkelman is the Director of Transportation and Adaptation Programs at the Center for Clean Air Policy, a think tank for climate air quality policy. And Mr. Mike Acott is the President of the National Asphalt Pavement Association (NAPA), which is the Washington, D.C., organization representing private companies and individuals involved in surfacing and pavement.

You will each have five minutes for your spoken testimony. Your written testimony will be included in the record for this hearing, and when you complete your testimony, we will begin with questions. Each Member will have five minutes to question the panel.

Mr. Matsuda, please begin.

STATEMENT OF MR. DAVID T. MATSUDA, ACTING ASSISTANT SECRETARY FOR TRANSPORTATION POLICY, U.S. DEPARTMENT OF TRANSPORTATION

Mr. MATSUDA. Thank you. Chair Wu, Ranking Member Smith and Congressman Luján, thank you for the opportunity to appear before you today to discuss climate change research at the U.S. Department of Transportation (DOT) including past and current activities and future research needs.

The Obama Administration considers climate change a major priority. The President is committed to aggressive action to reduce the impacts of climate change and ensure that the United States is a leader in the global effort to reduce greenhouse gas emissions. The Department of Transportation will continue working with our colleagues in the Administration and this subcommittee to meet these goals.

The transportation sector is one of the fastest growing end-use producers of greenhouse emissions. It accounts for about 30 percent of the U.S. total. There is still much to be learned about the impacts and potential mitigation strategies of emissions from the transportation sector and the Department is taking steps to ensure we tackle the right issues and target the most effective actions. These steps include research on both the mitigation of these greenhouse gases as well as research into the adaptation of our transportation systems to the changing climate.

DOT's Virtual Center for Climate Change and Environmental Forecasting sets priorities for most of the Department's inter-modal climate change policy analysis and research. The center is currently directing work on a report to Congress discussing the impact of the Nation's transportation system on climate change and solutions to mitigate greenhouse gas emissions. The report is expected to be completed mid-summer.

With the Subcommittee's indulgence, I would like to briefly mention some of the research taking place at the various DOT agencies. Let me begin with the Research and Innovative Technology Administration, or RITA. As you know, this agency coordinates all the De-

partment's research and technology efforts and oversees much of the Department's research on alternative fuels, alternative vehicles, hydrogen fuels and fuel cells. The Federal Transit Administration continues to study public policy approaches to expand public transportation services, which can greatly impact emissions, and the agency has also done work on alternative fuels and vehicles that help usher in the use of hybrid electric buses, compressed natural gas vehicles and biodiesel buses.

The National Highway Traffic Safety Administration, or NHTSA, develops and sets fuel economy standards for highway vehicles. On Friday, the Secretary of Transportation, Ray LaHood, announced that the Department has published the newest fuel economy standards for cars and light trucks for the 2011 model year. NHTSA's work on a multi-year fuel economy plan for model years after 2011 is already underway. This work sets the United States on a course to meet the requirement of the Energy Independence and Security Act of 2007 for a fleet-wide fuel economy performance of at least 35 miles per gallon by the year 2020.

The Federal Highway Administration is working on a number of initiatives including setting ways to improve the efficiency of our highway and road network. The agency is also developing a framework to conduct assessments of transportation infrastructure most vulnerable to the effects of climate change.

The Federal Aviation Administration, or FAA, is working collaboratively with other agencies and stakeholders to gain a better scientific understanding of aviation emissions, accelerate deployment of more-fuel-efficient aircraft engines and develop alternative jet fuels.

In brief, climate-related research is crucial for the transportation sector. In the short-term, we need to work to identify the most effective emissions mitigation strategies. In the long-term, research should focus on transformational technologies and strategies in order to make significant reductions in these emissions. In formulating its plan, the Department will continue to balance climate research needs with other environmental research concerns such as air quality, water quality and potential noise reduction approaches, to name a few.

I look forward to working with this subcommittee as you consider a transportation research agenda that enables our Nation to better meet the challenges presented by global climate change. Thank you again, and I will be happy to respond to any questions.

[The prepared statement of Mr. Matsuda follows:]

PREPARED STATEMENT OF DAVID T. MATSUDA

Chairman Wu, Ranking Member Smith, and Members of the Committee,

Thank you for the opportunity to appear before you today to discuss climate change research at the U.S. Department of Transportation (DOT), including past and current activities and future research needs.

The Obama Administration considers climate change a major priority. The President is committed to aggressive action to reduce the impacts of climate change and ensure that the U.S. is a leader in the global effort to reduce greenhouse gas emissions.

President Obama has called for a number of fundamental policy changes to revolutionize the way we use energy, including:

- Enacting cap-and-trade legislation designed to achieve a rapid and profound transformation;
- Increasing the production and use of renewable energy;
- Strengthening efforts to build a clean energy future while creating millions of new jobs through strategic investment of billions of dollars over the coming years;
- Getting on the road plug-in hybrid cars that get radically better fuel economy.

The President has already initiated other ambitious and far-reaching actions to lower greenhouse gas emissions. The President:

- Announced policies that will improve the fuel efficiency of automobiles, significantly reducing dependence on foreign oil and cutting U.S. emissions of greenhouse gases;
- Signed the *American Recovery and Reinvestment Act of 2009*, which intensifies U.S. actions on energy efficiency and renewable energy; and
- Directed a review to determine how to best regulate U.S. greenhouse gas emissions.

The President's actions signal a renewed U.S. commitment to lead global efforts confronting climate change. DOT will continue working with our Administration colleagues and this committee to meet these goals, building on current research, and defining the next climate related research and development agenda to ensure we tackle the right issues and reduce the transportation sector's greenhouse gas emissions.

Transportation accounts for about 30 percent of total greenhouse gas emissions.¹ Transportation-related greenhouse gases include carbon dioxide (CO₂) nitrous oxide (N₂O) methane (CH₄), and hydrofluorocarbons (HFC). Carbon dioxide is the most commonly emitted greenhouse gas, accounting for 95 percent of U.S. transportation emissions in 2006. Transport sector emission sources include:

- light-duty trucks and passenger cars (59.3 percent);
- medium- and heavy-duty trucks (19.6 percent);
- aircraft (12.5 percent);
- rail (2.7 percent);
- marine (4.9 percent); and
- pipelines (1.5 percent).

Transportation life cycle emissions, which consider the entire extraction, production, and use of materials, give a larger picture of transportation's greenhouse gas emissions. For instance, while burning fuel to operate vehicles amounts to 60 percent of light duty vehicle life cycle emissions, 17 percent of emissions come from construction and maintenance of infrastructure such as roadways and parking, 10 percent of emissions come from the fuel production cycle, and 12 percent come from vehicle manufacture. Transportation infrastructure life cycle emissions include emissions from the production of roadway materials, such as asphalt and concrete; fleet vehicles necessary for constructing and maintaining roadways and other transportation infrastructure; and traffic impacts of work zones.

CURRENT DOT RESEARCH

While there is much more to do, the Department has taken steps to address transportation related greenhouse gas emissions through its research activities.

As transportation both contributes to and is affected by climate change, the Department's research has focused both on mitigation of transportation's contributions to greenhouse gas emissions and adaptation to potential impacts on infrastructure. This research addresses improving vehicle fuel economy, developing alternative fuels, and improving system efficiency.

DOT's climate change research activities have been developed through inter-agency groups and within the Department. DOT has actively participated in the Interagency Working Group on Climate Change Science and Technology and its subordinate groups, the Climate Change Science Program (CCSP) and the Climate Change Technology Program (CCTP). DOT has followed the research guidance provided by the Office of Science and Technology Policy. Research agendas are set within the Department through DOT's Center for Climate Change and Environmental Forecasting Strategic Plan as well as the individual research agendas of specific

¹ EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006.

modal administrations. All of these efforts have been informed by stakeholder input. The Department has also cooperated with the Transportation Research Board (TRB).

CENTER FOR CLIMATE CHANGE AND ENVIRONMENTAL FORECASTING

DOT's virtual Center for Climate Change and Environmental Forecasting sets priorities for most multi-modal climate change policy analysis and research. The Center's Strategic Plan for 2006–2010, released in 2006, contained four strategy areas: Research and Policy Analysis; Integrated Approaches and Mutual Benefits; State and Local Transportation Planning; and Communication, Education, and Capacity Building.

The virtual Center's work is carried out by operating administration staff. Most of DOT's operating administrations make voluntary financial commitments to fund Center activities and research.

One example of the Center's work is DOT's *The Impacts of Climate Variability and Change on Transportation Systems and Infrastructure*. The report was conducted under the Climate Change Research Initiative to provide information for decision-makers. This case study of the Gulf Coast was designed to understand the possible effects of climate change on transportation infrastructure and aid transportation decision-makers in determining how to account for potential impacts in the transportation planning process. Phase I of the study was completed in 2008 and studied how changes in climate over the next 50 to 100 years could affect transportation systems in the U.S. central Gulf Coast region. Phase II, currently under development, will explore more detailed information about impacts at the local level. It will develop tools and guides for transportation planners including a *risk assessment tool* to allow decision-makers to understand vulnerability to climate change. This important work has already gained considerable interest within the transportation community about planning for transportation investments.

The Center is currently overseeing preparation of a Report to Congress on the impact of the Nation's transportation system on climate change, and solutions to mitigate climate change by reducing greenhouse gas emissions from the transportation sector.

The report, mandated by the *Energy Independence and Security Act of 2007*, will identify national policy approaches, evaluate pros and cons, and estimate magnitudes of emission reductions. This research will allow DOT to evaluate the implications of various approaches on other transportation goals. The report, expected to be completed mid summer, will consider co-benefits of fuel savings and air quality improvement. The report results will compare strategic options to reduce transportation emissions and will inform future research and policy development.

The Center's Transportation and Climate Clearinghouse was launched in early 2009 and includes information on greenhouse gas inventories, analytic methods and tools, greenhouse gas reduction strategies, potential impacts of climate change on transport infrastructure, and approaches for integrating climate change considerations into transportation decision-making.

FAA

Additional mitigation efforts are underway throughout DOT. The FAA leads the transformation to the Next Generation Air Transportation System (NextGen). One NextGen key environmental goal is to limit or reduce the impact of aviation greenhouse gas (GHG) emissions on the global climate. To achieve this, one key approach is to more efficiently use the Nation's airspace, which will in itself lead to less fuel use and therefore have a positive GHG and air quality impact. In an effort to reduce fuel burn and other emissions, the FAA is developing and improving environmentally friendly procedures covering gate to gate, terminal, and surface operations.

Fully achieving this goal, however, will also require better understanding of atmospheric science, as multiple interrelated impacts due to aviation emissions influence climate change as well as ambient air quality. Associated magnitudes and metrics needed to express climate impacts properly are not well known. While pressure exists to identify and implement solutions, effective solutions must be based on a full understanding of the underlying science.

The FAA is leading work to improve scientific understanding of the impacts of aviation emissions on climate. With participation from the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA), the FAA recently launched the Aviation Climate Change Research Initiative (ACCRI) to accelerate scientific understanding that will inform policy decisions on mitigation. Funding for

ACCRI was included in the recent Fiscal Year 2009 Omnibus bill, and FAA expects to initiate efforts in the next few months.

Aside from ACCRI, FAA is pursuing a number of research and development initiatives to reduce aviation emissions at the source. With support from NASA, the FAA recently launched the (Continuous Lower Energy Emissions and Noise) CLEEN Program to advance maturing engine and aircraft technologies for quick deployment into the fleet in order to increase in fuel efficiency and reduce emissions.

The FAA helped form—and is an active participant in—the Commercial Aviation Alternative Fuels Initiative (CAAIFI), which was one of the subjects discussed at the hearing on Aviation Biofuels held by the Subcommittee on Space and Aeronautics last week. CAAIFI seeks to develop and deploy alternative jet fuels for commercial aviation which offer reductions in life cycle emissions. The CLEEN Program also supports this effort.

In addition, FAA is conducting research to inform Administration decisions about potential impacts on domestic and international aviation of possible policies such as aircraft carbon emissions standards, emissions cap-and-trade, and carbon taxes on aviation emissions and their impacts on the climate change.

FHWA

Research specific to the FHWA includes mitigation and adaptation work on improvements to system efficiency, land use, planning. The FHWA is working to evaluate how land use, transportation infrastructure, and policy changes would affect travel activity and greenhouse gas emissions. Analysis tools developed by this research will be used by planners and policy-makers. FHWA is also determining how new energy and greenhouse gas performance goals impact fundamental transportation system performance and inform the development of measures for reducing emissions. Additional work is going on at the State DOT and Metropolitan Planning Organization (MPO) levels.

FHWA is also developing a strategy to address adaptation issues, including a framework to conduct assessments and determine data gaps of transportation infrastructure most vulnerable to the effects of climate change. Guidelines will be developed concerning consideration of climate change impacts and adaptation in project development and environmental review.

The DOT report on *Potential Impacts of Global Sea Level Rise on Transportation Infrastructure* used multiple data sources to identify the potential impact of sea level rise on land and transportation infrastructure along the Atlantic Coast, from Florida to New York. The study created maps of land and transportation infrastructure that, without protection, could be inundated regularly by the ocean, or stand at risk of periodic inundation due to storm surge under a range of sea level rise scenarios. The study produced statistics to demonstrate the potential extent of land areas and transportation infrastructure affected.

Additionally, FHWA has research underway to demonstrate the value of sequestering or capturing carbon from the highway right-of-way (ROW) through modified maintenance and management practices and through changes to the type of vegetation planted. The effort was initiated to help State DOTs reduce emissions and maintenance costs and other environmental benefits such as reduced erosion, better retention of stormwater in soil, enhanced ability to hold snow, and improved wildlife habitat.

FHWA conducts several activities that reduce greenhouse gas emissions from transportation infrastructure construction. The Department is working closely with the hot mix asphalt industry on warm-mix asphalt which allows production of asphalt mix at lower temperatures, thereby reducing fuel use and emissions. FHWA is also expanding efforts to increase the use of recycled asphalt and concrete pavements, roofing shingles and other potential reuse materials in the construction of highways, which reduces the cost of emissions related to extraction of mineral resources, the production of highway materials and the transportation of materials. The concrete industry has worked hard to reduce emissions resulting from the production of cement through modifications to the production process and greater use of alternative materials such as fly ash and lime. FHWA is conducting research to expand the amount of fly ash that can be used in concrete paving.

FHWA through its Turner Fairbank Highway Research Center (TFHRC) is developing or conducting R&D on mitigation and adaptation of infrastructure for climate change. FHWA also actively participates in the National Science and Technology Council Subcommittee on Disaster Reduction (SDR). SDR focuses on science and technology issues to reduce disaster vulnerability covering all natural and technology hazards which include climate change issues. Currently research at TFHRC is being conducted on bridge vulnerability to hydraulic events such as flooding, scour and storm surges. Today most bridge failures occur in the U.S. due to flooding

and scour; this could significantly increase due to climate changes such as changing water levels and storm intensities. Other ongoing and planned research with potential to reduce the impact the effects of climate change include: development of guide specifications for bridges vulnerable to coastal storms and a handbook of retrofit options; optimum bridge deck shapes to minimize pressure flow scour; and development of hydrodynamic bridge systems to address flooding, overtopping, scour, surge and wave actions.

FHWA also has several programs underway to develop and implement innovative solutions to reduce traffic congestion and its effects on the environment, including: enhanced design and implementation of work zones; quicker response to traffic incidents; improved timing of traffic signals and other traffic management strategies; provision of information to allow travelers to make informed decisions on route, mode and timing of trips; and better balancing supply and demand through congestion pricing where appropriate.

FTA

The FTA's research on climate change falls into two main areas:

- 1) policy-oriented research investigating the potential for expanded public transportation service and transit-oriented development to reduce overall transportation emissions while providing convenient and economic mobility options; and
- 2) technology research that will enable local public transportation agencies to provide their already relatively energy efficient service in an even more efficient manner.

FTA conducts ongoing research on the synergies from combining investment in public transportation with compact, mixed-use development around transit stations. These synergies amplify the greenhouse gas reductions of each strategy. FTA is funding a new synthesis on greenhouse gas emission savings from transit through the Transit Cooperative Research Program. FTA also has sustainability partnership projects with key stakeholders, the American Public Transportation Association and the Association of Metropolitan Planning Organizations.

FTA research on alternative fuels and high fuel efficiency vehicles has contributed to the introduction of low emission technologies such as hybrid-electric buses, compressed natural gas vehicles, and biodiesel. FTA is planning research on improving the energy efficiency of electric rail propulsion and hybrid bus technology. FTA's National Fuel Cell Bus Program is developing and demonstrating fuel cell transit bus technology.

MARAD

The Maritime Administration has partnered with academia to develop a model known as the Geospatial Intermodal Freight Transport (GIFT) tool. The model is unique in that it identifies optimal freight transportation routing pathways based on minimization of energy and emissions (including CO₂), as well as time and cost. The current project is being developed regionally but will ultimately be incorporated into a national-scale model. The Maritime Administration is also working with ports and vessel operators exploring methods for using cold iron technology to provide shore-based power in order to reduce greenhouse gas and other air polluting emissions from vessels.

NHTSA

The National Highway Traffic Safety Administration (NHTSA) promulgates fuel economy regulations for passenger and non-passenger automobiles. On March 27, 2009, Secretary of Transportation Ray LaHood announced that DOT has posted the new fuel economy standards for cars and light trucks for the 2011 model year, and also noted that work on a multi-year fuel economy plan for model years after 2011 is already well underway. NHTSA's 2011 fuel economy will set the US on a course to meet the requirement of the *Energy Independence and Security Act* (EISA) for a fleet wide fuel economy performance of at least 35 miles-per-gallon (MPG) by 2020. NHTSA is hard at work on the next round of rule-making, which will include a thorough Environmental Impact Statement reviewing the impact of fuel economy standards on climate change and other environmental issues.

For the first time NHTSA was given authority under EISA to address options to regulate the fuel economy of medium and heavy duty trucks, the second largest contributor to domestic transportation greenhouse gas emissions. NHTSA has initiated a study with the National Academies of Sciences to study the potential methods.

NHTSA is also simultaneously working on implementing the other provisions of EISA, including the establishment of a new consumer information program for fuel efficiency of replacement tires. This program will serve to educate consumers about the effect of tires on fuel efficiency, safety and durability.

RITA

The Research Innovative Technology Administration (RITA) coordinates the majority of the Department's surface transportation research on alternative fuels, alternative vehicles and hydrogen fuels and fuel cells. RITA released its *Transportation Vision for 2030* in January of 2008. The *Transportation Vision* included environmental sustainability as a high priority, envisioning a future transportation network that will curb greenhouse gas emissions.

RITA coordinates research throughout the Department on advanced vehicle technology, including multiple research projects covering emissions testing and performance evaluation of advanced diesel engines, development of fuel cells, and advanced transit and bus technologies and research to better understand biofuel emissions. RITA also manages hydrogen research projects. Multiple research projects are ongoing regarding hydrogen, including finding safe and effective storage materials, testing hydrogen fuel cell vehicles, and training emergency responders on characteristics of hydrogen.

While not a complete summary of all DOT activities, this provides an overview of DOT's current research.

Climate related research is crucial for the transportation sector to address the mitigation of greenhouse gases and the need to adapt to likely impacts of climate change.

As transportation is the fastest growing end-use sector, DOT plans to continue research in the short- and long-term on identifying the most effective strategies to mitigate greenhouse gas emission from transportation. Identification of areas where additional science is needed to determine the most effective practices is critically important. Mitigation research would include, for example, vehicle efficiency and low carbon fuels technologies, integrating land use and transportation planning, systems efficiencies, and operational practices that could reduce energy consumption from transportation systems.

DOT also plans to continue policy-oriented research that examines the effectiveness of different policies employed by the U.S., federal agencies, or other countries to reduce greenhouse gas emissions from transportation, including policies such as emissions standards, tax incentives, and land use practices. The results of this research could be used to shape current transportation policies and near-term transportation decisions to reduce greenhouse gas emissions.

Longer-term research that focuses on transformational technologies and strategies will also be needed to achieve significant reductions.

DOT has focused its research on reducing emissions from transportation sources. DOT has conducted fewer research studies with respect to climate change contributed by building transportation infrastructure and has instead focused on infrastructure adaptation research. Significant investments in transportation infrastructure could be vulnerable as a result of potential climate impacts.

DOT plans to continue adaptation research to build on DOT's seminal Gulf Coast study, to identify vulnerable infrastructure and plan future infrastructure taking these impacts into account. Adaptation research would focus on developing risk assessment tools and reassessing current design and operations standards to better plan transportation systems of the future. Additional climate science and weather research is also planned to develop information on the range of potential future environmental conditions affecting transportation infrastructure over the longer-term. This includes providing more regional or local scale information of climate change impacts; developing further understanding of how projected climate change influences weather patterns and the ultimate effects on the natural environment. Such research is needed to inform transportation investment decisions, which should be made in light of long-term environmental (out 50- to 100-year) conditions. As many important impacts on transportation infrastructure will result from the incidence of extreme conditions such as localized flooding from heavy downpours and other severe weather events, more information is needed to prepare the transportation community for these likely events.

The transportation sector may also need to more rigorously examine transportation construction contributions to climate change and opportunities to mitigate emissions, building on the work that DOT has already initiated. This is especially relevant as the transportation sector seeks the most efficient strategies to adapt to the potential national, mandatory cap-and-trade program called for by the President.

DOT will continue to balance the need to reduce transportation-related climate emissions while continuing to support efforts to attain air quality and water quality standards, learn more about harm from air toxics related to transportation, and maintain noise reductions. Climate research provides the opportunity to identify the potential co-benefits of mitigation strategies, such as reductions in criteria air pollutants, as well as potential unintended consequences of mitigation strategies, such as increased risks to public health.

DOT will continue to work with the White House Office on Energy and Climate Change Policy, the other federal agencies, and the transportation community to identify and pursue the most critical climate research priorities. DOT's Climate Center will undertake a new strategic plan which will provide an excellent opportunity to develop a future climate-related transportation research agenda.

I look forward to working with this committee as we consider a transportation research and development agenda that enables our nation to better meet the challenge of climate change.

Thank you again, and I will be happy to respond to any questions you may have.

BIOGRAPHY FOR DAVID T. MATSUDA

David T. Matsuda serves as Acting Assistant Secretary and Deputy Assistant Secretary for Transportation Policy. This is his second tour of duty at DOT.

Mr. Matsuda rejoined DOT in March, 2009, after seven years on Capitol Hill. Most recently he served as senior counsel and primary transportation advisor to U.S. Senator Frank R. Lautenberg (D-NJ). While working in the Senate, Mr. Matsuda was engaged in the formulation and debate of most major federal transportation legislation from 2002–2009.

In 2002, Mr. Matsuda became a Georgetown University Government Affairs Institute fellow on the staff of the Senate Committee on Commerce, Science and Transportation. Mr. Matsuda worked with committee staffers to develop and carry out surface transportation policy/legislative agenda for former Committee Chairman Hollings and former Subcommittee Chairman Breaux. He also worked to enact bills on pipeline safety and Amtrak.

Previously at DOT, Mr. Matsuda worked as an attorney with the Safety Law Division of the Federal Railroad Administration, where he pursued regulatory enforcement of legal cases on railroad safety and hazardous materials violations and he led the drafting of the agency's proposed rule for safety standards of positive train control systems.

Mr. Matsuda earned his B.S. in engineering from Harvey Mudd College in Claremont, CA, and his J.D. from the University of San Diego School of Law in San Diego, CA.

Chair WU. Thank you, Mr. Matsuda.

Ms. Ciarlo, please proceed.

STATEMENT OF MS. CATHERINE CIARLO, TRANSPORTATION DIRECTOR, OFFICE OF MAYOR SAM ADAMS, CITY OF PORTLAND, OREGON

MS. CIARLO. Thank you, Chair Wu and Members of the Committee. My name is Catherine Ciarlo. I am the Transportation Director for Mayor Adams in Portland. We developed these comments cooperatively with TriMet, our transit agency, Metro, our MPO [Metropolitan Planning Organization], and the Oregon Transportation and Education Consortium, which Chair Wu is personally responsible for creating.

I would like to frame our comments today by just sharing a bit of Portland's experience. In 1993, we were the first U.S. city to adopt a comprehensive climate strategy. Since then our per capita emissions in the city have dropped one percent below 1990 levels, this at a time when emissions levels nationally rose 17 percent. In the Portland region, our per capita daily vehicle miles traveled [VTM] since that time have dropped eight percent. At the same time, nationally daily vehicle miles traveled rose eight percent. These statistics are the result of many years of conscious planning

in Portland. However, even with our successes, transportation today accounts for 40 percent of our greenhouse gas emissions in Portland. This June, we are set to update our climate action plan and it is clear that transportation will have to be a centerpiece of that plan. Our projections show that if we are going to meet our 2050 climate goals, we will need to reduce vehicle miles traveled by 68 percent per person below 1990 levels. No easy feat. Vehicle fuels and technology will help but we are obviously going to need new tools as well.

This is where our request to the Committee regarding research comes in. We hope that you will help us achieve a transportation bill that funds climate and transportation research in two parallel and inter-related tracks. The first would address short-term early wins, recognizing that a ton of carbon reduced in 2010 is more valuable than a ton of carbon reduced later. We would like to have you focus on the demand management and system management strategies that can reduce emissions immediately. I have a few examples of this. High-occupancy vehicle, or HOV lanes, inexpensive capacity can be created almost overnight, reduces emissions, increases the number of people with fewer vehicles. But we need appropriate models, incentives and decision criteria to document those emissions reductions. Another example is real-time information tools that give users access to current information about transit and traffic conditions. We have seen these change driver behavior and increase transit use in our community. We would like to apply them broadly and even in innovative contexts such as ride sharing, but again we need funding for pilot projects and solid evaluation mechanisms. Finally, we have individualized marketing campaigns called Smart Trips programs in Portland. These encourage driver behavior changes and have shown a nine to twelve percent drop in drive-alone trips on a neighborhood level. We would like to see funding an additional evaluation to make these programs stronger and to help us apply them more broadly.

All three of these examples are relatively new. At this point they tend to be judged based on traditional evaluation tools such as level of service. Those tools don't lend themselves to measuring climate change outcomes and as a result it is difficult to gain acceptance of these strategies and to apply them more broadly. Then over the medium-term, the Portland region needs better travel data collection, modeling tools and performance evaluation standards to help us fund capital investments. That data will help us make the case to decision-makers and to the public for climate-friendly projects.

Specifically, we encourage you to invest in several areas. We would like to see the transportation bill expand existing emissions modeling to address a wider range of vehicles including hybrids and electric vehicles and to address a wider range of fuels including biofuels and ethanol. We would like it to fund research to develop models that forecast trip training and time-of-day decisions in response to congestion. This would be very helpful also to help us better project responses to variable pricing and to tolling. And we would like to see the bill encourage and fund development of land-use allocation models which would be more sensitive to the impacts of induced demand. An example of where this would apply

is in the work currently being done on the Columbia River Crossing project to link I-5 and build a bridge between—replace the bridge between Washington and Oregon. That project's current forecast models predict demand for the new bridge without addressing the possibility of induced demand triggered by greater freeway capacity. That has made the project vulnerable to criticism in the areas of greenhouse gas emissions and promoting sprawl. We would love to have new tools to use moving forward there.

We hope that it will fund the development of forecasting models and evaluation tools for walking and biking. We would like to see it improve tools to assess the travel patterns of commercial and freight traffic, and we would like it to incent roadway pricing pilot projects to evaluate the effects of congestion pricing, of VMT taxes and a variable tolling mechanisms.

Finally, in addition to research on forecasting models, we need multi-modal performance evaluation standards. Today's level of service standards simply don't allow for multi-modal comparison of projects based on emissions goals. Again, a multi-modal standard would enable us to make the case for climate-friendly projects in a way that we can't do today. We end up right now being limited to sort of an "if you build it, they will come" argument in favor of non-traditional projects. Although this has in many cases been shown to be true, it is a hard sell in a competitive funding environment.

So in conclusion, the Portland region has invested in high-quality transportation options linked to land-use policies promoting compact growth but our ability to continue to make the progress we need to address climate change will depend on new research and tools to leverage our investment so far. We appreciate very much the opportunity to be here. We believe that the transportation bill with a substantial research agenda will help pay both climate and economic dividends, and we look forward to working with you in the future. Thank you for your leadership.

[The prepared statement of Ms. Ciarlo follows:]

PREPARED STATEMENT OF CATHERINE CIARLO

Chairman Wu, Members of the Subcommittee:

The Portland Story: Climate and Transportation

Thank you Congressman Wu and Members of the Committee on Science and Technology, for the opportunity to provide input on this important topic. The testimony I am providing today was developed by City of Portland transportation staff in conjunction with Portland State University, the Oregon Transportation and Education Consortium (OTREC), TriMet, and Metro (our regional MPO). These comments are consistent with the regional reauthorization position paper adopted by JPACT (the Portland-area MPO board) and the Metro Regional Council.

In the Portland region, we benefit from high-quality decision-making based on the integration of land use and transportation planning backed by data and research. For over 30 years, the region has pursued a path different from most urban areas of the United States. In the 1970's, we began to direct resources into a multi-modal transportation system rather than investing in a longstanding freeway expansion project. Coupled with the state's establishment of an urban growth boundary, this landmark decision laid the groundwork for three decades of transportation and land use innovation that has positioned the city well to meet the coming challenges posed by climate change . . .

Twenty years later, in 1993, the City of Portland was the first city in the Nation to adopt a comprehensive climate strategy that included an aggressive transpor-

tation agenda. As a result of that strategy (and high bike ridership and strong commitment to transit), Portland's per capita emissions have dropped to 10 percent below 1990 levels. During that same period, greenhouse gas emissions throughout the country have increased by 17 percent.

Between 1996 and 2006, transit ridership in the Portland Metro region increased by 46 percent, while our population increased by 16 percent. At the same time, daily vehicle miles traveled (DVMT) per capita in the Portland region declined by eight percent, while the average length of a work trip decreased 33 percent. In contrast, national DVMT per capita rose by eight percent over the same period.

This progress is not accidental. It is the result of many years of planning for compact growth, investing in high quality transportation options and adopting climate-friendly policies rooted in quality research and modeling supported by data.

Challenges

Today in Portland, transportation accounts for 40 percent of our greenhouse gas emissions. As we began to update our Climate Action Plan (scheduled to be adopted in June 2009), it became evident that transportation must be a centerpiece of our strategy if we are to achieve the climate goals established in our region. The draft plan includes aggressive transportation targets and calls for reporting of greenhouse gas emissions on all transportation projects.

Despite our successes to date, the next steps are challenging. First, projections show that, even with rapid introduction of electric vehicles and alternative fuels, we must reduce vehicle miles traveled by 68 percent per person to achieve our 2050 climate goal of reducing overall greenhouse gas emissions by 80 percent. Vehicle technology and fuels can help, but are insufficient to make real reductions in emissions and meet Oregon and Portland's climate goals.

Portland's challenge, and the Nation's, is to research, develop and implement new tools to help us make real change in our climate impacts. As of today, we lack the data, the models and the decision-making tools to get us there. What we do have is a clear idea what strategies and actions we need to succeed.

The window for effective climate action is closing quickly—many scientists believe that we must significantly reduce emissions in the next five and ten years in order to avoid major and irreversible climatic changes.

To have a realistic chance of achieving an 80 percent reduction by 2050 we must prioritize short-term "early wins," the quick-to-implement strategies that will pay forty years of dividends starting in 2010, 2011 and 2012. We must close the major gaps in data collection, travel modeling and decision-making that inhibit our ability to plan and select climate-friendly transportation projects, policies and plans.

Thus, we ask you to support two parallel and interconnected tracks in the climate and transportation research agenda:

First, transportation planners and engineers need data, models and decision tools to evaluate demand management and system management strategies. Demand management and system management are two highly cost-effective "implementation-ready" strategies, which can be implemented today to begin reducing emissions immediately and on a significant scale.

Second, we need significantly better travel data collection and modeling tools to improve capital project development and system plan evaluation. Implementation of the "Travel Data and Modeling Recommendations to Support Climate Policy and Performance-Based Transportation Policy" presented by Mr. Winkelmann would substantially address our concerns in this regard.

Solutions

Because of the need to act quickly and wisely, we encourage you to prioritize research on quick-to-implement strategies such as Transportation Demand Management (TDM) and Transportation System Management (TSM).

As it stands today, some of the most effective climate change strategies are relatively easy and inexpensive to implement but do not always rise to the top of community needs based on modeling and decision-making practices. Best practices for demand and system management strategies include tools that allow road users to access real time information about traffic conditions and ride-sharing. In addition, targeted marketing campaigns have shown dramatic increases in transit and bicycle use. Research showing the effectiveness of these tools will lead communities to prioritize and invest in them. In turn, the programs will allow users to make travel choices that have a significant impact on congestion.

Additionally, managing corridors based on established performance goals is a key strategy to reduce congestion and emissions. To do this effectively will require quality data and research. Planners need data on vehicle miles traveled, mode choice,

and trip patterns to make informed decisions about projects and programs related to climate change.

History has shown that research, methods, practices, and tools are a key element of major paradigm shifts in the field of transportation. Focusing the current reauthorization of the transportation act on climate change and “greening” our transportation system is one such shift. By comparison, the National Defense Highway System Act (which initiated construction of the interstate highway system in the late '50's and '60's) was accompanied by significant research on safety, highway geometrics, metropolitan planning and other areas that had not previously been contemplated.

Similarly, ISTEA, adopted in 1991, included flexible funding categories, air quality conformity, an emphasis on freight and inter-modal facilities, a new emphasis on system performance, and other innovative elements to advance transportation in the U.S. Research and technology advances around these topics were widespread in the 90's, helping to forge productive partnerships between the Federal Government, universities, states, MPOs, Ports, transit districts, and private enterprise.

The “Green TEA” or Green Reauthorization can set us on a path toward a transportation system that is sustainable, reduces our emissions and builds a system for the future. The treatment of climate change in this reauthorization promises significant advances in research and knowledge that will be result in real change.

Throughout the transportation field, models are key to enabling decisions for policies and programs/funding. Locally, we have attempted to model greenhouse gas emissions at the project level. While the experience was enlightening, it became evident that we lack sufficient data (in terms of trip lengths, VMT, mode choice) and modeling capacity to predict accurately the climate impacts of specific projects.

If we are to measure innovative programs and policies, new model enhancements are required to address the increased technical demands imposed by the rigor of environmental analysis. Improvements are needed for measuring:

1. Emissions

- The EPA MOVES model was developed for the purposes of quantifying the green house gases from mobile sources. Improvements are needed in this tool to address more easily different vehicle types (hybrids, electric) and fuels (bio-diesel, ethanol).

2. VMT and congestion

- Improving data and capacity for “Tour Models” will lead to better modeling of trip chaining and time of day decisions as a response to congestion. It will also improve our ability to model responses to pricing mechanisms.

3. Dynamic traffic assignment

- This assignment technique better captures queuing and upstream route choice effects due to bottlenecks. Overall, it provides better measurement of congestion effects.

4. Land use allocation models

- These models lead to better sensitivity to induced demand related to transportation investments.

5. Non-motorized travel (walk and bike)

- Focus on tools that are better equipped spatially to address the acuity required for non-motorized modal decisions.

6. Vehicle choice

- Need to develop tools to emulate the choice of purchasing a new vehicle, what kind, and which vehicle is used for a particular trip.

7. Commercial traffic and goods movement

- This component of travel is a major contributor to the environmental health of the region. Tools to address their travel patterns need improvement if we are to achieve our goals.

Conclusion

The Portland region has achieved considerable success in limiting emissions growth from transportation:

Transit ridership has doubled since 1990, with increases every year and exponentially with the cost of gas.

Portland has a higher percentage of bicycle commuters than any other major U.S. city with a bicycle commute rate of eight to twelve percent; eight times the national average.

Portland adopted a renewable fuel standard requiring that all diesel sold in the city include at least five percent biodiesel and all gasoline 10 percent ethanol.

Nevertheless, transportation of goods and people continues to account for 40 percent of Multnomah County greenhouse gas emissions. Land use planning and transportation funding decisions greatly influence transportation-related greenhouse gases emissions. Decision-makers need quality data to inform decisions about how and where to spend public dollars to build and manage a transportation system that works towards our climate goals.

Our Metropolitan Planning Organization, at the direction of our policy committee on transportation, recently adopted Resolution 09-0416 which outlines the region's position on the transportation re-authorization. Support for a robust research agenda tied to climate change is among the key recommendations of that resolution and we encourage you to pursue avenues that foster an environment of learning and collaboration among jurisdictions. We consider it a sign of the times that Congress chose Oregon for a national University Transportation Center (OTREC), whose theme is sustainable transportation and whose success stems from partnership among four universities and collaborations with public agencies around the state.

A commitment to regional planning rooted in quality research and data has paid dividends for the Portland region over the past forty years, and the Nation has benefited from our experience in addressing climate change through an integrated approach to land use and transportation planning. Looking toward the reauthorization of the transportation bill, we look forward to continued partnership with the Federal Government. Portland is committed to being a leader in climate change and clean technologies; a transportation bill with a robust research agenda that provides us with the data and decision-making tools will ensure an outcome that benefits both our region and the country. Thank you for the invitation to speak before you and your partnership in addressing the impact transportation has on our environment.

BIOGRAPHY FOR CATHERINE CIARLO

Catherine Ciarlo is the Director of Transportation in the Office of Mayor Sam Adams in Portland, Oregon. In that role, she serves as the senior policy advisor for the Mayor on transportation issues in the city.

Prior to joining the Mayor's staff in January 2009, Ms. Ciarlo was the Executive Director of Oregon Women Lawyers, where she set strategic direction for the professional association and oversaw its communications and operations. At the same time, she served as an appointed member of the City of Portland Planning Commission, where she participated in deliberations and decisions on a broad range of transportation and planning issues.

From 1998 to 2005, Ms. Ciarlo was the Executive Director of Oregon's Bicycle Transportation Alliance. During that time, the organization's staff grew from two to ten, and its membership from 800 to 4,000. In addition to increasing its stature and influence in Oregon, she was able to define the organization's mission more broadly to address bicycling as one element of a safe, vibrant, environmentally sustainable community.

Ms. Ciarlo is a graduate of Reed College and Lewis & Clark Law School, where she was awarded membership in the Cornelius Honor Society for her civic and environmental work. She has served on numerous transportation stakeholder advisory committees, giving her a first-hand understanding of the community-based aspects of transportation planning. In 2002, she was recognized by the Women's Transportation Seminar in Portland as the WTS Woman of the Year for her professional accomplishments and leadership in the transportation industry.

Chair Wu. Thank you, Ms. Ciarlo. Those very specific recommendations are very helpful to us. We appreciate it.

Dr. Rilett, please proceed.

STATEMENT OF DR. LAURENCE R. RILETT, KEITH W. KLAASMEYER CHAIR IN ENGINEERING AND TECHNOLOGY; DIRECTOR, MID-AMERICA TRANSPORTATION CENTER; DIRECTOR, NEBRASKA TRANSPORTATION CENTER, UNIVERSITY OF NEBRASKA-LINCOLN

Dr. RILETT. Chair Wu, Ranking Member Smith, Vice Chair Luján and other Members of the Subcommittee, it is my honor to participate in this hearing today to provide my views on the research in addressing climate change and transportation infrastructure.

I have broken down my talk into four areas basically that I see that are necessary to address. The first is that over the past few years a lot of the transportation models have become much more simulation based, much more individual based where we are looking at tours, we are looking at activities. This is a fantastic development but they haven't gone far enough in terms of what we are looking at here in terms of being able to make these tradeoffs. The second relationship is to the emissions models themselves that these transportation models feed. They are very average, they are very aggregate but the end result is that a lot of projects that we get asked to look at, demand management pricing, it is almost impossible for us to use these models to answer the questions that we are being asked and we would certainly like to see research directed at making these models much more disaggregate so that we can make these kinds of tradeoffs in terms of congestion management, congestion relief projects.

The second issue that we see as very important is related to the data, not surprisingly. Part of the reason that the models are not as good as they could be is that we don't have a lot of information to feed those models, and again, that comes in two forms. The first is in real-time data on activities and driving behavior. With the advent of intelligent transportation systems, we have a lot of data out there. In fact, it is easy to show we have terabytes of data. Even in Nebraska we can collect terabytes of data every month. The reality is though that a lot of that data is not very useful in terms of the information that we need and so a lot of work needs to be done on collecting that data, putting it into usable form and then allowing the modelers to access that data not only for developing these models and calibrating them and validating but also to measure whether these policies that we are putting into effect are really achieving their goals.

The other aspect of that, to the data is that a lot of work, because we are interested not only in averages now but also in distributions, for example, if you are looking at pollution, the idea of the average is nice but really you are looking at the outliers, hard accelerations, hard decelerations, old vehicles, those types of things. The data has to be much more robust in the sense of looking at the distribution of events, and because of that, our standard statistical models that we have been using in the past probably won't apply for this new level.

The third issue that was identified was to really encourage the research to be multi-discipline enough so that the impacts can be understood by the decision-makers, and again, this gets back to the idea of not only looking at—it is fine to look at one issue but so much of our work impacts each other that not only do we have to

look at the environment but also the impacts on safety, the impacts on other aspects of the transportation system because a lot of our policies tend to interact with each other. For example, the one I put in my written testimony related to the fact that we are asking drivers to rest more for safety reasons, which is a very good thing, but also at the same time we are asking them to idle less for the environment, which then impacts their ability to do safety. That is just one anecdote, but again, being able to look at these complex problems at a system level would be very advantageous.

The other aspect of that I would like to point out is that there is a lot of—because of the multi-discipline nature, there is a lot of advantages to pursuing public-private partnerships where they make sense. A classic one to me would be reducing emissions related to the logistics industry. They have very good data on operations. They know where their vehicles are. They know where their freight is. They can do lots of good things in terms of the environment, in terms of rerouting and that, rerouting their freight, moving it at different aspects, but again, that would involve a very strong partnership and I think there is a lot of potential for that.

The fourth issue is sort of an overarching issue related to what I would call sustainability and that gets again back to this idea that these problems are fairly complex and we really need to look at them from all aspects. That in itself is a research topic. How do you go and measure whether these initiatives are actually doing what they are doing? How do you get the data back to the decision-makers so they can make rational decisions based on all these competing objectives? And I would encourage the Committee to think about that in terms of the research agendas.

And my concluding remarks, again, very similar. I wanted to go over those four issues of modeling data, private-public partnerships and sustainability. I am obviously very biased. I am a Director of a UTC [University Transportation Center]. But I think because of the complexity of these issues, the universities have a lot to offer. They are not only educating the next generation of students but they are getting students to work on problems that might not have a solution in the next year or the next two years but ten years or fifteen years from now, which is really what we are talking about. This is a very good environment for that.

I appreciate the opportunity to give my thoughts and I would be happy to address any questions that you have.

[The prepared statement of Dr. Rilett follows:]

PREPARED STATEMENT OF LAURENCE R. RILETT

Chairman Wu, Ranking Member Smith, Vice Chairman Luján, and distinguished Members of the Subcommittee on Technology and Innovation:

My name is Larry Rilett and I am a Professor of Civil Engineering and the Director of the Mid-America Transportation Center at the University of Nebraska-Lincoln. It is an honor to participate in this hearing and to provide my views on the role of research in addressing climate change and transportation infrastructure.

The Mid-America Transportation Center (MATC) was designated as the USDOT Region VII University Transportation Center following the 2006 competition. Our consortium partners include Kansas State University, University of Iowa, University of Kansas, Missouri University of Science and Technology, Lincoln University and Prairie View A&M University. The Center's theme is improving safety and minimizing risk associated with increasing multi-modal freight movements. Our ad-

visory board includes the research directors from all region VII State DOT's, USDOT personnel, and participants from the rail, trucking, and waterway industries. Consequently the MATC research program is not only multi-modal but also significantly representative of public and private sector transportation interests of the Midwest.

The states that comprise Region VII (Iowa, Kansas, Missouri, and Nebraska) have many commonalities and their respective transportation agencies face many of the same issues in providing a safe, efficient, and effective transportation infrastructure. For example, the majority of the region's roadway networks are primarily rural, although there are a number of major cities interspersed throughout the area that face traditional urban transportation problems. Because the region's roadways, railways, and waterways are located at the crossroads of the Nation's transportation system, the four states share the challenge of an enormous amount of freight traffic.

Within Region VII, Interstates I-70 and I-80 are vital east-west corridors, and Interstates I-35 and I-29 are major north-south corridors. The two largest Class 1 railroads in the U.S. have significant portions of their networks in Region VII. Given the region's diverse economy, and the growing trade with China, Mexico, and Canada, freight traffic is increasing every year, which profoundly affect the region's infrastructure. Congestion on the roadways, railways, and waterways caused by this additional freight traffic is having an increasingly detrimental effect on the safety and health of the region's traveling public, its economy, and its transportation infrastructure. These challenges to the transportation system of Region VII appear to be indicative of transportation problems faced by the Nation at large.

I have broken down my comments into four critical areas that I believe need to be addressed in order to develop a successful research program related to infrastructure and the environment.

1: Transportation Modeling and Mobile Source Emissions Modeling

In order to estimate the amount of pollution emitted from mobile sources on the U.S. roadway system (both passenger and commercial trucks) the Environmental Protection Agency recommends using the MOBILE suite of emissions models of which the latest version is MOBILE 6. This model can estimate emissions for a variety of pollutants including: volatile organic compounds (VOC), carbon monoxide (CO), and nitrogen oxides (NO_x). The composite emission rate for a given pollutant type, vehicle class, model year and speed is derived as the product of the basic emission rate and a number of correction factors that are related to the model years and operating characteristics of the vehicles. The correction factors (by vehicle class and model year) include among other variables fuel volatility, refueling, running loss, crankcase and other evaporatives, speed, loading factor, air conditioning factor, trailer towing factor, humidity factor and cold start/hot start adjustment factors.

While the MOBILE model is used extensively across the U.S. for emissions modeling, there are a number of research issues that need to be addressed. For example, MOBILE requires, among other inputs, vehicle kilometers of travel (VKT) for each vehicle class as a function of average speed. This information traditionally has been obtained from macroscopic planning models whereby the average speed on a given length of roadway is the same for all vehicle classes. This makes it challenging to examine the effects of changes in policy (e.g., commercial carriers reducing their average fleet speed in response to diesel prices) and the effects of changes in various driver behaviors (e.g., some drivers having excessive accelerations and decelerations which lead to correspondingly higher emissions). This is problematic when analyzing the effects of demand management proposals such as HOV/HOT lanes, congestion pricing, etc.

Related to the above point is that over the past ten years there has been a shift from macro level transportation modeling to a more simulation-based approach. One example is the TRANSIMS model, which can simulate the daily activities of every individual in an urban environment—and hence their transportation choices including mode, route, time of travel, etc. These types of models allow for detailed spatial and temporal analyses of policy decisions at an individual traveler level. However, the current mobile source emission models cannot take advantage of these improvements because their inputs are based on averages. In fact, it can be shown that when the simulation data is aggregated and input to the MOBILE model the resulting emission estimates can vary up to twenty percent depending on how the modeler wishes to aggregate the data. EPA's recent development of the MOVES emission model, which is more disaggregate, is a step in the right direction.

In addition to the advancements in simulation modeling techniques, the advent of Intelligent Transportation Systems (ITS) has opened numerous possibilities for capturing detailed transportation-related information. The capabilities of modeling and observing individual driving behavior has increased substantially over the past

few years. This increase in fidelity should lead to better understanding of emissions related to transportation infrastructure.

The tools used to model spatially distributed transportation networks have become increasingly simulation based. This means that detailed analyses of activities and decisions (where to live, where to work, what mode to choose) of the population can be made over networks that are spatially and temporally distributed. However, significant research is required to ensure that the relationship between the transportation supply (e.g., physical network) and the transportation demand (e.g., activities of private citizens and businesses) is modeled accurately—particularly with respect to factors that affect emissions such as speed profiles (e.g., acceleration, deceleration). In addition, the mobile source emission models that can take advantage of these new capabilities need to be further developed and adopted. It is my belief that these changes cannot be done in isolation as the linkage between the transportation and mobile source emission models will be critical to the success of the research.

2: Data and Information Needs

While transportation models are becoming more sophisticated (e.g., modeling urban cities down to the individual citizen) there is a corresponding requirement for significant amounts of data for calibrating and validating these models. In addition, it is imperative that detailed emissions data be provided if the mobile source emissions models are to be updated so that they can take full advantage of the new transportation model capabilities.

Given today's computer and communication technologies, the ability to obtain detailed transportation-related information has never been greater. Unfortunately this data has not always been made available to researchers and/or was saved in a form that was not conducive to research. For example, speed data is collected in most metropolitan areas of the U.S. and this type of data is useful for both transportation and mobile source models. While the data is often saved it typically has a significant error which, while adequate for transportation operations applications, does affect its use for other applications such as model development. In addition, the data is often saved in aggregate form (e.g., average five-minute speeds) while disaggregate data will be much more useful. For example, the distribution of speeds is often much more informative than average speed with respect to environmental modeling. If two links have the same average speed of 55 km/h they may still have markedly different emissions if one has greater variability in speed. Currently, however, mobile source emission models cannot differentiate between these two scenarios.

Compounding this problem of insufficient meaningful traffic data is the dearth of empirical information on transportation-related emissions. Portable Emission Measurement Systems have shown potential for obtaining emissions readings from tailpipes. This type of information would be useful for emission model development and analysis.

With the recent advances in Intelligent Transportation Systems, both in the private and public sectors, there is a significant amount of data available for research. Unfortunately this data is not readily available researchers and/or is not in a form conducive to research. Both transportation models and environmental modelers will need this information for model development, model calibration and model validation. A comprehensive and internally consistent data set of vehicle data, activity data and emissions data is required.

In addition, because of the non-linear relationship between pollutants and their causal factors (e.g., CO emissions and vehicle speed) the statistics used in both empirical measurements and modeling will, in all likelihood, be non-parametric. Which techniques are best is still an open research topic. Traditional statistical analyses based on average conditions and/or normality assumptions, however, have been shown to be inadequate for analyses related to environmental effects.

3: Private Sector Initiatives

Needless to say the negative health effects associated with poor air quality are continuing to gain prominence as a national issue. The U.S. Environmental Protection Agency (EPA) has designated numerous counties across the Nation as non-attainable in terms of various environmental standards. These designations have prompted authorities in the nonattainment areas to implement a wide range of emissions control strategies. As an example, one such strategy is to reduce idling of light and heavy duty vehicles. Over the past twenty years, as vehicle and fuel technologies have improved, the relative contribution of truck idling to total mobile source emissions has increased substantially. The basic approaches to reducing long-

term idling include 1) legislation to limit long-term idling, 2) provision of alternate power sources at fixed locations, and/or 3) providing on-board auxiliary power units (APUs).

Drivers decide to let their trucks idle for various reasons which may be categorized into two distinct groups. The first is for what the EPA refers to as "hoteling." The U.S. Department of Transportation (USDOT) mandates that a truck driver must rest for eight hours after eleven hours of driving. During this down time, many truck drivers will leave the truck idling to provide a suitable environment for rest (air conditioning or heating to the sleeper cab), to keep the engine and fuel warm in cold weather, to operate appliances, and to maintain vehicle battery charge while appliances are in use. The second category of truck idling occurs when trucks are waiting to either pick up or drop off a load. This type of idling can occur at congested border crossings, busy inter-modal terminals, ports, etc., where the drivers can wait upwards of several hours.

It is important to note that there are multiple dimensions to these types of environmental policy decisions. For example implementing long-term idling restrictions while simultaneously requesting truck drivers to take longer rest breaks may result in drivers not getting the rest they require which could impact safety. Reducing truck driver hours of service has resulted in an inadequate supply of large truck parking spaces (at rest areas, truck stops, etc.). The short-term impact is illegal parking of heavy vehicles and the long-term issue is an increase in parking infrastructure to support this increased demand. Lastly, even environmental policy decisions can be in "competition." For example, the recent policies to reduce large truck NO_x emissions have resulted in lower fuel efficiencies. However, fuel usage has an approximately one to one correlation to carbon dioxide emissions which means that some of the recent policies for reducing NO_x emissions simultaneously increase green house gas emissions.

The research agenda should be multi-disciplinary and be comprehensive enough so that all impacts of any proposed action are understood by the decision-maker. For example, safety policy measures should include the effect on the environment while environmental policy decisions need to include the effect on other priorities such as driver safety. The interaction, and mitigation strategies, of potentially conflicting policies of various U.S. federal agencies should be a focus of the research agenda.

Because the logistics industry is extremely competitive, many companies have adopted fuel saving technologies and strategies which has the desirable effect of lower emissions, all else being equal. As in the previous example of policies made to reduce long-term idling, many trucking firms are now providing an APU in each of their cabs because of the cost in fuel savings. Other fuel saving technologies such as more aerodynamic trailers, single unit tires, etc., also have been adopted by the industry. It should be noted that it is still unclear whether recent improvements in vehicle technology affect fuel consumption, and hence emissions. Quantitative information on these benefits, based on solid statistical analyses, is critical if the traveling public and logistics companies are going to be able to make rational decisions about whether to adopt these new technologies. This information will also be essential to mobile source emission models.

Potential research in fuel saving technologies include 1) trailer design research to decrease aerodynamic drag and improve fuel efficiency, 2) transport refrigeration unit (TRU) research aimed at the next-generation of TRU's (using main engine power as a supplement, and 3) advanced battery/energy generation sources to power new components at reduced energy consumption/idling levels. In addition, many trucking companies have adopted real-time communication technologies whereby they can control their fleet in order to increase fuel efficiency, which results in lower emissions. Consequently, increased research in productivity in freight movements, across all modes, is critical to reducing congestion and energy dependence. With the increased use of Intelligent Transportation System technologies in the public and private sector, this goal has become increasingly achievable.

There is great potential for public-private partnership in reducing emissions related to the logistics industry. The freight and logistics industries have a vested interest in reducing their fuel use—which has a strong positive correlation with reducing emissions. The EPA SmartWay program is an excellent example of this type of collaboration and there is potential for public-private sector partnerships in other fuel saving technologies and operations-related research to reduce congestion in urban environments.

Issue 4: Sustainability

While transportation is essential for the economic well-being of any society, the negative externalities associated with transportation, including the erosion of non-renewable resources and environmental pollution, are considerable. The challenge, therefore, is to develop the transportation system in a sustainable manner. Regardless of the specific definition of sustainability chosen, transportation professionals are increasingly challenged to incorporate sustainability concepts into the planning, design and operation of transportation networks. To assess whether a particular strategy is moving towards or away from sustainability it is important to monitor key performance indicators. If policy-makers are to make good decisions relating to sustainable development and sustainable transportation, they need reliable information on the state of the environment and the factors that impact upon it.

It is important that the transportation research agenda related to environmental impacts considers sustainability. The definition of sustainability, how this definition will impact decision-making, and which metrics should be used are all open research questions. The trade-offs between the various goals of safety, congestion relief, minimal environmental impact etc., need to be explicitly and empirically accounted for in the decision-making process—particularly when the goals of various agencies and/or policies conflict.

Concluding Remarks

In summary, I believe there is a definite need for research related to transportation infrastructure and the environment. Principal areas of research include the following:

- Make the transportation and emission models fully compatible and able to model the individual user. This would allow policy decisions, particularly at the project level, to be more accurately analyzed.
- Develop comprehensive traffic, emissions and activity databases so that the transportation-emission models can be developed, calibrated and validated.
- Encourage public-private partnerships for developing and testing fuel saving/emission reduction technologies.
- Develop a sustainability research program so that the policy decisions can be analyzed simultaneously across various (and sometimes competing) objectives.

The results of such research would enable policy-makers to understand in advance of implementation what effects their policies will have on the environment, on safety, on the economy, etc. These problems are complex, and research into their solutions will need to be multi-disciplinary and broad enough to include all aspects of the transportation system. Given the scope of the challenges faced by the U.S. transportation system, all stakeholders, including universities, the USDOT University Transportation Centers, federal agencies, and the private sector will have to be involved in order to maximize the effectiveness of the research.

BIOGRAPHY FOR LAURENCE R. RILETT

Dr. Laurence R. Rilett is a Distinguished Professor of Civil Engineering and the inaugural holder of the Keith W. Klaasmeyer Chair in Engineering and Technology at the University of Nebraska–Lincoln. He also serves as the Director of the UNL Mid-America Transportation Center, which is the U.S. Department of Transportation Region VII University Transportation Center, and is Director of the Nebraska Transportation Center.

Dr. Rilett received his B.A.Sc. and his M.A.Sc. degrees from the University of Waterloo and his Ph.D. degree from Queen's University in Canada. He has held academic positions as an Assistant Professor and an Associate Professor (1995) at the University of Alberta and as an Assistant Professor, Associate Professor, and Professor at Texas A&M University (TAMU). Additionally, he is a Professional Engineer in the State of Texas. Over the past twenty years he has taught seven different undergraduate courses and four different graduate courses in statistics, risk analysis, and transportation planning. He has been awarded two TAMU Department of Civil Engineering teaching awards: the Zachry Award for Excellence in Teaching in 1997 and the Dick and Joyce Birdwell Endowed Teaching Award for 1999. In 2001 he was honored as the inaugural holder of the E.B. Sneed II Professorship at TAMU.

Dr. Rilett has been a principal investigator or co-principal investigator on over 25 research projects. His research sponsors have included the U.S.D.O.T., the National Science Foundation, the Texas Department of Transportation, the Nebraska Depart-

ment of Roads, the Canadian Natural Science and Engineering Research Council, the U.S. Environmental Protection Agency, and the Federal Railway Administration. Dr. Rilett's field of research is in the transportation system analysis area and his specific research may be divided into two main areas: (1) Intelligent Transportation Systems applications and (2) large-scale transportation system modeling. He has authored or co-authored over 60 refereed journal papers and over 70 conference papers based on his research. In 2002 he was awarded the Texas Transportation Institute TTI/Trinity Researcher Award and in 2007 he was awarded the UNL College of Engineering Research Award. Dr. Rilett is an Associate Editor of the *ASCE Journal of Transportation Engineering* and on the editorial board of the *Journal of Intelligent Transportation Systems: Technology, Planning, and Operations*.

The first research area is in use of information from Intelligent Transportation Systems (ITS) for real-time traffic applications and transportation model calibration. At the University of Alberta he was principal investigator on a project that involved the development of algorithms to route non-commuter vehicles such as paratransit vehicles, delivery trucks etc. using ITS information. At the Texas Transportation Institute he developed various statistical methods for estimating origin-destination matrices, estimating link and corridor travel times, routing vehicles through transportation networks using information input from Automatic Vehicle Identification (AVI) Systems, and estimating mobile source emissions from field observations. He is currently working on a project to automatically calibrate the traffic flow parameters in traffic micro-simulation models (e.g., CORSIM, TRANSIMS) using ITS data.

The second research area is in the field of transportation modeling with specific emphasis on developing new models and techniques to analyze advanced technologies in transportation networks. Previous work has included modeling the TravTek route guidance logic with the INTEGRATION traffic simulation model. He has also worked extensively in transportation sustainability issues and has developed methods for incorporating environmental and equity objectives within traffic models. Much of his work involves using advanced statistics to analyze simulated and observed data.

Chair WU. Thank you very much, Dr. Rilett, and please give my best to Coach Osborne. We miss him here, but I think he is in a far, far better place.

Mr. Winkelman, please proceed.

STATEMENT OF MR. STEVEN WINKELMAN, DIRECTOR OF TRANSPORTATION AND ADAPTATION PROGRAMS, CENTER FOR CLEAN AIR POLICY (CCAP)

Mr. WINKELMAN. Chair Wu, Ranking Member Smith and Mr. Luján, good morning. My name is Steve Winkelman. I am the Director of the Transportation Program at the Center for Clean Air Policy, also called CCAP, a Washington, D.C., and Brussels-based environmental think tank.

CCAP helps governments at all levels design and implement climate policies that balance economic and environmental concerns. We conduct technical analyses and facilitate dialogue among stakeholders and government, industry and environmental groups in the United States and worldwide to craft practical and effective solutions. CCAP encourages our partners to "Ask the Climate Question": how will infrastructure and land-use decisions affect greenhouse gas emissions and vulnerability to climate change impacts? Congress is poised to spend \$500 billion on transportation infrastructure. Asking the climate question about that investment poses new challenges that transportation officials are not equipped to address. CCAP has seen firsthand the hunger that federal, State and local officials have for the missing data and tools needed to address climate change.

Implementation of the ambitious research agenda that I propose would have major benefits beyond climate policy. I believe it would provide a solid foundation for a performance-based approach to

transportation policy grounded in verifiable facts and accountability for outcomes.

Research is needed on the following topics. One, assess the costs and benefits of emissions reductions; two, expand research on improving travel choices such as transit, walking and telecommuting; three, measure performance of transportation investments; four, improve data models; and five, plan for adapting transportation infrastructure to the impacts of climate change. I will highlight priority research opportunities and offer more detail in my written testimony.

First, the Transportation Research Board, the Department of Transportation, the Environmental Protection Agency [EPA] and the Department of Energy should collaboratively conduct the first-ever comprehensive study to assess the costs, benefits and co-benefits of greenhouse gas emissions reduction measures including vehicles, fuels, improved travel choices, travel demand management and system efficiency. Second, Congress and federal agencies should treat research on improving travel choices as seriously as R&D on efficient vehicles and fuels. We will need it all for climate protection. While we marvel at the scientists inventing the next generation of batteries and hybrids, we should also support the visionary planners, architects and economists doing the R&D to invent healthy communities and more walkable and bikable neighborhoods. The empirical evidence shows that residents of walkable neighborhoods emit less CO₂ than those of car-dependent neighborhoods, even if that car is a Toyota Prius, which is why I like to say, "Sidewalks are as sexy as hybrids!" We should therefore fund smart growth planning as applied R&D which can have significant payoffs. For example, the Sacramento region spent some \$4 million on smart growth planning and discovered more than \$9 billion of infrastructure savings while reducing greenhouse gas emissions by 14 percent. In Portland, a \$70 million investment in streetcars helped attract more than \$2 billion in private development.

Third, Congress should require greenhouse gas measurement for major transportation projects and programs. Federal, State and local agencies will need new resources for a performance measurement so that they face what I call a "funded responsibility" and not an unfunded mandate.

Fourth, accurate travel data is critically needed to evaluate transportation system performance. Transportation experts have identified major deficiencies in the reliability and completeness of travel data and key travel surveys have lost federal funding in recent years. Working with high-level dialogue participants, CCAP has developed a set of travel data recommendations which I include in my written testimony. We call for TRB to conduct a study and develop recommendations on the highest-priority data and modeling improvements needed to reduce greenhouse gas emissions and we ask Congress to provide funding for the study and for implementation of its findings. Specific improvement opportunities include collection of odometer data, electronic data collection and advanced travel models that can address non-motorized travel, freight, and pricing strategies.

Finally, CCAP recommends establishment of research and technical assistance networks to adapt transportation infrastructure,

planning and operations to climate change impacts. We still have a chance to stave off the worst impacts of global climate change if we act swiftly and thoughtfully to reduce greenhouse gas emissions. By asking the climate question about the pending \$500 billion investment, Congress can make sure that transportation is part of the solution and not the problem. The research agenda I propose would allow us to plan and invest wisely and reap dividends measured in economy efficiency, energy security and healthy communities. Thank you.

[The prepared statement of Mr. Winkelman follows:]

PREPARED STATEMENT OF STEVE WINKELMAN

Chairman Wu, Ranking Member Smith and Members of the Subcommittee: good morning. I appreciate the opportunity to testify before you today. My name is Steve Winkelman. I am the Director of the Transportation and Adaptation Programs at the Center for Clean Air Policy (CCAP), a Washington, DC and Brussels-based environmental think tank.

Since 1985, CCAP has been a recognized world leader in climate and air quality policy and is the only independent, non-profit think-tank working exclusively on those issues at the local, national and international levels. CCAP helps policy-makers around the world to develop, promote and implement innovative, market-based solutions to major climate, air quality and energy problems that balance both environmental and economic interests.

Our behind-the-scenes dialogues educate policy-makers and help them find economically and politically workable solutions. Our Future Actions Dialogue provides in-depth analyses and a "shadow process" for climate negotiators from 30 nations from around the world to help them develop the post-2012 international response to climate change. We also facilitate policy dialogues with leading businesses, environmental groups and governments in the European Union and the U.S. on designing the details of future national and transatlantic climate change mitigation, adaptation and transportation policies.

CCAP played a major role in the design and passage of the SO₂ trading system enacted in the 1990 *Clean Air Act Amendments* and was the lead consultant in the original design of the European Union's Emissions Trading System (EU ETS). It has also helped develop national, regional, State and local climate policies in the U.S. and many other nations, including emission mitigation policies, smart growth initiatives, forestry policies and innovative approaches to climate adaptation.

CCAP's *VMT and Climate Policy Dialogue* brings together high-level decision-makers and experts on transportation, smart growth and climate policy from all levels of government, car and oil companies, the non-profit community and academia. Participants include the secretaries of transportation from Kansas, Maryland, Pennsylvania, executives from, the American Association of State Highway and Transportation Officials (AASHTO), the California Air Resources Board and the Sacramento Area Council of Governments (SACOG), and senior representatives from American Public Transit Association (APTA), U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA), New York City, Brookings, Bipartisan Policy Commission, BP, Exxon, Ford, Honda, Environmental Defense Fund, Natural Resources Defense Council, and Transportation for America.

Through the *Urban Leaders Adaptation Initiative*, CCAP is assisting ten partner cities and counties in developing effective policy and investment decisions to increase their resiliency to the impacts of climate change. Urban Leaders partners include representatives from Chicago, King County, Los Angeles, Miami-Dade County, Milwaukee, Nassau County, New York City, Phoenix, San Francisco and Toronto.

Ask the Climate Question

In all of our transportation and adaptation work, CCAP encourages our partners in government and industry to "Ask the Climate Question"—How will planning, policy, funding, infrastructure and land development decisions affect greenhouse gas (GHG) emissions and our vulnerability or resilience to the impacts of climate change?

There is little doubt that answering the "Climate Question" requires both basic and applied research. More importantly, CCAP has seen first hand in our work the hunger State and local governments and other stakeholders have for the information, tools and policy options needed to answer the climate question.

The transportation community has awoken to the dangers of climate change, but has much ground to make up if we are to act swiftly enough and spend our money wisely enough in the future. My testimony today will explain in more detail why we need this research and the benefits of doing it. It also provides a detailed road-map of research priorities and implementation needs.

We are poised to spend as much as \$500 billion in federal funds on transportation infrastructure, which will leverage billions more in State, local and private investments. Asking the Climate Question about that \$500 billion investment poses new challenges that we are not currently well prepared to address. How can we most effectively reduce transportation GHG emissions? How much will that cost? What other costs and benefits will arise from GHG reduction policies? What tools, data and technical capacity do we need to implement GHG reduction policies? How can we reliably measure policy progress? What performance measures are most effective and practical?

Basic and applied research is necessary to build the tool box to answer those questions. Research findings will help federal agencies such as DOT and EPA provide technical assistance to states, MPOs and local governments as they act to reduce their transportation GHG emissions.

While there are differences of opinion about which policies we should adopt to address climate change, today there is an unusually wide consensus on the need for basic and applied research to support policy choices to address climate change. This is a welcome change from even a few years ago, when the transportation community began to appreciate its role in reducing GHG emissions.

Is research needed to help address climate change issues in transportation infrastructure?

Yes, research is needed to inform how transportation infrastructure will impact GHG emissions and how transportation infrastructure will be impacted by climate change. Such research is critical to aid federal, State and local decision-makers as they develop transportation plans, design policy and decide upon infrastructure investments that have both immediate and long-term economic and environmental implications.

What purpose would the research serve?

Basic and applied research is needed to help federal agencies, State and local governments to:

1. Assess the **costs, benefits and co-benefits** of transportation GHG reduction measures;
2. **Measure performance** of transportation investments and **evaluate** when, where and why changes occur;
3. **Improve data and models** to enable performance measurement and forecasting;
4. Plan for **adapting transportation infrastructure to climate change impacts**.

I provide details on each of these issues and offer suggestions as to how the research agenda could be implemented. In the appendices I provide additional details on data improvement and research needs. I also request to submit, for the record, the "CCAP Travel Data and Modeling Recommendations to Support Climate Policy and Performance-Based Transportation Policy."

Implementing the research agenda—priority opportunities

To help navigate the long list of research needs, I have highlighted priority research opportunities that could be initiated or executed rapidly:

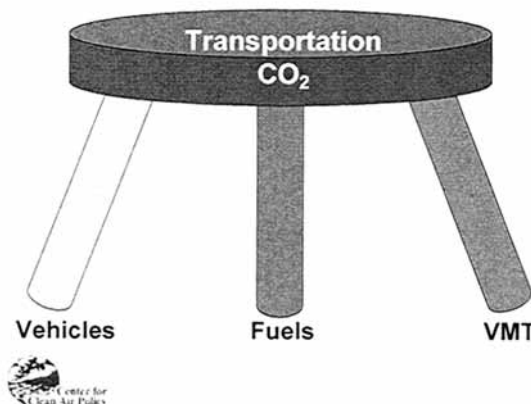
- TRB, DOT, EPA and DOE should systematically and collaboratively **assess the costs, benefits and co-benefits of transportation GHG reduction measures**, including vehicles, fuels, improved accessibility and travel choices, travel demand management, and improvements in system efficiency and construction practices.
- Congress should **require GHG measurement for major projects and metropolitan transportation programs** to assess the climate impacts of federal infrastructure investments. Federal, State and local agencies will need new resources to conduct measurement and evaluation, say up to one percent of project costs, so that they face a 'funded obligation' and not an unfunded mandate.

- TRB should conduct a **study and develop recommendations on the highest priority data and modeling improvements** needed to support performance-based transportation decisions that reduce GHG emissions.
 - Congress should **provide funding** to implement the study's recommendations.
- The Federal Government should **establish national climate services extension networks** to provide customized information and technical assistance to better adapt transportation planning, infrastructure and operations to climate change impacts.

1. Assess costs, benefits and co-benefits of transportation GHG reduction measures

While there is significant literature on the costs, benefits and co-benefits of vehicle fuel efficiency and low-GHG fuels,¹ there is limited information on the costs, benefits and co-benefits of GHG reduction measures of the transportation system and its infrastructure.

Transportation GHG emissions are a result of what CCAP refers to as the “three-legged stool”—vehicles, fuels and travel demand as measured in vehicle miles traveled (VMT). Some government transportation officials have offered a fourth leg of the stool that addresses system efficiency, such as traffic flow smoothing and logistics enhancements.



More research is needed to systematically assess the costs, benefits and co-benefits of transportation GHG reduction measures, including vehicles, fuels, improved accessibility and travel choices, travel demand management, system efficiency and construction practices.

This research should:

- Explore the **level, timing, and cost of GHG reductions** from a comprehensive set of transportation GHG reduction options, including:
 - Vehicle efficiency
 - Low-GHG fuels
 - Improved accessibility
 - Improved travel choices, including transit, walking and cycling
 - Travel demand management, including pricing policies
 - System Efficiency
 - Low-GHG construction practices

¹For example, see Lutsey, Nicholas P. (2008) Prioritizing Climate Change Mitigation Alternatives: Comparing Transportation Technologies to Options in Other Sectors. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-08-15. http://pubs.its.ucdavis.edu/publication_detail.php?id=1175

- Assess the **co-benefits** and impacts of transportation GHG mitigation measures on economic vitality, energy security, safety and social equity.
- Analyze the **interactions** among GHG reduction measures, including synergies and conflicts, such as: the rebound effects from higher fuel economy, induced demand and development from faster travel speeds, pricing, land use and travel alternatives.
 - This will require fundamental research into how the rapid changes in fuel prices and economic performance over the last few years have affected travel behavior. Are drivers recent response to fuel price changes (the price elasticity of demand) consistent with past studies?
- Assess the **effects of fuel price increases** upon fuel sales, VMT, mode split, local economic activity, passenger and pedestrian safety, **in regions and cities with varying levels of accessibility**.
- Draw from **real-world pilot projects** conducted in partnership with expert researcher teams aiding with design, monitoring and evaluation. This would enable researchers to learn from real-world experiments on cutting-edge policies and add the credibility of external review.
- Enable DOT and EPA to **provide technical assistance** and guidance to help states, metropolitan planning organizations (MPOs) and local governments reduce GHGs from transportation. There are a few recent and forthcoming studies that contribute on this front:
 - The *CCAP Transportation Emissions Guidebook* helps State and local officials calculate the GHG emissions savings from 40 transportation policies and measures, including smart growth, transit, bicycle infrastructure, pricing strategies and inter-modal freight.² The *Guidebook* includes policy overviews, success stories and links to key models and resources. It was last updated in 2005. National Cooperative Highway Research Program (NCHRP) study 20–64(64) is reviewing the CCAP Guidebook to assess its effectiveness at estimating mobile-source GHG emissions.
 - In Spring 2009, CCAP will release a working paper, “Growing Wealthier: The Economic Benefits of Smart Growth,” which summarizes savings in infrastructure costs, fuel use, building energy use, water use, household costs, social equity, and benefits such as local economic development and public health.³
 - In Summer 2009, the Urban Land Institute will publish its *Moving Cooler* study, which evaluates the cost and effectiveness of a variety of strategies to reduce VMT and increase operational efficiency, including pricing, land use, transit, carpooling, freight, intelligent transportation systems, and regulatory measures.⁴

Applied research is one of the best ways to improve accessibility, travel choices, travel demand management and system efficiency.

People marvel at the scientists and technologists toiling away in laboratories and garages inventing the next generation of windmills, batteries, hybrids, and LED light bulbs. And we must ensure that their research is adequately funded, because we desperately need them to succeed.

We should also venerate and support the heroic planners, architects and engineers working to design livable communities and more walkable neighborhoods, where basic services can be obtained without the need to drive. The empirical evidence shows that a typical resident of a traditional, walkable neighborhood emits significantly less transportation GHG emissions than typical auto-oriented development—30 percent lower on average. For example, there is 40 percent lower VMT in Chapel Hill, North Carolina’s Southern Village and 75 percent lower in Atlanta, Georgia’s Atlantic Station than the regional average.⁵ That’s more effective than driving a Toyota Prius, and can bolster the local economy and physical health to boot. Or, as I like to say, “Sidewalks are as Sexy as Hybrids!”

² http://www.ccap.org/safe/guidebook/guide_complete.html

³ S. Winkelman, “Growing Wealthier: The Economic Benefits of Smart Growth (sneak preview),” TRB Annual Meeting, January 2008: [http://www.ccap.org/docs/resources/567/Winkelman%20-%20Growing%20Wealthier%20\(TRB%20Jan%202009\).pdf](http://www.ccap.org/docs/resources/567/Winkelman%20-%20Growing%20Wealthier%20(TRB%20Jan%202009).pdf)

⁴ <http://commerce.uli.org/AM/Commerce/ProductDisplay.cfm?Productid=1754>

⁵ R. Ewing, K. Bartholomew, S. Winkelman, J. Walters and D. Chen, *Growing Cooler: The Evidence on Urban Development and Climate Change*, Urban Land Institute, 2008.

And don't forget the honorable economists and engineers developing management and pricing solutions to maximize efficient use of existing infrastructure and generate valuable streams of revenue that can be reinvested in sustainable infrastructure.

CCAP applauds the new Housing and Urban Development (HUD) and DOT Inter-agency Partnership to Promote Sustainable Communities,⁶ which calls for joint research, data collection and outreach efforts to develop information, analytic tools to track housing and transportation options and expenditures, establish standardized and efficient performance measures, and identify best practices. An interagency working group, led by DOT, is currently developing performance metrics, research and data needs to support an integrated regional planning framework. This research effort is the analog to technology R&D for vehicles and fuels and will provide the building blocks for more livable communities.

2. Measure performance of transportation investments, and evaluate when, where and why changes occur

In an era of shrinking budgets and transportation systems falling short of meeting community needs, there is a growing need for a performance-based approach to transportation policy.

Why Measure?

From a GHG perspective, there are several reasons for measuring performance, such as: maintaining a GHG inventory, informing policy design, assessing implementation status, and evaluating policy performance.

Research is needed to determine how performance-based policy can be operationalized in a practical and efficient way. Transportation policy aims to address many objectives such as: accessibility and mobility, economy, safety, energy, environment, equity and health. But if we're considering a dozen metrics, then many of them are likely to carry little weight and be ignored. A key research objective is to develop a workable number of highly practical and useful measures—four or five?—that address multiple policy objectives. For example, improving accessibility and travel choices can reduce GHGs, energy uses and, in some cases contribute to safety, public health and economic efficiency.

What Metrics?

Research is needed to assess which metrics are most effective for specific purposes. For example, as part of the CCAP VMT and Climate Policy Dialogue, CCAP maintains a Travel Data and Performance Measurement Workgroup. The workgroup strongly believes we have to be able to measure transportation GHG emissions per capita if we are to assess State and regional GHG performance. Although the GHG per capita metric is sufficient for GHG inventory purposes, it is not sufficient for understanding *why* GHG emissions have changed, or *where* the changes occur—critical questions for policy design. An effective research effort will need to measure performance on all four legs of the stool (fuel economy, fuel GHGs, VMT, system efficiency), but do so at an appropriate geographic resolution (e.g., region, corridor, neighborhood) to inform policy design and evaluation.

Measuring Accessibility

Research on alternative measures of accessibility will be important for assessing how to most efficiently connect people and goods while minimizing GHG emissions. There is a growing agreement on the importance of measuring mobility and accessibility, in order to focus on transportation outcomes for people and goods in additions to vehicles and segments of roadways. Traditional transportation performance measurement focuses on measures of *mobility* such as vehicle throughput, facility level of service and traffic congestion. Mobility measures such as, flow improvements, are important as they can tell us enable vehicles to move more efficiently, and in some cases with lower net GHG emissions. However, *accessibility* is the ability to reach desired goods, services, activities and destinations. Accessibility improvements (e.g., higher density mixed-use development) can enable people to reach the goods and services they need more efficiently, and with less vehicle travel and lower GHG emissions. Accessibility can be measured in terms of number and types of destinations reachable within a set period of time, or in terms of ease of access such as the proportion of the population within a 10-minute walk of transit service with a minimum 15-minute frequency. Both mobility and accessibility improvements can allow for more efficient use of existing infrastructure.

⁶ <http://www.hud.gov/news/release.cfm?content=pr09-023.cfm>

According to the Oregon Department of Transportation, “Cities and other major activity centers tend to have a relatively poor vehicle mobility (due to congestion), but are economically successful due to excellent accessibility (activities that are clustered together and many travel options).”⁷

How to Measure and Evaluate?

With climate change, we are in the midst of what some scientists refer to as an experiment of global proportions. Research must respond accordingly. There is much real-time learning to do to assess what works and how measures interact, and many opportunities to measure and evaluate reactions, interactions, costs and benefits.

Research is needed to determine the tools and agency capacities required to conduct timely analysis and interpretation of travel data, and provide actionable information that is relevant to planners and decision-makers.

As we measure transportation system performance, based on continually improving data, we need to analyze the data to characterize and attempt to understand changes in key variables. For example, how much did VMT change, which VMT changed (freight or passenger, for which trip purposes), when and where did the changes occur and what are the likely reasons for those changes?

Out of labs and into the streets!

There is a crucial need for research that occurs in the laboratory and in front of the computer monitor, such as vehicle R&D and data analysis. However, addressing climate change will require that we take a broader perspective on research, and integrate measurement and evaluation more thoroughly into project planning and execution. *Research is needed to assess options for incorporating measurement and evaluation into standard transportation operating procedures, and to determine the resources required for implementation.*

Requiring GHG measurement for major projects and metropolitan transportation programs would be invaluable for assessing the climate impacts of federal infrastructure investments. Federal agencies, State MPOs and local governments will need new resources to conduct measurement and evaluation, say up to one percent of project costs so that they face a ‘funded obligation’ and not an unfunded mandate.

3. Improve data and models to enable performance measurement and forecasting

In February, the U.S. House of Representatives and U.S. Senate approved the conference report for the *American Recovery and Reinvestment Act (AARA)* of 2009. The bill emphasizes **accountability and transparency**, calling for clear, accurate and timely reporting of public benefits, and that programs “meet specific goals and targets, and contribute to improved performance on broad economic indicators.”⁸ The accountability and transparency experience with AARA should offer important insights as Congress and the Administration moves to create a similar framework for upcoming surface transportation bill authorization.

- *Research is needed on how to increase the transparency of how federal transportation funds are actually spent at the State, regional and local level, including investment type (preservation, road capacity expansion, transit capacity, bicycle and pedestrian facilities, demand management) and specific geographic location.*

Research is needed to assess travel data and modeling tools required to support climate policy and performance-based transportation policy.

Accurate, timely and geographically-specific travel data are critically needed to effectively plan, manage and evaluate transportation system performance across a range of issues including economic efficiency, metropolitan accessibility, GHG emissions, energy security, safety and system preservation. Transportation practitioners and researchers have identified deficiencies in the reliability, consistency, completeness, resolution and timeliness of travel data. State and local governments recognize the need, but are concerned about their ability to pay for travel data improvements. Key travel data collection efforts have lost funding or been terminated in recent years. To use the expression of transportation policy expert, Tom Downs, we’re “flying blind” when it comes to transportation data.

In CCAP’s Travel Data and Performance Measurement Workgroup, discussions on performance metrics quickly lead to the critical need for better and different travel

⁷ODOT, “Accessibility and Mobility Differences,” www.oregon.gov/ODOT/SUS/accessibility_mobility.shtml

⁸<http://www.recovery.gov/?q=content/accountability-and-transparency>

data and models, with sufficient funding for data collection and evaluation. Attached to my testimony are the Workgroup's recommendations finalized in January, titled "CCAP Travel Data and Modeling Recommendations to Support Climate Policy and Performance-Based Transportation Policy."

In summary, they recommend to:

- **Substantially increase funding for transportation data and model improvement.** We are poised to spend as much as \$500 billion in federal funds on transportation infrastructure, which will leverage billions more in State, local and private investments. Higher quality and more timely data will be required to ensure that these funds are spent effectively, and, frankly, to credibly make the case for generating a sustainable revenue stream to invest in critical public infrastructure. Increased funding is needed to: collect and improve travel data; research and analyze travel data trends; improve travel models; improve fuel economy measurement; and support cross-agency coordination at the federal, State, MPO and local levels.
- **Improve Quality and Utility of Travel Data**

Conduct a study and develop recommendations on the highest priority data and modeling improvements needed to support performance-based transportation decisions that reduce GHG. The study should develop recommendations for, with participation from, federal, State, MPO and local governments, as well as experts from the private sector, academia and NGOs. As we move into authorization of a new surface transportation bill, federal, State and local decision-makers need such information. Data and model improvement efforts must be strategically focused to balance needs, time, costs and benefits. The recommendations should reflect that the level and resolution of data required will vary by policy scale, geography and scope.

Research is necessary to assess the costs and benefits for states to process, collect and analyze odometer data. This information is needed first to understand local travel behavior and determine land use influence on travel behavior and ultimately to aid policy evaluation and improve predictive capabilities of travel models. Collection and analysis of odometer data could provide quick and useful information on VMT and GHG emissions. MassGIS, the Massachusetts' Office of Geographic and Environmental Information has mapped odometer readings from vehicle inspection and maintenance programs in a way that both protects privacy and illuminates how VMT differs by land use characteristics such as density, mix of uses and regional location. Such information is invaluable in understanding where policy intervention is most needed and can be most effective. Policy-makers in California are considering similar data collection and analysis.

Specific data improvement opportunities identified by participants in CCAP's workgroup are included in Appendix A. Highlights include:

- Provide stable funding for the National Household Travel Survey (**NHTS**) at a frequency appropriate to inform transportation, energy and climate planning, policy design and evaluation.
 - Re-instate the Vehicle Inventory and Use Survey (**VIUS**) to provide information on truck characteristics and truck travel.
 - Develop a **national rotating panel** on vehicle and fuel use.
 - Expand coverage and increase the detail on the Commodity Flow Survey (**CFS**)
 - Determine how State departments of taxation fuel track **fuel sales data**, whether these can be mapped to specific retail service station locations.
 - Pursue **electronic data collection tools** such as transponders, GPS, and cell phones, following industry standards to protect privacy. Such data sources would be invaluable for efficient transportation system planning, management, and GHG policy design.
 - **Improve the availability of data from the Census** Transportation Planning Package (CTPP) at the level of detail and small area geography needed to support more extensive travel demand modeling and forecasting.
- **Enhance travel and emissions modeling capacity**

In an age of climate change, transportation planners and modelers are going to be tasked with answering new questions and more detailed questions. New responsibilities will require new resources, tools, practices and staff training.

New research is needed to improve travel and emission modeling capability to address GHG concerns: GHG vs. speed and traffic flow, induced demand, land use, geographic and temporal resolution, transit, non-motorized travel, freight, fuel price sensitivity, and macro system efficiency. Improved travel and land use data will be required to calibrate and apply the models.

Research is needed to develop quick response sketch planning models to complement major regional and State level models.

Specific opportunities identified by CCAP's workgroup include improving models' treatment of:

- Operational issues that affect CO₂ such as speed, acceleration, traffic flow uniformity;
- Behavioral issues such as response to pricing strategies;
- Induced travel demand, land use changes (regional, micro, induced development) and non-motorized travel; and
- Multi-modal freight travel.

- **Improve accuracy and reliability of fuel economy measurements**

New research is needed to measure real-world vehicle fuel economy, continue to develop better driving cycle tests, and conduct research to develop better ways to predict the fuel economy any individual will get. Such vehicle testing could be executed by the U.S. EPA and the California Air Resources Board and used to update their emissions models (MOVES and EMFAC, respectively) to better reflect GHG emissions. Such data are also key for validating, corroborating and analyzing fuel use and VMT data collected by DOT and DOE.

- **Improve coordination and collaboration across government agencies and levels of government** to support data corroboration, quality assurance, policy design and evaluation.

Federal agencies such as DOT, EPA, DOE, IRS, HUD and the Census Bureau should share, compare, and integrate complementary data sets (travel, fuel sales, fuel economy, GHGs, demographics, land use) and establish procedures for data corroboration. These agencies should conduct joint research to understand relationships among policy variables and inform policy design. There is also a need to coordinate at the inter-regional, inter-state and regional levels, especially regarding freight movement.

4. Plan for adapting transportation infrastructure to climate change impacts

Research on how a changing climate might affect transportation is in its early stages. While there is sufficient information today to begin to assess risks and implement adaptation strategies, further development of data and analysis would help planners, engineers, operators, and maintenance personnel as they create an even more robust and resilient transportation system, ultimately at lower cost. Key research opportunities include integrated climate data and projections, risk analysis tools and region-based analysis.

Research is needed to develop replicable and efficient techniques to inventory transportation infrastructure vulnerabilities to climate change impacts such as sea level rise, storm surge, and flooding. Studies to date on climate change and transportation, such as, a Gulf of Mexico study⁹ have started these inventories, but are not at the level of detail that would allow for effective local decision-making on transportation planning. King County, Washington has used available climate change information from University of Washington researchers as a guide to increasing the capacity of their transportation infrastructure to withstand higher river flows including building one major bridge over the Snoqualmie River higher and longer, reinforcing smaller bridges, expanding culvert size under roadways, and using permeable pavement and rain gardens in road projects. Additionally, King County has worked with the same researchers to develop a GIS tool to assess the vulnerabilities

⁹ Final Report of Synthesis and Assessment Product 4.7, Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study. <http://www.gcrio.org/library/sap-final-reports.htm>

of their 31 wastewater treatment facilities around Puget Sound to sea-level rise, storm surge, and tides—a tool that can also be applied to assessing transportation infrastructure vulnerabilities.

CCAP sees the need for *national climate services extension networks*¹⁰ to provide customized information and technical assistance to better adapt transportation planning, infrastructure and operations to climate change impacts, including:

- Best practices in evacuation planning and execution
- Hardening of buildings to create safe shelters that avoid the need to evacuate (e.g., Florida International University Campus Library)
- Research on innovative materials and material standards for transportation infrastructure to withstand climate extremes (e.g., cold for permeable pavement; heat for rails);
- Research how to mitigate subway flooding.

Other opportunities include:

- Interagency Joint research conducted by NOAA, EPA, DOT, DOE, U.S. Geological Survey, DOE, National Center for Atmospheric Research, with State, regional and local transportation planners to **develop climate change scenarios**, including probabilities of occurrence, and evaluate risks to transportation infrastructure under the scenarios;
- FEMA research to **update flood maps** that reflect climate change scenarios, and use these to evaluate transportation infrastructure vulnerability;
- Research to improve **transportation and weather data collection and integration**, including from fixed and mobile, sources to improve the resilience of transportation systems to climate extremes; and
- Research on the **impact of future development patterns on the vulnerability** of infrastructure, natural resources and communities to climate change impacts (e.g., development in floodplains, coastal and desert areas, slope instability).

Summary

We are about to invest some \$500 billion on transportation infrastructure. Or at least we need to. How can we find the courage and vision to generate the revenue streams needed to maintain, improve and thoughtfully expand our transportation system? I think of the \$500 billion as an investment in a robust economy, in a sustainable environment, in energy security and public health. I believe that the ambitious research agenda I propose would provide critical support for a performance-based approach to transportation policy, grounded in verifiable facts, sound analysis and accountability for outcomes.

It used to be that when driving somewhere new, we sometimes had to stop at the gas station to ask for directions. Now we can be thankful for our GPS navigators, and for the research, technology, data and information systems that make them work. To address climate change, to help our economy thrive - we have a pretty good idea of where we need to go, but we're not exactly sure how to get there. We're not lost, but we need navigation guidance.

A robust and applied research effort can provide that guidance for us. High quality data and reliable information systems will be critical, so we don't have to listen to that the electronic voice say "recalculating" or "lost satellite reception." I look forward to the Subcommittee's leadership in guiding us forward to hear, "now arriving at destination!"

I would be happy to respond to any questions the Subcommittee may provide. Thank you.

¹⁰ For more information on CCAP's approach to national climate services and extension networks, see Appendix B and the Urban Leaders Adaptation Initiative: <http://www.ccap.org/index.php?component=programs&id=6>

APPENDIX A:**Further Travel Data, Model Improvement
& Research Opportunities**

Below I offer additional detail on travel data improvement opportunities:

Travel Data Improvements

- Provide stable funding for the National Household Travel Survey (**NHTS**) at a frequency appropriate to inform transportation, energy and climate planning, policy design and evaluation
- Improve land use, travel patterns and demographic data in the NHTS and the ACS
- Re-instate the Vehicle Inventory and Use Survey (**VIUS**) to provide information on truck characteristics and truck travel.
 - Expand the VIUS to include buses and passenger cars.
- Develop a **national rotating panel** on vehicle and fuel use (e.g., 5,000 participants at any time, done quarterly, with participants tracked for a year).
- Re-recruit people already in several travel surveys across many regions of the Nation and to design a plan that stratifies regions by type and size.
- Add fuel use diaries to the EIA Residential Energy Consumption Survey.
- Expand coverage and increase the detail on the Commodity Flow Survey (**CFS**).
- Determine how State departments of taxation fuel track **fuel sales data**, whether these can be mapped to specific retail service station locations, and what it would take and cost to process such data to be available at the metropolitan regional level, State level and aggregated to the national level.
- Examine how the IRS ExSTARS data base can be used to identify the State of destination for gallons of motor fuel sold to better determine how much fuel to attribute to each State. This would improve data currently used in formulas that apportion federal funds to the States.
- Survey design and implementation refinements:
 - Conduct travel surveys in census years.
 - Include weekend data in any survey effort.
 - Improve consistency and sampling coverage and reduce margin of error.
 - Synchronize vehicle classification reporting and collection methodologies.

Additional Research Opportunities

- Demographic and market trends influencing demand for different real estate products
- Induced investment and travel shifts resulting from highway infrastructure, transit and high-speed rail investment
- Impediments to local implementation of regional smart growth plans including fiscalization of land use
- Impacts of 'black swan' events on travel and the economy, such as unprecedented and sustained increases in energy price.

APPENDIX B:

Detailed Transportation Adaptation Research Opportunities

CCAP sees a need for the Federal Government in collaboration with public universities, companies, states, and technical experts around the country to work to establish national climate services and extension networks to aid State and local governments in implementing climate change solutions.¹¹ These networks should provide information and technical assistance on:

- adaptation planning and risk management best practices;
- models, data, decision support tools, hardware, and systems improvements; and
- early warning on weather and climate impacts.
- These networks should help local governments and communities, particularly in urban areas, to **prepare for and cope with climate impacts** such as severe storms, flooding, sea-level rise, drought, wildfire, and heat island effects.
- These networks should **improve climate related decisions across diverse sectors** such as emergency management, building codes and zoning, ecosystem services, transportation, and water supply and wastewater infrastructure.
- In practice, **merging a classic agricultural extension model with a community organizing and education approach** will ensure that local decision-makers, businesses, and citizens will have the resources and information to understand their climate risks, and the opportunity to learn about and participate in solutions to reducing greenhouse gas emissions, preparing for extreme weather, planning ahead for real and emerging climate change impacts, and increasing overall community resilience.
- Sample transportation climate extension activities:
 - Research, monitor and test of **pavement designs** for roads and parking lots to determine optimum reflectivity and thermal properties to lower urban heat island effects and permeability characteristics to address extreme rainfall and flooding.
 - Assess **frequency and severity of flood impacts** along different road segments under historical and climate change scenarios to determine persistent vulnerabilities in order to assist with travel and evacuation planning.
 - Work with emergency managers to **educate the public, particularly vulnerable populations**, on the basics of severe weather (e.g., hurricanes, tornadoes, flood, heat) under different climate changes scenarios and what to do in case of emergency or evacuation including shelter in place strategies.
 - Strengthen the capabilities of federal agencies, such as, the National Hurricane Center to convey information to local decision-makers and the public at the nexus of **climate change and hurricane preparedness and planning**. Information could include FAQs on the impact of climate change on hurricane frequency and intensity, evacuation planning software tools tailored for local emergency managers, enhancement of flood and storm surge maps, support for community readiness planning, and community vulnerability assessment tools.

¹¹ CCAP Urban Leaders Adaptation Initiative: <http://www.ccap.org/index.php?component=programs&id=6>

FINAL: January 30, 2009



CCAP Travel Data and Modeling Recommendations to Support Climate Policy and Performance-Based Transportation Policy

Informed by stakeholder discussions in the
CCAP VMT & Climate Policy Dialogue

In an era of shrinking budgets and transportation systems falling short of meeting community needs, there is a growing call for a performance-based approach to transportation policy. The new emphasis on addressing climate change and reducing petroleum dependence reinforces this point. However, current data, models and planning capacity are not up to the task.

Accurate, timely and geographically-specific travel data and planning capacity are critically needed to effectively plan, manage and evaluate transportation system performance across a range of issues including economic efficiency, metropolitan accessibility, greenhouse gas (GHG) emissions, safety and system preservation. Transportation researchers and policy analysts have identified deficiencies in the quality, resolution and timeliness of travel data. State and local governments recognize the need, but are concerned about their ability to pay for travel data improvements. Key travel data collection efforts have been defunded or terminated in recent years.

That is why members of the Center for Clean Air Policy's VMT & Climate Policy Dialogue,¹ a diverse group of governments, advocacy groups and industry, have identified improvements in travel data as a high priority to support policy design, implementation and evaluation. The group discussed at length options for improving travel data to support climate policy and a performance-based approach to transportation policy. The recommendations below reflect the group's general consensus of policies that, if followed, would be of great value to climate and transportation policy design, implementation and evaluation.²

¹ CCAP has convened a unique dialogue of top thinkers and decision makers with expertise in transportation policy, climate policy, smart growth planning and air quality regulation to explore, debate and develop effective and tenable policy packages for reducing GHG emissions associated with travel demand or vehicle miles traveled (VMT) in upcoming climate and transportation legislation. CCAP is carrying out the VMT and Climate Policy Dialogue using its well-tested approach of bringing diverse interests together to share lessons learned, consider diverse view points and develop a common understanding of potential policy options. The premise of the dialogue is that slowing VMT growth and increasing system efficiency are needed to complement vehicle efficiency improvements mandated in the 2007 Energy Bill, a potential CO₂ cap on petroleum refiners and any low carbon fuels standard in meeting long-term climate protection goals.

² CCAP is preparing a supplemental memo listing some specific recommendations to make the overarching recommendations more actionable (e.g., re-establish VIUS survey).

**CCAP Recommendations to Improve Travel Data and Modeling
to Support Climate Policy and Performance-Based Transportation Policy**
FINAL: January 30, 2009

General Observations

1. High quality data are essential for performance-based transportation policy with implications across a broad range of national priorities including climate change, system efficiency, metropolitan accessibility, economic development, safety, system preservation and petroleum use.
2. Developing, implementing and evaluating GHG reduction policies will require improved travel data and modeling capacity.
3. The required precision, resolution and quality of data and modeling will vary by application (planning, policy evaluation, financing, regulation).

Key Recommendations for Improving Travel Data and Modeling

1. **Substantially Increase Funding for Travel Data Improvement:**
 - a. Travel, fuel use and land use data collection and improvement
 - b. Research and analysis
 - c. Travel modeling improvements
 - d. Fuel economy measurement
 - e. Cross-agency coordination at the federal, state, MPO and local levels
2. **Improve Quality and Utility of Travel Data**
 - a. Conduct a study and develop recommendations on the highest priority data and modeling improvements with recommendations for, and participation from, federal, state, MPO and local governments, as well as experts from the private sector, academia and NGOs.
 - i. Assess the costs and benefits of collecting and integrating travel and fuel use data from multiple sources to fill holes, corroborate data and assess interactions among policy variables.
 - ii. Assess the appropriate level and rigor of data for different uses and users.
 - b. Assess the costs and benefits for states to process, collect and analyze odometer data to track local travel behavior and determine land use influence on travel to aid policy evaluation and improve predictive capabilities of travel models.
 - c. Enhance collection and analysis of freight data
3. **Enhance Travel and Emissions Modeling Capacity**
 - a. Improve travel and emission modeling capability to address GHG concerns: CO₂ vs. speed and traffic flow, induced demand, land use, geographic and temporal resolution, transit, non-motorized travel, freight, fuel price sensitivity, and macro system efficiency. This will require improved travel data.
 - b. Provide resources to help states, MPOs and local governments to enhance modeling capacity and shift towards advanced travel models while maintaining and improving current models.

**CCAP Recommendations to Improve Travel Data and Modeling
to Support Climate Policy and Performance-Based Transportation Policy**
FINAL: January 30, 2009

4. **Improve Accuracy and Reliability of Fuel Economy Measurements**
Provide resources to expand testing of real-world vehicle fuel economy, continue to develop better driving cycle tests, and conduct research to develop better ways to predict the fuel economy any individual will get.
5. **Coordinate and Collaborate Across Government Agencies and Levels of Government** to support data corroboration, quality assurance, policy design and evaluation.
 - a. Share, compare, and integrate complementary data sets (travel, fuel sales, fuel economy, GHGs, demographics, land use) and establish procedures for data corroboration.
 - b. Analyze data and conduct research to understand relationships among policy variables and inform policy design.
 - c. Provide guidance, technical support, tools and information on: data collection, data integration, model improvement, planning, scenario analyses, best practices, policy design, implementation and evaluation.

**CCAP Recommendations to Improve Travel Data and Modeling
to Support Climate Policy and Performance-Based Transportation Policy**
FINAL: January 30, 2009

Representatives from the following organizations participated in the VMT & Climate Policy Dialogue Meetings:

AASHTO	National Governors Association
ACEEE	New York City DOT
APTA	New York State Department of Environmental Conservation
Arlington County, VA	North Carolina Division of Air Quality
AMPO	North Central Texas Council of Governments
Bay Area Rapid Transit	NRDC
BBG Group	Pennsylvania DOT
Bi-Partisan Policy Institute/NTPP	Rails to Trails
BP	Sacramento Air Quality Management District
Brookings Institution	Sacramento Area Council of Governments
California Air Resources Board	Serafix
Clean Air Task Force	Smart Growth America
East-West Gateway COG	STPP
Entergy	Transportation for America
Environmental Defense Fund	UC Berkeley
Exxon Mobil	US EPA
Federal Highway Administration	Utah DOT
Ford Motor Company	Van Ness Feldman
American Honda Motor Company	Veolia Transportation North America
Kansas DOT	Virginia DOT
Maryland DOT	WRI
Metropolitan Transportation Commission	

For more information, please contact:

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About the Center for Clean Air Policy

Since 1985, CCAP has been a recognized world leader in climate and air quality policy and is the only independent, nonprofit think-tank working exclusively on those issues at the local, national and international levels. Headquartered in Washington, D.C., CCAP helps policymakers around the world to develop, promote and implement innovative, market-based solutions to major climate, air quality and energy problems that balance both environmental and economic interests.

For more information about CCAP, please visit www.ccap.org.



BIOGRAPHY FOR STEVE WINKELMAN

Steve Winkelman, Director of the Transportation and Adaptation Programs at the Center for Clean Air Policy (CCAP), has more than 17 years of experience in the transportation, energy and environmental fields. He is a co-author of the book, *Growing Cooler: The Evidence on Urban Development and Climate Change*, published in 2008 by the Urban Land Institute.

Steve directs CCAP's VMT and Climate Policy Dialogue, which engages top decision-makers and leading experts on integrating transportation and climate change policies. He has successfully focused the attention of key policy-makers on the importance of slowing growth in VMT (vehicle miles traveled) for reducing transportation sector GHG emissions, and has testified to two Congressional committees on the subject. Steve directs CCAP's Urban Leaders Adaptation Initiative, which as-

sists ten partner cities and counties in increasing their resilience to the impacts of global climate change.

Steve provides technical and policy assistance in developing and implementing climate change policy to government officials in places such as California, Connecticut, Chile, King County, Mexico and New York. He developed the *CCAP Transportation Emissions Guidebook* with tools for quantifying GHG savings from 40 transportation policies and measures including feebates, biofuels, smart growth, pricing strategies and inter-modal freight.

Prior to joining CCAP, Steve managed ICF Kaiser's Climate Wise industrial energy efficiency work for the U.S. EPA. At Argonne National Laboratory he designed, built and tested a magnetically levitated vehicle (maglev). Steve holds a BS in Physics from the University of Michigan, and an MA in Public Policy from the University of Minnesota. Steve is an active member of the National Academy of Sciences' Transportation Research Board Sustainability Committee. <http://www.ccap.org/index.php?component=issues&id=9>

Chair Wu. Thank you, Mr. Winkelman.

Mr. Acott.

STATEMENT OF MR. MIKE ACOTT, PRESIDENT, NATIONAL PAVEMENT ASSOCIATION

Mr. ACOTT. Good morning, Mr. Chair and Members of the Subcommittee. I very much appreciate the opportunity to chat with you this morning. I am very pleased to report to you that we are on the verge of several major breakthroughs in the area of asphalt pavement technology which with your help we think are going to be transformative.

The reason why this is so important is the sheer scale of asphalt pavement infrastructure. Of the 2.6 million miles of paved roads in the United States, over 94 percent of those roads are surfaced with asphalt. Approximately 85 percent of the Nation's airfield pavements and parking lots are also surfaced with this material. Because of the extensive use of this material, small changes in technology will make a big difference in greenhouse gas emissions.

I would like to touch on two such technologies and the research needed to accelerate deployment. My written testimony actually discusses four technologies: warm-mix, recycling, perpetual pavement and porous asphalt. However, I am going to focus on the first two because they have created an unprecedented amount of interest from our stakeholder partners.

If you look at a cross-section of asphalt, and I am showing a cross-section of asphalt here, you can actually see the crushed-stone particles of various sizes. These are held together with a mortar of asphalt cement or glue and fine particles. These materials are combined in the mixing facility. They are dried and they are mixed with the asphalt binder, which is the black glue. Typically the composition of asphalt is about five percent asphalt cement and about 95 percent of stone, sand, and gravel. How the material is manufactured, the ingredients used in the mix are key to understanding what the opportunities are for reducing greenhouse gas emissions.

The first very exciting technology for us is warm-mix asphalt. Warm-mix asphalt allows for the production and placement of asphalt pavement materials at much lower temperatures than conventional technologies. Running warm-mix can reduce energy consumption during the manufacture of asphalt pavement by an average of 20 percent. This would equate to about a million tons reduction in greenhouse gases. So far, implementation of warm-mix has

proceeded with virtually no complications. We do that in partnership with the State DOTs, the Federal Highway Administration, EPA, NIOSH [National Institute for Occupational Safety and Health] and our labor union partners. Warm-mix also makes it possible for us to increase the rate of recycling or reuse of asphalt pavement. Research on this topic could be very helpful in speeding up the rate of acceptance. Research funding would also be needed for emissions studies and for monitoring the long-term performance.

The second very exciting technology is recycling. The use of reclaimed asphalt pavement has been widespread for about 30 years. Asphalt pavement is America's most reused or recycled material. Every year more than 100 million tons of asphalt pavement is reclaimed and recycled. Virtually all of it is recycled back into asphalt pavement. A singular quality of asphalt pavement is that you can actually restore and rejuvenate the asphalt binder in the pavement. You can actually bring it back and replace it one for one for conventional virgin asphalt cement. In other words, it becomes an integral part of the binder. This is referred to as the highest and best use. No other pavement material has this unique quality. With high reuse/recycling rates in many states and the evidence of the very good performance recycled pavement, we believe that there is great opportunity to double the quantity of recycled material within a five-year period. For asphalt pavement, it is possible to reduce greenhouse gas emissions simply by incorporated recycled asphalt pavement in new pavement. Currently the average recycling rate is about 12 percent in asphalt. We believe that this could be doubled and it will save about two million tons annually. We also estimate we have about 18 billion tons of asphalt pavement already in place on America's roads and highways, and because of the ability to reuse and recycle this material indefinitely, our existing highways are a resource for future generations.

In closing, Mr. Chair, Members of the Subcommittee, NAPA recommends in the next surface transportation bill that we should include asphalt pavement research and accelerated deployment program. This program should be focused on the four core areas described in my testimony: warm-mix, recycling, perpetual pavement and porous asphalt. We believe that it should be led by the Federal Highway Administration. This program should bring together all of the stakeholders from government, industry, academia, labor unions, and EPA on these core topics. We also recommend a very modest \$10 million per year for this program.

Mr. Chair, with this investment, within the next five years I believe we will see full deployment of warm-mix, you will see much higher rates of recycling, you will see the development and application of perpetual pavement technologies, and you will see much more extensive use of porous asphalt technologies. All of these will lead to a substantial reduction of greenhouse gas emissions and other environmental and economic benefits.

Thank you again, Mr. Chair and Members of the Subcommittee. Thank you.

[The prepared statement of Mr. Acott follows:]

PREPARED STATEMENT OF MIKE ACOTT

Mr. Chairman and Members of the Subcommittee on Technology and Innovation, thank you for the opportunity to present testimony on the role of research in addressing climate change in transportation infrastructure. I am Mike Acott, President of the National Asphalt Pavement Association (NAPA).

NAPA represents asphalt pavement producers and related industries at the national level. Asphalt pavement material is composed of approximately five percent asphalt cement and 95 percent stone, sand, or gravel. Of the 2.6 million miles of paved roads in the United States, over 94 percent are surfaced with asphalt. Approximately 85 percent of the Nation's airfield pavements and 85 percent of the parking lots are also surfaced with asphalt. There are about 4,000 asphalt mixing plants located in the United States and the industry employs, directly or indirectly, 300,000 U.S. workers. Because of the vast extent of use of this material, even small changes in asphalt pavement technology can make a big difference in terms of greenhouse gas emissions.

Annual U.S. production is around 500 million tons of new asphalt pavement material, including about 60 million tons of reclaimed material that is reused or recycled directly into pavements every year.[1] Additionally, about 40 million tons of reclaimed asphalt is reused or recycled into other pavement-related applications each year.[1] When asphalt pavement is reused, the asphalt cement in it is rejuvenated so that it becomes an active part of the binder in the new pavement. This unique quality of asphalt cement means that asphalt pavement is a renewable material.

Asphalt pavement reuse and recycling is ubiquitous in this country. Reuse/recycling and other sustainable technologies are so completely integrated into our normal processes that virtually all 300,000 of our workers could be considered green collar workers.

NAPA has a long history of developing and promoting innovations that enhance sustainability, energy efficiency, and the other environmental and economic aspects of asphalt. The industry and its partners have worked for the past two decades on technologies to reduce air emissions including greenhouse gases and other contributors to climate change, and to enhance environmental sustainability in other ways. Greenhouse gas-reducing technologies include warm-mix asphalt, reuse/recycling, and Perpetual Pavement. Also of interest are porous asphalt pavements, which improve water quality and provide for more harmonious, rational land-use policies.

None of this would have been possible without a vibrant research and technology deployment program. Leading the asphalt research effort is the National Center for Asphalt Technology (NCAT) in Auburn, Alabama, which originally was endowed by industry and today is directed by a public-private partnership. With its 1.7-mile pavement test track and its 40,000-square-foot research facility, NCAT conducts a productive, \$5 million per year research program that focuses on innovations that directly affect and improve the roads we drive on every day.

The industry produces a sustainable, environmentally friendly material that is adaptable to different climates and end-use applications. Due to high variability in climates, traffic loading, and locally available materials, the design of asphalt pavement mixes is a complex process that must be based on sound engineering principles.

An important aspect of the industry's research program is that it is based on partnering. NAPA's partners in current and past initiatives include the Federal Highway Administration (FHWA), the Federal Aviation Administration (FAA), the American Association of State Highway and Transportation Officials (AASHTO), the State Departments of Transportation (DOTs), the Transportation Research Board (TRB), the U.S. Army Corps of Engineers, the Environmental Protection Agency (EPA), related industry associations, the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the labor unions. We also have a broad range of international partners with whom we share knowledge, conduct joint research, and cooperate on industry matters.

Superpave was an important breakthrough in asphalt pavement technologies. It was developed with federal funding under the Strategic Highway Research Program (SHRP) in the late 1980s and early 1990s. Superpave gave us pavement design approaches that have enhanced the performance and durability of pavements in many ways. Superpave has become so widely accepted that use of the term is actually disappearing—what used to be called the Superpave design system is now the norm for designing asphalt pavements in much of the U.S.

One example of NAPA's partnering approach is the initiative that began in the late 1980s in which NAPA worked with EPA on research into air emissions including greenhouse gases from asphalt plants. The studies showed that emissions from

asphalt plants are low and well controlled, and resulted in EPA declaring that asphalt plants are not major sources of hazardous air pollutants.[2] In fact, total emissions from asphalt operations decreased by 97 percent from 1970 to 1999, while production of asphalt pavement material increased by 250 percent.[3] The industry is proud of its record of environmental stewardship and its proactive position of continuously reducing emissions, including greenhouse gas emissions.

As requested by the Subcommittee, NAPA's testimony will address the following questions:

1. Is research needed to help address climate change and other environmental issues in transportation infrastructure? What purpose would it serve?
2. What issues and topics should be encompassed within a research agenda to address climate change and other environmental issues in transportation infrastructure? How should the research agenda be implemented?

With Congress and this Subcommittee preparing for the authorization of a new transportation bill, it is appropriate to review what has been accomplished in developing sustainable asphalt pavement technologies and establish goals for applied research and accelerated deployment of such pavements.

In the next five years, we can achieve significant gains in addressing climate change by accelerating research and deployment of technologies that reduce greenhouse gas emissions. These include warm-mix asphalt, reuse/recycling, and Perpetual Pavements. Also worthy of attention are porous asphalt pavement technologies.

By 2014, with assistance in applied research and technology deployment that may be provided through the next highway bill, we can increase use of warm-mix asphalt to represent the majority of all the pavement material produced in the U.S.; we can double the reuse/ recycling of asphalt pavements; make Perpetual Pavements the standard design method; and have porous pavements accepted as a best management practice for reducing stormwater runoff and improving water quality.

The industry and its partners have come a long way in reducing contributions to climate change. More research and technology deployment funding is needed in order to hasten the pace at which these innovations are adopted. We believe there is a critically important role for the Federal Government in helping to fund the development and evaluation of these new technologies, assess their long-term performance, and ensure their deployment.

A primary focus should be to get greenhouse gas-reducing technologies onto the roads in all the states. We are well poised to make this happen, with your help.

Asphalt Pavement Research To Help Address Climate Change and Other Environmental Issues

There are four technologies that have the potential to be transformational in the field of sustainable pavements. These include warm-mix asphalt, reuse/recycling, Perpetual Pavements, and porous asphalt.

Warm-Mix Asphalt

Warm-mix technologies allow for production and placement of asphalt pavement material at lower temperatures than conventional technologies. Conventional asphalt pavement material is produced at around 320°F and warm-mix is typically produced at temperatures ranging from 280°F down to 212°F.[4] Since the first public demonstration of warm-mix in the U.S. in 2004, warm-mix projects have been constructed in all but ten states.

Warm-mix was originally explored for its environmental benefits, which include reduced fossil fuel consumption and reduced emissions, including greenhouse gas emissions. Contractors and agencies have also discovered numerous construction benefits, including the potential to extend the paving season in northern climates, the potential to store pavement mix for longer periods, a longer window of opportunity for compacting pavement, and increases in recycling rates.

Running warm-mix can reduce energy consumption during the manufacturing of the asphalt pavement mixture by an average of 20 percent, which decreases total life cycle greenhouse gas emissions by five percent. This equates to one million tons offset annually. Combining warm-mix with reuse/recycling yields even greater benefits. Warm-mix with 25 percent reclaimed asphalt pavement could potentially offset asphalt pavement life cycle greenhouse gas emissions by 15 to 20 percent. The potential for total savings in greenhouse gas emissions using both warm-mix and recycling is about three million tons per year.

NAPA, FHWA, AASHTO, and researchers created a Technical Working Group whose purpose is to evaluate warm-mix technology performance, quantify environ-

mental benefits, develop performance specifications, provide technical guidance, and disseminate information. The partnering approach has been of immense support to efforts to deploy warm-mix.

So far, implementation has proceeded with virtually no complications.[5, 6, 7, 8, 9, 10] Demonstration projects, trials, and test projects have included the full variety of asphalt mixture types. At least 10 states have adopted permissive specifications, clearing the way for contractors to produce and place the mix at low temperature as long as it meets all other criteria.

Experience with applied research and technology development suggests that warm-mix may make it possible to increase the rates of reuse/recycling even further. Applied research on this topic could be helpful in speeding the rate of acceptance of combining the two technologies.

Another opportunity for applied research is full documentation of emission reductions, with specific focus on greenhouse gas emissions. Such research would assist also agencies in taking full advantage of warm-mix to meet air quality guidelines. Research funding will be needed both for emissions studies and for monitoring of long-term pavement performance.

Doubling the Use of Reclaimed Materials in Asphalt Pavements

The use of reclaimed asphalt pavement (RAP) has been widespread for about 30 years.[11] Asphalt pavement is America's most recycled material. Every year, more than 100 million tons of asphalt pavement material is reclaimed and virtually all of it is reused or recycled into new pavements. Materials from other industries, including roofing shingles and ground rubber from used tires, can also be beneficially incorporated into asphalt pavements. The key to this is sound engineering, design, and technology.

Consumption of fuels in the process of acquiring and processing raw materials accounts for a significant share of the greenhouse gas emissions associated with producing asphalt pavement material. Therefore, it is possible to reduce greenhouse gas emissions simply by incorporating RAP in new pavement. Currently, the average rate of reuse/recycling is 12 percent. These numbers include both states that routinely use 30 percent RAP and states that permit minimal use. Using 25 percent RAP reduces total life cycle greenhouse gas emissions by 10 percent, which equates to two million tons offset annually.

A singular quality of asphalt cement is that it is rejuvenated when RAP is incorporated into new pavement, becoming an integral part of the binder. This is referred to as the highest and best use.

In view of the high reuse/recycling rate in lead states, including a preponderance of evidence that the quality of asphalt pavements incorporating RAP is equal to or better than pavements using all virgin materials, there is ample opportunity to double the quantity of RAP used within five years.

Part of the challenge is to encourage agencies in rural areas to allow milling on pavements prior to the placement of asphalt overlays. This will provide more material for recycling in areas where RAP is scarce, and it will improve the performance of the rehabilitated pavement by removing distresses from the existing surface.

Reuse/recycling is not only an environmentally sustainable practice, it is an economically sustainable one. NAPA estimates that we have 18 billion tons of asphalt pavement already in place on America's roads and highways. Because of the ability to reuse and recycle this material indefinitely, our highways are a resource for future generations. Not only are our roads a primary engine of the economy, they have a high residual value as a source of construction materials. As a note, the process of reclaiming and processing these materials has a very low environmental impact.

FHWA has organized the RAP Expert Task Group (ETG), which brings together stakeholders from government, industry, and academia to investigate obstacles to increasing RAP use. As part of this mission, the ETG has identified states with particularly high and particularly low levels of reuse/recycling. The ETG is also charged with achieving the desired increases through technology transfer/accelerated deployment strategies, and eliminating artificial and arbitrary barriers to increased recycling in favor of performance-based pavement criteria.

There are also opportunities for applied research, including quantifying the environmental benefits of increased RAP use, developing technologies and procedures to recycle high percentages of reclaimed material, developing technologies and procedures to better preserve the aggregate gradation in RAP, and improving performance testing methods and specifications for use of RAP and roofing shingle mixtures. All these activities would contribute to increasing the overall rate of recycling and therefore reductions in emissions of greenhouse gases.[12]

Perpetual Pavement

Perpetual Pavement is the name given to an asphalt pavement that is designed not to fail. Construction is in layers whose properties serve a combination of different functions; they all add up to an extraordinarily long-lasting pavement. Surface distresses may occur eventually, but they do not penetrate deep into the pavement's structure. Routine maintenance involves infrequent milling of the top layer for recycling, then placing a smooth, quiet, durable, safe new overlay. A Perpetual Pavement never needs to be completely removed and replaced. In the world of pavements, this is the ultimate in economic and environmental sustainability.

Perpetual Pavements can mitigate climate change by reducing greenhouse gas emissions, both now and for generations to come. Perpetual Pavements reduce greenhouse gas production several ways. Since only the surface is renewed, the base structure stays in place, thereby significantly reducing greenhouse gases associated with virgin raw materials acquisition and placement. Greenhouse gas emissions associated with complete removal and replacement of pavements that have reached the end of their useful life is avoided.

Additionally, greenhouse gas emissions associated with construction delays are greatly reduced because maintenance and rehabilitation can be done quickly in off-peak hours, unlike the remove-and-replace option, which necessitates 24-hour road closures. Limiting closures to off-peak hours can reduce delays for road users by at least a factor of 12.

Perpetual Pavements are more cost-effective than traditional asphalt pavements while enhancing durability, performance, and long life. Reuse/recycling is part of the maintenance and rehabilitation process.[13] All these factors conserve construction materials and reduce greenhouse gases.

Once the road is constructed, it becomes a permanent asset within the transportation infrastructure system. A Perpetual Pavement never becomes a reconstruction problem for future generations.

Perpetual Pavements can also keep roads smoother. Significant fuel savings are associated with smooth pavements. It has been documented under tightly controlled conditions that driving a heavily loaded truck on a smooth road consumes about 4.5 percent less diesel than driving on a rough one.[14]

The history of Perpetual Pavements goes back to the 1960s, although the term was not used until around 2000. Full-depth asphalt pavements first achieved wide acceptance in the 1960s as a way of minimizing materials use and construction costs.¹¹ At that time, it was assumed that the design would result in a "20-year design life," but experience has shown that such pavements have lasted for over 40 years with no sign of structural failure. Engineering studies in the States of Kansas,[15] Minnesota,[16] Ohio,[17] Oregon,[18] and Washington[18] have validated these observations.

Beginning in 1999 and 2000, asphalt pavement researchers initiated efforts to understand the engineering features and performance characteristics of Perpetual Pavements. Research has been conducted at NCAT, the Asphalt Institute, the University of California at Berkeley, the University of Illinois, and other leading institutions in the U.S. and around the world. The research has led to the development of materials, design methods, and performance criteria to enable agencies to design pavements that ensure long life without wasting materials due to over-design.

There are already many pavements around the United States that fit the Perpetual Pavement definition. In recognition of that fact, in 2001 the asphalt industry created a program to identify Perpetual Pavements and honor the agencies that have designed and maintained them. Fifty Perpetual Pavement Awards have been presented since that time.

There are many opportunities to accelerate deployment of Perpetual Pavement technologies. Full integration of Perpetual Pavement into the new AASHTO Mechanistic-Empirical Pavement Design Guide would be very helpful. Open houses, demonstration projects, conferences, publications, and webinars can also help to push implementation forward.

There are currently two national studies on Perpetual Pavement through the National Cooperative Highway Research Program (NCHRP) focused on the engineering characteristics that will be critical to the design of long-life pavements. Pavements have been constructed with instruments embedded in the various layers to ascertain their responses to truck loadings at a variety of locations. These include the NCAT Pavement Test Track and the Minnesota Road Research Project, as well as in highways located in Kansas, Ohio, Pennsylvania, Wisconsin, and other states. These will provide crucial information on the field behavior of Perpetual Pavements.

Significant opportunities for applied research on Perpetual Pavements include an investigation of high-stiffness base materials, which have the potential to reduce

both costs and greenhouse gas emissions, and research on the impact of these long-life pavements on climate change, specifically greenhouse gases.

In summary, Perpetual Pavements conserve natural resources, reduce life-cycle costs, save fuel, and reduce fuel consumption and greenhouse gas emissions.

Porous and Open-graded Pavements

Porous and open-graded asphalt pavements have been shown to have a dramatic beneficial effect on water quality. These pavements have been used widely for over 30 years with an excellent record of success. Open-graded pavement is made with same-size rocks, creating a web of interlocking pores that allow water to flow through the surface.[19]

Open-graded pavements are used mainly in two types of applications. First, open-graded friction courses are widely used for surfacing roads and highways. The pavement layer directly beneath this is impermeable. During a rainstorm, instead of pooling on the surface or bouncing off it, rain drains through the surface and out to the sides. Splash and spray are greatly reduced, enhancing safety. Second, porous pavement systems are stormwater management tools with an open-graded surface over a stone recharge bed. The system is designed and constructed to collect stormwater, which then infiltrates into the ground. Porous pavement systems are used mostly for parking lots, but they have also been used successfully for roads in communities like Pringle Creek in Salem, Oregon.[20]

Both applications can be used to improve water quality. Porous asphalt surfaces allow roads and highways to function as linear stormwater management systems. Porous parking lots store stormwater, reduce runoff, promote infiltration and groundwater recharge, allow evaporative cooling of the atmosphere, diminish erosion on stream banks, reduce particulates in stream water after storms, and improve water quality.[21]

Porous asphalt pavements are accessible and affordable. They can be produced and constructed by any qualified contractor. Open-graded highway surfaces have additional environmental and safety benefits. They reduce road noise significantly.[22, 23, 24, 25, 26] Texas DOT reported that replacing a conventional surface with open-graded friction course in a high-accident area reduced wet-weather accidents by 93 percent and reduced fatalities by 86 percent.[27]

With respect to porous pavement systems for stormwater management, some local authorities may allow the construction of porous pavement systems but still require total redundancy with the use of conventional stormwater management structures.[28] Applied research documenting the effectiveness of porous pavements, together with a program of continuing education, could be helpful. It is important to recognize, however, that porous pavements are not appropriate for all sites, and therefore legislative or regulatory mandates for porous pavement systems would be counterproductive.

The significant benefits of porous asphalt make it desirable to accelerate their deployment. There are many opportunities to do so. Applied research, demonstration projects, open houses, Web-based tools, and other continuing education efforts focusing on the use of porous asphalt could result in accelerated deployment.

Implementation could be further assisted through development of design guidance for use by Federal Government agencies such as the DOT, EPA, Corps of Engineers, Parks Service, Forest Service, and National Fisheries Service.

Opportunities for applied research include documenting the environmental effectiveness and cost benefits of porous asphalt pavement, improving materials and mix designs, and evaluating highways as linear stormwater management systems.

A Model for Implementation

Many of our nation's highways and bridges need significant improvement and this needs to be done in an environmentally sustainable way. An ongoing asphalt pavement research and technology program aimed at continuous improvement in the performance and environmental sustainability of asphalt pavements is vital to the national interests.

We believe that significant progress in the reduction of greenhouse gases and improvement in overall sustainability of asphalt pavements can best be achieved through a federally led, nationally coordinated applied research and implementation effort. An inclusive, well-coordinated national effort is necessary to foster a strong legacy of technological advancement in asphalt pavement knowledge and practice.

Therefore, we urge the House Science and Technology Committee to authorize an Asphalt Pavement Research, Technology Development, and Accelerated Deployment Program focused on increasing the reuse and recycling of asphalt pavements, increasing the acceptance and deployment of warm-mix asphalt, advancing the adop-

tion of Perpetual Pavements as a standard pavement design, and furthering the use of porous asphalt. The program should allow for broad intellectual competition, and be directed by a consensus of stakeholders with the Federal Highway Administration in the lead.

We also recommend that Congress provide \$10 million annually in the next transportation reauthorization bill for the Asphalt Pavement Research, Technology Development and Accelerated Deployment Program. With this modest investment, significant reductions in greenhouse gas emissions would be very achievable during the next reauthorization period.

Through partnership with Federal and State governments, industry, and academia, we can develop and implement improved asphalt pavement and material technologies that ensure the continued delivery of safe, economical, and environmentally sustainable pavements that meet our nation's needs.

Closing

Allow me to close by summarizing the benefits that would result from this program.

- A conservative estimate of reductions in greenhouse gas emissions through full implementation of warm-mix asphalt is one million tons per year.
- Doubling the reuse/recycling rate to 25 percent could reduce greenhouse gas emissions by two million tons. Using warm-mix together with reuse/recycling could reduce greenhouse gas emissions by a total of approximately three million tons.
- Full deployment of Perpetual Pavements would not only improve the condition of America's roads, it would conserve construction materials and potentially reduce greenhouse gas emissions.
- Accelerated deployment of porous asphalt could turn highways into linear stormwater management facilities.

The following actions will help us achieve these targets:

To make warm-mix asphalt the majority of annual asphalt pavement production:

- Full documentation of emission reductions, with specific focus on greenhouse gas emissions
- Monitoring of long-term pavement performance.

To double the use of reuse/recycling:

- Further quantify the greenhouse gas reduction and other environmental benefits of increased RAP use using an accurate and recognized life cycle assessment model
- Develop technologies and procedures to recycle high percentages of reclaimed material
- Develop technologies and procedures to better preserve the aggregate gradation in RAP
- Improve performance testing methods and specifications for use of reclaimed asphalt pavement and roofing shingle mixtures.

To accelerate full deployment of Perpetual Pavements:

- Investigate high-stiffness base materials, which have the potential to reduce both costs and greenhouse gas emissions
- Conduct research on greenhouse gas reduction associated with these pavements.

To accelerate deployment of porous asphalt:

- Document the environmental effectiveness and cost benefits of porous asphalt pavement
- Improve materials and mix designs
- Evaluate highways as linear stormwater management systems.

In order to conduct the research and accelerate deployment, we respectfully request that you include \$10 million for the Asphalt Pavement Research, Technology Development and Accelerated Deployment Program in the authorization of the new highway bill.

The asphalt industry is committed to providing the best possible transportation facilities for America, with the least possible impact on the environment. Reducing

climate change is a priority for us. We look forward to working with you and the other Members of Congress as you prepare the research title in the next transportation reauthorization bill.

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to discuss the ways that research can help the asphalt pavement industry reduce climate change. I would be happy to entertain any questions you may have.

Thank you.

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BIOGRAPHY FOR MIKE ACOTT

Mike Acott is President of the National Asphalt Pavement Association (NAPA), the trade association representing asphalt paving producers, contractors, and suppliers. His career activities involve more than 30 years of experience in the pavement industry, including experience with aggregate and asphalt cement suppliers, and management of an asphalt construction company.

He has been the President of NAPA since 1992, and has led proactive strategies that have resulted in a continued improvement in the workplace environment and asphalt's long-term sustainability.

Mr. Acott has authored and co-authored many publications and reports on various facets of asphalt pavements. He has been active on the Transportation Research Board (TRB) and is a former ex-officio member of its Executive Committee and is a Board Member of the National Center for Asphalt Technology (NCAT). He has a B.S. degree in Physics and an M.S. degree in Civil Engineering.

DISCUSSION

Chair WU. Thank you very, Mr. Acott, and at this point we will open for our first round of questions, and the Chair recognizes himself for five minutes.

I would like to open with a layman's question. Mr. Winkelman, Ms. Ciarlo, you both referred to reduction for the need to commute. How much of the greenhouse gas emissions that we have seen in places where such reductions have been achieved, what percentage would you allocate to reductions in the need to commute or elimination of the need to commute versus all other sources combined such as more-efficient vehicles, better use of materials, et cetera?

Mr. WINKELMAN. Thank you for the question. I think looking back is different than looking forward because over the past couple of decades there hasn't been major improvement in vehicle efficiency. There has been great technology improvements that has gone into sort of increased weight and power so where we have seen reductions of greenhouse gas emissions, some of the biggest

benefits then are from increased travel choices, improved accessibility that allows for walk trips and shorter drive trips. In fact, the research on smart growth is interesting that the majority of the reductions come from shorter vehicle trips so it is not about getting everyone out of the car, it is having things closer together and more accessible. If we look forward over the coming decades, I agree that we will see the majority of reductions coming from vehicles and fuels and that there are major opportunities on the travel demand side of improving choices.

Chair WU. So Mr. Winkelman, looking back, virtually all the gains have been from reduction of the need to travel?

Mr. WINKELMAN. I would say for greenhouse gases, the majority are. For air pollution, it has been the other way around. Technology and fuels have done it.

Ms. CIARLO. Mr. Chair, thank you for the question. Looking at Portland's experience, I mentioned earlier that since 1996 we have seen an eight percent reduction in vehicle miles traveled and a one percent reduction in emissions over 1990 levels at a time when those things were both going up. I can share a few more statistics with you. Since that time, as Portland has developed our system, which includes a streetcar system, an expanding light rail network, 200 miles of bikeways, we have seen a number of developments that parallel those decreases in vehicle miles traveled and emissions. One of the interesting overall developments is that throughout the Portland region, not just in the central city, work trips have generally been reduced in length by 33 percent. Now, that really speaks to what you were talking about the smart growth element paying the kind of emission and trip reduction dividends that it is hard to quantify and that we would like to have tools to quantify it moving forward. We have also seen since 1991, so it dates back a little bit earlier, an increase in the bike mode share from around two or three percent of trips into downtown Portland to around 10 or 12 percent of trips into downtown Portland now. Again, we don't have a solid way of measuring the emissions reductions here, but we see a reduction in the overall numbers that I talked about earlier in my testimony.

And then in terms of transit, since 1990 we have had a 16 percent population increase in the Portland region and we have had a 46 percent increase in the use of transit. So that is another one of those examples where we have provided the system, we have built up the system, we have really made it usable for people and we have a very high transit because of it. We don't have great emissions tracking figures but we see it in that aggregate total. Is that helpful?

Chair WU. It is, when it begins to look like it is very parallel to what Mr. Winkelman said that in the rearview mirror, if you will, that perhaps all the gains can be attributable to getting people out of their cars or turning their cars off and using some other mode of transportation and one hopes for a different mix of savings going forward.

Ms. CIARLO. That is right.

Chair WU. Thank you very much. I am getting close to my time limit. I would like to recognize the Ranking Member of this committee, the gentleman from Nebraska for five minutes.

Mr. SMITH. Thank you, Mr. Chair.

Ms. CIARLO, I am very intrigued by your testimony and I guess commend the efforts of the city in reducing emissions and so forth. Your numbers are very compelling. I hear you saying that it is more consumer choices in transportation that have led to these things. How do you think we could address in rural areas—I mean, it is very difficult to provide all those choices obviously, if not impossible. How do you recommend we adopt policy or fashion policy that reflects the flexibility that is necessary? I mean, in urban areas we use tax dollars to reduce traffic in some senses and in rural areas we use tax dollars to increase traffic, given economics and various things. How would you suggest we address that?

Ms. CIARLO. That is a good question. I work in the city so I am not going to have great answers for you. I think you look to places that have tackled the questions of transportation in rural areas. There has actually been amazing work done in other countries where they use transit in ways to truly link rural communities in a more usable way than we have been able to do here. So I think looking to a system like Switzerland where they link all of the villages with buses and trains and mail delivery service. It is definitely work looking into. I think also looking at some of the strategies that you mentioned in your opening remarks, looking at ways to price trips so that the price of those trips, possible of vehicle miles traveled pricing structure, weighs into people's decisions about the kind of transportation they use, and I guess the last piece of that, which is an important piece, is looking at the sort of jobs-housing mix, how do people get to their jobs, how they get to the daily activities that they need to do when they live in rural areas. That being said, I would invite Mr. Winkelman as well, who I think has done a little more work in the rural areas.

Mr. SMITH. Please.

Mr. WINKELMAN. Thank you. I think first of all in rural areas, we are going to see the biggest greenhouse gas reduction opportunities from technology and fuel so you might say, you know, subways for cities and green pickup trucks for rural areas in terms of where the opportunities lie in terms of the previous question. That said, if we look at the traditional sort of rural village with mom-and-pop shops, that is a walkable kind of place so to the extent that you are attracting new development if that is done in a way where there is walkability, especially if fuel prices go back up and driving 20 miles to that discount center may not be so affordable when you face higher costs. Also, the notion of telecommuting. Now, obviously if you are working on a farm that is not going to work but for those jobs or those errands where purchases can be done online, then broadband-type technologies can help facilitate those trips, which reduce the need to travel. Finally, inter-modal freight options applying both to urban and rural areas can look at improving the overall system efficiency so that you are minimizing emissions that may be more from the freight side than the passenger side.

Mr. SMITH. Okay. If you might also tell us, does the CCAP support the Transportation Financing Commission's recommendation to transition away from the fuel tax to the VMT-based system and wouldn't such a transition reduce current incentives to buy fuel-efficient vehicles?

Mr. WINKELMAN. Well, we don't support any particular funding mechanism except to note that we are going to need to fund this and look at it as an investment. That is why we look at the broader sort of economic picture so you are not looking just narrowly at dollar per ton or just narrowly at, you know, how are we going to stick it to the taxpayers and raise this money, you are not going to. But if you say this is an investment and this is how we are growing our economy, and you are doing the kind of research and analysis to say, as you mentioned in your comments, let us look across research needs, let us figure out which measures both advance environment and economy, then you can find out which pricing mechanisms make sense. We are going to need to pay to maintain the infrastructure we have and to grow in a thoughtful way. The money will need to come from somewhere. It is probably gas tax or VMT tax. So, you know, whichever one it is, if it is fuel tax, we are going to see reduced revenues because of improved fuel economy. That is why people are looking at pricing. Looking at the synergies, are you able to collect information about system management, that kind of data, whether it is fuel or vehicle-mile-travel data will be beneficial. So looking at those multiple benefits I think will lead to the answer.

Mr. SMITH. Okay. Thank you.

Chair WU. Thank you very much, Mr. Smith.

The gentleman from New Mexico, five minutes. Please proceed.

Mr. LUJÁN. Thank you, Mr. Chair.

Mr. Winkelman, you state that the transportation community has recently awoken to the dangers of climate change and now it has to make up ground. What do you attribute this delay to?

Mr. WINKELMAN. I think from my earlier comments, if we look at the tremendous progress in vehicle technology and fuels, it made a huge difference in air quality, and so there was a sense and the sort of mission of transportation departments to focus on congestion at specific facilities and focusing on the roadways. There are efforts in many places like Portland or Arlington that are successful on sort of improving travel choices, but they never really had to deal with the demand side in the same way that we have to here. My calculations show that even if we have 55-mile-per-gallon-vehicle CAFE standards in 2030 and 15 percent cut in fuel greenhouse gas emissions, we will still be well above where we need to be for greenhouse gas reductions. So we need to look at improving those travel choices and it is basically—it is why I talk about sort of a funded responsibility. If we are going to be asking agencies to do something they have never really done to really focus strongly on improving travel choices, they are going to need new resources and policy to support it.

Mr. LUJÁN. Thank you very much.

Mr. Acott, according to your testimony, total emissions from asphalt operations decreased by 97 percent from 1970 to 1999. One, that is a large decrease, and is there still room for improvement in this area?

Mr. ACOTT. Yes, the emissions we are discussing here are primarily what comes out the stacks of our plants, and throughout that period there was rapid deployment of all sorts of techniques to reduce emissions. These included scrubbers and various tech-

nologies. So it was a very significant drop. What we have found is what is left can pretty much be taken away by deploying warm-mix. If we go to any paving site or any manufacturing facility running warm-mix, I think it would be very hard to detect any emissions or odor around these facilities. So for us, warm-mix is very exciting in terms of having a manufacturing facility actually set up within a community. So I think the initial reduction is what we call end-of-pipe technology. You are dealing with that afterwards. What warm-mix does is actually control emissions at the source and in fact I think there would be significant savings in terms of some of the hardware and equipment that one would have in an asphalt facility as a result of controlling emissions at the source.

Mr. LUJÁN. How could that research be accelerated?

Mr. ACOTT. I think it is going at an incredible rate and I really believe the whole industry will shift to warm-mix within a five-year period, which is really unheard of, and I think with your encouragement some of the studies that are needed just to make sure the material is performing as well as conventional material, everything that we have seen, all the accelerated testing, all the experiences in the field have been very, very positive. So we just need to make sure that we are going to get pavements to perform as well as conventional material and also some actual emission reduction tests would be very helpful but I would be very confident just looking at the rate of deployment in a very short period of time we could get 100 percent deployment.

Mr. LUJÁN. Thank you.

Mr. Chair, in closing, a bit of an observation. As I read through the testimony of each of the witnesses today, it is interesting to see that there is something that seems to be repeated by each of the witnesses today: the need for more research, the need for more data, the need to be able to look at different ways of doing things. We refer to this as green transportation infrastructure. I would refer to this as smarter, innovative, improved infrastructure in the way that we are going to be approaching this, and Mr. Chair, I would just like to remind the Committee there is a piece of legislation that was moved forward through the Committee which you are very familiar with which is H.R. 5161, the *Green Transportation Infrastructure Research and Technology Transfer Act*. If that would have been adopted and moved forward, it would have done exactly what we are hearing from the witnesses today that needs to be done: more research, being able to be smarter and moving forward and accelerating the type of research that is needed to be able to accomplish the goals that we have heard today, Mr. Chair. So it is good to see that the Committee is on top of that, Mr. Chair, and hopefully we will be able to see that legislation move forward so we can be on top of this as well. Thank you, Mr. Chair.

Chair WU. Thank you very much, Mr. Luján, and I find your analysis not only insightful but something I agree with wholeheartedly. Thank you very much for your comments.

Let me follow up on your question. Many of the witnesses alluded to either gaps in research or different kinds of data that need to be collected in order to improve what we can do and even more importantly perhaps in planning going forward what we want to do. I would like you to address those data needs more. You have

each discussed them somewhat but I would like to encourage each of the witnesses to discuss that, and for those who can, can you please try to put it in the context of some of the transportation research agencies like the Center for Climate Change—I am sorry—yeah, the DOT's Center for Climate Change, RITA, and some of the other research entities that we have currently existing. Whoever would like to start. Mr. Acott.

Mr. ACOTT. Mr. Chair, in our view, one of the missing gaps is, there really isn't a very good model to actually evaluate in the paving material area greenhouse gas contributions in terms of throughout the full life cycle of the pavement. I think when you are looking at carbon footprint, you have to include the actual carbon generated during the raw material acquisition. So in the case of, for example, asphalt, you have got to look at the actual asphalt cement manufactured in the refinery, taking it all the way out to the full life of the pavement. In the case of cement, you have to look at both the energy consumption and also the carbon dioxide generated during the processing part of cement and you take that all the way out. You look at the 50-year life of the pavement. You have to take into account the maintenance cycles, the rehabilitation cycles. So I think what is missing is an acceptable model that characterizes pavement throughout its full life cycle.

Chair WU. There is no current baseline for that material?

Mr. ACOTT. There is some. I think there has been isolated work done throughout the world but I would say there is no accepted U.S.-based methodology. ISO [International Organization for Standardization] Standards has a model. I think NIST [National Institute of Standards and Technology] has a model. I think a model for pavement materials that includes all of those components would be very, very helpful.

Chair WU. Terrific. Thank you.

Mr. Winkelman.

Mr. WINKELMAN. Well, as my written testimony goes on and on, there are a lot of opportunities. There are a couple that come to mind. One is for the Department of Transportation and presumably this could be RITA and BTS [Bureau of Transportation Statistics], looking at how transportation money has been spent in different regions of the country across modes, how much in highway, how much in repair, how much transit, travel and land management and compare that to sort of VMT and greenhouse gas emissions to sort of understand the diversity of what is working in different places. We would expect different things in different places but we haven't actually looked at how the money is spent and how that maps with greenhouse gas performance.

Chair WU. You talked about continuing to take a regional approach to research, that research done in different regions will have different orientation and have results that are sort of differentially valued within the regions. Is that correct?

Mr. WINKELMAN. Yeah. I mean, a region that is more metropolitan or a region that is more urban, you are going to expect different solutions and different outcomes and understanding and just doing that measurement of the history of how the money was spent and what came out of it would be important. Also, just looking at alternative information sources, looking at fuel sales. There had

been an effort between FHWA [Federal Highway Administration] and the IRS to look at fuel sales and try to map that to specific locations. Those sorts of collaborations across agencies are key because sometimes you find some incestuousness in the data sets. Someone is calculating fuel economy on someone else's travel data and someone else's fuel-use data and that corroboration, getting data on vehicle use, on fuel sales for multiple agencies will be really important. I think that is a strong role for BTS. And then the kind of guidance on how do we measure these reductions, what to expect from them I think needs to tap the expertise of both the Department although working collaboration with other agencies to understand what you can save and what you can cost and then how you actually go about and implement this because in some ways people know what to do but they don't necessarily know what is the next step if I want to improve travel choices or if I want to increase bike mode share, for example. So those sorts of technical guidance based on the sort of research that we recommended would be quite valuable.

Chair WU. Dr. Rilett.

Dr. RILETT. Just going off of what I said earlier, I think some of the major issues again are getting data on activities. You know, we are talking about transportation but the reality is, we do transportation because activities are going on, economic activities, work, shopping, those types of things and we really don't have good databases on those aspects and this is critical for some of the questions that were being asked. I will give an anecdote. I ride my bike to work. I still have to go shopping. If I took my car, I would go shopping on the way home, so some of the benefits that you might immediately assess is this is a good thing might not be as great, and there are obviously ones that go the other way. But I guess the point is, there is not a lot of good activity-based knowledge out there, and again, that feeds into the activity-base models that we require to answer some of these questions.

Related to that is the traffic data again. We have very good—we have lots of traffic data but not in the form that is usable. We have a lot of averages, not a lot of distributions, not a lot of individual information such as driving profiles. A big gap on the traffic side is on the freight. Congressman Smith was talking about the differences between areas. There are parts in Nebraska that on the highway 60, 70 percent of the traffic is freight, which is completely opposite to a lot of the metropolitan areas. Understanding that—and there are parts of the Nebraska or the Midwest, in our small towns we get 140 trains a day. This is a large amount of freight traffic, and that is what our center set out to analyze. But my point is that there is not a lot of information on the freight movements and obviously they have a lot of impact. If you can move some of the freight away, you will reduce some of the congestion in your urban environments. So that kind of information is missing. Obviously that would be on the U.S. DOT side, and that information goes into both the models that we have been talking about as well as the analysis. Can we really identify that the policies we are putting into place are actually doing what we anticipated?

I would also like to make a point on the differentiation between data and information. We have a lot of data but what we are really

looking at is information. This gets back to the sustainability topic. Are we getting the metrics that we really need, that we want to analyze? We have had talks about HOV lanes. A lot of our data is in vehicle miles of travel. Maybe what we are really interested in is person miles or, you know, how many people are we moving per mile versus how many cars are we moving per mile. I think that is a very common one that we teach but there are other components of that that certainly could benefit from other research.

On the other side is the—from a modeling perspective on the emissions, we don't have a lot of good emissions data. We have a lot of average data that we put into models and we say yeah, this—we run the model and we say this is what is going on but if you are looking for a source of real-time emissions from actual vehicles, there is almost none of that out there. We have done some work on portable emission measurement devices. I think there is a potential for that. But really getting in and looking at the drive cycles, you know, how many hard accelerations, how many hard decelerations, that is where—you know, all other things being equal, they have a lot greater impact on the environment than just the normal driving cycle. That would be from the EPA side of things, and again, getting back to my earlier testimony, being able to integrate those two is critical. So thank you.

Ms. CIARLO. In my testimony I talked about some specific modeling and evaluation tools. We have heard some great ideas about where those might live. I think that we have seen great success with the sort of collaborative entities like the Oregon Transportation and Education Consortium that has been put together to deal with some of those questions locally or in the context of, for example, cities. So modeling and evaluation tools around walking, biking, trip chaining, I think those kinds of things would live well in that type of environment, that type of research. At Portland State University, there is a number of different institutes that address these questions and I think with additional funding and additional sort of research structure, they could—they and universities like them around the country could really move forward with some of this. I think a particularly important piece of that are models that address that land use and transportation relationship, and those are obviously going to live in these multi-disciplinary, multi-jurisdictional kinds of entities.

And then I want to just mention again the importance of some sort of a more widely accepted multi-modal performance-based evaluation standard, and that is obviously going to need to come up through FHWA, through some of the other federal entities to be accepted as something that really can be used to evaluate performance on highways and roadways throughout the country.

Mr. MATSUDA. Mr. Chair, thank you. I think the key is to really try and understand what the transportation needs are of end users of the system. The Obama Administration has an opportunity to revisit the approach taken to determining how we can determine how our transportation systems can be made much more efficient and that includes things like examining behavioral changes and the potential for reduced vehicle miles traveled. So, you know, we will be working in a comprehensive manner to take a collaborative approach, and as Secretary LaHood has indicated, that any proposal

on the reauthorization will include sustainability as a major theme of it.

Chair WU. So Mr. Matsuda, as a veteran of—as a 15-day veteran of your current post, what I take you to be saying is that to the extent that these research needs are not being met currently, you are open to suggestion for their incorporation in some meaningful way in the future.

Mr. MATSUDA. Absolutely, and we will certainly consider the views of this subcommittee as being very interesting.

Chair WU. We are all grateful for that generous response.

The Ranking Member, Mr. Smith, five minutes.

Mr. SMITH. Thank you. It is very interesting to try to piece together various perspectives here and I appreciate your willingness to think ahead and really prepare for the future. I think in so many cases we underestimate how in many of these cases it is good business. It is better economic utilization of our resources and our assets that boils down to, it is good business to stretch our resources further. I think of, you know, how much a farmer works to reduce consumption of fuel with no other concerns than economic perhaps but yet is a good thing to reduce that. I mean, the byproducts of the impacts on the environment are great, and I could go on down the list. So it makes folks very nervous when perhaps there might be some policies based on absent technology that will drive up the cost, drive down profits at very, very tedious times economically. I don't need to tell anyone that.

Mr. Matsuda, your testimony highlights the President's call for the cap-and-trade to reduce CO₂ emissions 80 percent by 2050. How do you think those costs—I mean, it is very clear based on the budget proposal, it is very clear that those costs do exist. How do you think those will be absorbed by consumers?

Mr. MATSUDA. Well, I do reference the cap-and-trade proposal in the testimony today. We understand that technology will play a major role in helping to promulgate some of the efficiencies that are really needed to make these reductions but that is primarily what we are looking at.

Mr. SMITH. Technology that is yet to be accessible to the common consumer or I mean—

Mr. MATSUDA. Well, we hope that the work of the Subcommittee in determining what research really needs to be done to gain those efficiencies can help play a role there.

Mr. SMITH. So, I mean, the timeline for the cap-and-trade proposal is I guess what I would say is rather aggressive. Are we ready for it?

Mr. MATSUDA. I am certain that it is something that the Administration takes very seriously and views as doable.

Mr. SMITH. The cap-and-trade proposal?

Mr. MATSUDA. Yes.

Mr. SMITH. And when do you think that is doable?

Mr. MATSUDA. I am not sure I am qualified to speak on that but I can check and get back to you if it pleases the Subcommittee.

Mr. SMITH. Well, I appreciate that, and I think that, you know, when you talk about biofuels, I mean, Ms. Ciarlo, you referenced biofuels a bit in your testimony as well. I think it is inspiring to know what some of our options are out there and how various sec-

tors of our economy geographically or otherwise can contribute to the solutions and so I think there is a lot of hope and I hope that we can use as many market-based approaches as possible. Thank you.

Chair WU. Thank you, Mr. Smith.

I would like to approach perhaps the final round of questions. There are a lot of other questions and concerns which the Subcommittee has and we will be submitting a number of questions to you all in writing. A number of the witnesses refer to performance-based approaches, and I would like to understand that a little bit further and also just focus in specifically on what the metrics of performance-based standards are. Do they currently exist, and if not, who would develop them? How quickly do you think we can develop them if they don't currently exist and how their availability would affect transportation policy? Some of you have referred to some of those topics but let me open that up to the entire panel and then hear your comments on this topic. Mr. Winkelman, first off the high dive.

Mr. WINKELMAN. Thank you, Mr. Chair. In CCAP's dialogue on transportation and climate policy, we have a number of the leading stakeholders in transportation and have been looking at the issue of performance metrics. In fact, those work group discussions led to the need for having improved data so that you actually have something meaningful to measure and evaluate. We think it is important that the metrics address multiple issues at once. If we care about ten issues in the transportation bill, for example, and we are going to measure all ten of them, none of them is going to carry significant weight to really make a difference in terms of policy and spending and so I think that if you look at some simple metrics that are practical and measurable on greenhouse gases, you could look at greenhouse gas per capita, for example, for a region. To get down below that, you might want to say what is vehicle miles traveled per capita, what is fuel economy in that region in order to not just measure but to figure out how to respond to that and look for the overlaps. We have seen with higher fuel prices and then the reduced driving levels, we have seen lower accident rates, fewer car crashes. So if we are reducing energy use, reducing greenhouse gases, improving safety, reducing wear and tear, then we have got something that addresses multiple things at once so looking for those overlaps will be key. So you can look at greenhouse gas per capita, crashes per capita, for example, on the safety front, but importantly, looking at those overlaps across metrics will be important for making them practical.

Chair WU. Dr. Rilett, Ms. Ciarlo, we are counting on you all to come up with the metrics that we are looking for. Mr. Matsuda, we are counting on you to tell us which part of your agency is going to solve those problems.

Ms. CIARLO. I am not going to be able to offer you metrics but I want to give you a situation where we could use them which may be useful as Dr. Rilett answers that. As we work on the Columbia River Crossing project, which I mentioned in my testimony, which is the I-5 bridge between Portland and Vancouver, we are looking at replacing an existing freeway bridge with a much larger freeway bridge that also has a transit component, a light rail component,

and one of the things that Mayor Adams has done is spearhead a bi-state effort to create what we call a mobility council that will provide performance-based management of this new bridge over time. That was important to both communities because the Portland side of the bridge feels very concerned about some of the environmental impacts, the possibility of induced travel, the possibility of greater congestion, and the Vancouver side feels very concerned about having free flow of travel, and both sides feel very concerned about freight being able to move through the corridor and not ending up in 10 years or 15 years in the situation where we are now where freight is completely captured by just single-occupancy vehicles. Freight can't move through the corridor. So in trying to come up with long-term performance-based goals, we have this mobility council that will be looking at what are our desires, what are our needs in terms of emissions, what are our needs in terms of freight mobility, what are our needs in terms of induced demand, how is it actually playing out as we have added this additional capacity, and then our desire is to be able to use a combination of tolling and transit and possibly HOV lanes and van pools, other strategies like that to manage the demand over time. But where we are right now is in the process of developing those metrics and it would be very helpful to not have to create those from scratch and to have better tools to kind of measure and work toward those.

Chair WU. I get you about what the need is. What do you need to measure?

Ms. CIARLO. We need to measure how, for example, the additional capacity affects the number of vehicles moving through and then in turn how those additional vehicles affect the greenhouse gas emission levels. So it is pretty basic information but it is not being gathered now. What we need are tools and strategies to gather that information.

Chair WU. Okay, and it sounds to me like under what you phrase as primary data there are actually a bunch of different measurements to try to get at those numbers.

Ms. CIARLO. I think that goes to Mr. Winkelman's point that a lot of those measures are going to be interrelated but especially when you have facilities as we do more and more that have transit pieces but also have highway pieces or where you are measuring for different outcomes. You are measuring for greenhouse gas emission outcomes but you are also wanting to move freight through the corridor. Well, a specific measure that might help both of those things would be a speed and reliability measure. If you could move—if you had a speed and reliability measure for freight moving at 45 miles an hour through the corridor, that may get to both those things that you want but again we need more work on that. And maybe Dr. Rilett will be able to help us with some of those things. I can give lots of practical questions but I am looking to him to help us with that.

Chair WU. This is very helpful and I would like Dr. Rilett and Mr. Matsuda to take a pass at this before we perhaps move on and close up, but I just want to comment that there is a lot of soaring rhetoric, and when it is not soaring rhetoric, there is a lot of hand waving that goes on in this town, and after five years as either Ranking Member or Chair of this subcommittee, I think this is my

inclination way before I came here in the first place, I have been kind of a nuts-and-bolts kind of person and, you know, I want to know what the "it" is that we are going to measure, how much it is going to cost, who it is going to cost, you know, what the downstream impacts are and so on and so forth and we're not as strong on that in this institution either. So Mr. Matsuda, you shouldn't feel badly about this. It is just that I know the phenomenon of which I am asking about in this instance.

Dr. Rilett, please proceed.

Dr. RILETT. I think it is a very valuable question. I think the results or the other comments are—I will just jump off those. You are asking a professor a direct question and that is always sort of dangerous. I will be the first to admit that. You know, we always need more research.

Chair WU. Listen, on this side of the microphone, you are looking at a lawyer who is asking a question to which he does not know the answer, which is also a very dangerous thing to do.

Dr. RILETT. But I will point out some things. A lot of what we want to measure really comes down to the decision-makers, which would be the politicians who represent the people, and that is what I teach in my classes, and that is, when I talk on sustainability, you know, what is important, that is what we want to measure. It is reducing—and again, I will get back to Mr. Winkelman's comment that they are interrelated. In my comments I made the point about reducing nitrous oxides, and I have heard this from the trucking industry where they have brought in the new fuel-efficient—or sorry, the new engines that are going to reduce nitrous oxides. They also have the tendency to reduce fuel mileage, which is what I hear from the trucking industry and there are worries about that, and obviously those two measures are in conflict. If you are talking about reducing fuel efficiency, you are increasing greenhouse gases but you are also doing something nice on the other side. So again, I will get back to the point that what you measure needs to be comprehensive. It has to be by definition measurable. A lot of things we want to know, we cannot get, and I mentioned that in my earlier comments on the freight data. But I would just say on the sustainability, getting the input from the decision-makers, I am going to take the typical professor's approach and say further research because it really comes down to saying can we measure it, where do we get it, is it the important thing that the decision-makers really want? Is it going to allow them to make the decisions? And again, I will get back to this, to the tradeoffs. You know, the decision-makers have to make decisions regarding, you know, do we put money into safety, do we put it into the environment, do we put it into congestion relief. Sometimes they all go in the same direction and then sometimes they don't. I cannot answer that right now but I can see where those types of things, those types of questions are valid research and important research that would help not only the Committees, this committee but also local and State governments as well.

Chair WU. Well, thank you for that answer, Dr. Rilett. You know, we were debating up here. I didn't want to ask the question without knowing the answer and finally I had to and you are say-

ing further research is needed, and that is something I can understand.

Mr. Matsuda.

Mr. MATSUDA. Thank you, Chair. As you mentioned, that is the key question, is what do we need to measure, and, you know, given that the Department really does have a multifaceted mission, it becomes a complex question because we need to measure things that impact—the decisions we make will impact both the mobility or safety or environmental stewardship factors. As I mentioned, this Administration, you will likely see a renewed focus on the environmental stewardship portion of its mission but a lot of what we are able to do is really determine by the resources that are given to the various programs that will study climate change research.

Chair WU. Very good, Mr. Matsuda. We are going from policy to data needs and now you put it back in my lap. You can't get the data unless you have more money. Okay.

Mr. Smith, five minutes.

Mr. SMITH. If I might, Mr. Matsuda, try to draw this to a close. How would you say DOT sets the transportation research priorities across the agencies and the programs, as concisely as possible?

Mr. MATSUDA. Well, currently we have an internal committee that collaborates among the different agencies to determine what the research agenda is going to be, and that is something that again the new Administration would like to revisit and be able to implement its own priorities within that agenda, so it is something that is coordinated to the extent possible.

Mr. SMITH. So what would you say are the objectives driving that?

Mr. MATSUDA. You mean what kind of priorities are we looking at for this Administration?

Mr. SMITH. Right.

Mr. MATSUDA. Well, I think I mentioned that definitely environmental stewardship and sustainability is something that we are going to see a major focus on within the next reauthorization. There has been a number of factors that the Secretary has mentioned as well, livability, for one, you know, and mobility is something that is key to obviously keeping our economy going and making sure that folks get to where they need to go and the jobs to do so.

Mr. SMITH. So mobility along with the sustainability and other—okay. At our last hearing, we heard DOT's former RITA administrator recommend that DOT should develop an overarching research agenda. Do you agree with that recommendation?

Mr. MATSUDA. Well, I believe that witness had a unique perspective, having served in the prior Administration. I would offer that I think that perspective is also driven by some of the, I guess, perceived frustration that someone in that role must feel and the agency, RITA, has the role of coordinating all of the Department's research and technology efforts, however, they don't really have the budget authority to do so. They don't—you know, much of—I would say about—for instance, in the climate research arena, about \$41 million was spent in fiscal year 2008. About two-thirds of it was earmarked for specific projects and the rest of it, you know, goes to the various agencies themselves to determine. So it makes it dif-

ficult to really draw some overarching priorities on things you want to focus. That is something that this Administration wants to take a look at.

Mr. SMITH. Well, you know, I certainly admire your willingness to take on I think some very important issues, and merely talking about sustainability and mobility in the same conversation I think reflects what we are up against. I mean, we need good policies that—you know, I appreciate forward-thinking policies. It gets frustrating on this end when we might have some policies in place that are based on wishful thinking. You know, I would love for various parts of our economy to be more efficient as it relates to energy consumption. When that technology isn't quite ready, it is not ready, and until such time, we need to understand that. Otherwise I have a feeling that we will cut corners in various respects. I mean, I can think of some safety issues that would likely come up that will be huge challenges if we are encouraging too many people to ride in a vehicle perhaps, that the number of people exceeds the number of seat belts. I mean, that is just one approach that I think we need to be very careful of. Again, I appreciate everyone's willingness to be here today, and Mr. Matsuda, to take on the bureaucracy and I admire your public service, so thank you.

Mr. MATSUDA. Thank you.

Chair WU. I thank the gentleman.

The gentleman from New Mexico.

Mr. LUJÁN. Mr. Chair, two questions.

Mr. Matsuda, you also mentioned with RITA conducting advanced vehicle technology research. You mentioned testing performance evaluation of advanced diesel engines, battery research, hydrogen fuel cell technology. How is DOT coordinating their efforts with DOE [Department of Energy] and with EPA to be able to move forward with some of these important approaches?

Mr. MATSUDA. Thank you, Congressman. DOT does participate in a number of inter governmental organizations that help coordinate the research that goes on, and the idea is not to duplicate research but to make sure that the resources are used effectively and that, you know, we can get the most out of the efforts that we are doing. I can get you the names of the specific groups if you like. I can get back to you with those.

Mr. LUJÁN. And with your familiarity over the last, you know, few days that you have had the great fortune of taking on this immense responsibility, do you see, you know, the opportunity and the hope really behind implementing a lot of what has already been looked at and we can move forward to accomplish some of the goals of the Administration?

Mr. MATSUDA. Well, I think so. I think there is a lot that is already out there in terms of lessons learned and things that work. For example, the city of Portland is probably a very good example of what can be accomplished for a city of that size, and there is going to be differences across the various regions. You know, as Ranking Member Smith mentioned, the rural areas have unique challenges. I believe about a third of all VMT is created in rural areas and so that is something that we can't really ignore. But, yeah, there are definitely things that we know now that we can be using to help implement future policies. One may be modal shifts,

for example, you know, a renewed focus on transit spending might influence people's behavior or, for instance, is there availability to take a bus or rail service, folks might be more willing to do it if good service is available and that, you know, has some positive effects on greenhouse emissions.

Mr. LUJÁN. Well, thank you, and, you know, with that being said, Mr. Matsuda, I represent a rural district as well, 16 counties that runs from the State of Arizona to the State of Texas across the Colorado border. The furthest point for me to get across the district takes eight hours in a car from one tip in the southwestern part of my district to the northeastern part of my district. But one thing that is happening out there is, we are seeing a lot of coordination with some of the local transportation districts and moving together to take advantage of a light rail system that was built in New Mexico. They are bringing in buses. They are being smarter about the types of fuels that they are using. They are coordinating efforts now throughout the region, recognizing that the largest impact is coming from passenger and light truck, people having to get to work. And so if we can target, you know, in this area where we can mitigate and be smarter about the way that we are going to move people, I think we can have some significant gains.

Mr. ACOTT, the last question that I have is around the importance of what is happening with water runoff, and going back again to the technology that you have been talking about. This is another area that the Committee reviewed, it is my understanding, last year as well, or during the 110th Congress. Moving forward with some of the technology, the different ways of utilizing asphalt and the way that we are going to be paving our vehicles—or paving our roads, I apologize for that. Would that help address some of the concerns with some of the runoff and replenishing with some of the concerns with, you know, big cities where they are having to pay increased fines for runoff and people are being smarter about the way that they are taking this into account?

Mr. ACOTT. Yes, the opportunity with runoff is really threefold. One is to just use an open graded material in the surface and that would cut back on splash and spray and the water just permeates through the mix and then runs out the side. The next step is to build a completely porous pavement structure rather than having retention basins, thereby reducing the rate of runoff, the speed of runoff, and the erosion. The pavement itself is really a retention basin. Most of that work has been done, used in parking lots, parking areas, but there is a very notable exception in Oregon actually. Pringle Creek is a community where all of the highways within that community are made from completely porous pavement. So a very interesting development would be, can we actually make our highways porous, could they be linear water treatment facilities where perhaps you have porous at the edge of the pavement, the water runs off, runs through the shoulder material and you are actually using the pavement itself as retention basin. So I think there is a lot of opportunity for doing some very solid civil engineering work in that area.

Mr. LUJÁN. Thank you, Mr. Chair.

Chair WU. Thank you, Mr. Luján, for your contributions to this subcommittee. I appreciate it very, very much. Unfortunately, it

feels like we have just scratched the surface of many of the topics that we have opened up. I also on the other hand feel that this hearing has gone on a little bit longer than I originally intended it for. It has been very, very productive and I thank the witnesses for pointing out a significant number of data and information needs which can inform the policy-making process going forward. We will be submitting a number of written questions to all of you, and I would like to close up by making some general comments and I would invite Mr. Smith to respond if he wishes to.

We face some great challenges going forward in this particular topic area and in many other arenas in this Congress. As someone who—now, I have taken a lot of criticism from my young and eager staff, for example, for alluding to climate change as a theory, and I point out to them that evolution is theory, that relativity is a theory and so on and so forth, electricity is a theory. I have never seen it. But you know, I am sufficiently convinced by the data thus far that the risks of doing nothing are sufficiently dire to take the risk of doing something, recognizing that there are significant risks in doing something. In doing something, there is a significant possibility that we might not get things right the first time, that things need to be improved as time goes on.

No major reform in our society that I can think of has happened without bipartisan support, and I personally think that that is very, very important. If there is significant opposition to doing something on this, then of course there is the political risk that we calculate in this town all the time about one side or the other gaining a substantial number of seats in the next election and so on and so forth, and that is a calculation that goes on all the time in this town about any major policy decision. I think that as public leaders, what we need to do also is to stand back and I think this is true of the economy currently and this may be true of the climate change issue also, whether there is a broader responsibility at this particular point in time to try to come together from both sides to address issues that are of such magnitude that if we don't come up with a consensus response, that may not be what everybody wants but to effectively address either the economy or the climate change issue, the consequences will be too dire for the Nation and for the world that it is not just the moral equivalent of war but it really is the equivalent of war, that one bad path could lead to the extinction of our economy and another bad path potentially leads to the form of civilization as we have organized it since the Industrial Revolution, and these are serious consequences that I think we will be trying to address in the coming months, and I hope that we will be able to find not just the data solutions to some of these issues but also a gathering consensus based on the data and a willingness to come together on some of these issues. Having been in the minority and now in the majority, I certainly understand the impetus to draw distinctions but there may be some issues where it is increasingly dangerous for either side to try to draw those distinctions instead of coming together on it.

Mr. Smith, if you would like to comment, you are certainly welcome to. I am ready to close up.

Mr. SMITH. Well, I appreciate that, and I certainly want to offer my willingness to work together. You know, I am with you on the

theory of climate change. But it is more than that. When I have heard over the last few months various measures being taken that have never been taken before in an effort to I think in good faith do good things for our economy, I am not sure we should, you know, take such drastic measures perhaps, especially in light of the fact that we know that there will be cause and effect or there will be some consequences to some things. I mean, that is pretty clear and it is not just transportation and the costs associated with a heavy hand of government but it is production not only of crops in Nebraska but manufacturing across the country, and so that is why I hope that we can move very judiciously and not over-aggressively in the name of many things and not just our economy, not just being good stewards of our environment but all of the moving parts of our society. So thank you.

Chair WU. Thank you very much, Mr. Smith. I think that one of the most challenging things to do is to try to, if you will, go where no man has gone before and also move judiciously at the same time. It is a very, very difficult thing to do.

Thank you all for being here today. I appreciate it very much. We will be following up with a good number of written questions, particularly about the Bureau of Statistics at DOT. The record will remain open for additional statements from the Members. We will be asking a significant number of additional questions. I thank the witnesses again and the witnesses are excused, and the hearing is now adjourned.

[Whereupon, at 11:47 a.m., the Subcommittee was adjourned.]

Appendix:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by David T. Matsuda, Acting Assistant Secretary for Transportation Policy, U.S. Department of Transportation

Questions submitted by Chair David Wu

Q1. How do current ITS Joint Program Office program activities contribute toward using ITS technologies in the sustainability and climate change context? Could you please provide specific examples of Intelligent Transportation Systems (ITS) technologies that could be deployed now to address the effects of surface transportation on the climate and the environment?

A1. Current investments in ITS and operations are fully consistent with contributing to sustainability goals and addressing climate change. Many ITS applications and strategies are effective at improving the operational efficiency of the transportation system. The JPO conducts research, performs field tests, and disseminates the resulting information on traffic signal systems, freeway management systems, traffic incident management systems, and traveler information systems. All of these areas result in decreased delay, reducing fuel consumption and emissions outputs.

Similarly, ITS research into advanced transit management systems will improve the operational efficiencies of transit and paratransit fleets, reducing the required number of trips and potentially increasing average ridership.

The IntelliDrive[SM] research program is investigating both safety and operational efficiencies that can be gained by providing data communications with in-vehicle sensors. Several automobile companies are researching how traffic signal timing information provided to the vehicle can be used to automatically stop and start the engine, reducing fuel consumption and emissions.

In addition to reducing transportation's contribution to climate change, ITS research can mitigate the expected effects of climate change that do occur.¹ Real-time information on road weather conditions (included flooded roadways and bridges), evacuation traffic flows; and on transit and paratransit fleets used in evacuations, particularly can be collected through ITS systems.

Specific examples of ITS technologies that could be deployed now include:

- **Traffic Signal Optimization/Retiming**

Traffic signal system retiming and optimization ranks as one of the most cost-effective urban transportation improvement actions, increasing mobility, reducing fuel consumption, and improving environmental quality. Signal retiming projects in several U.S. and Canadian cities have been shown to reduce fuel consumption.²

Example: In Syracuse, New York, benefits were realized when signal timing was optimized for 145 intersections. Based on the data from this one site study, signal retiming decreased the number of stops by approximately 15 percent, reduced travel time by approximately 16 percent, lowered delay by approximately 18 percent, caused a decline of approximately 13 percent in fuel consumption, and resulted in approximately three percent reduction in vehicle emissions and noise pollution.*

*[The data cited has not been scientifically peer reviewed, does not address induced travel impacts, and only assesses short-term or isolated emission reductions. Annual emissions reduction estimates were based upon vehicle-hours of incident delay and average tons per hour of emissions.]

- **Traffic Incident Management**

Managing traffic incidents is a proven strategy for addressing significant portions of the Nation's traffic congestion problems. Traffic crashes are the most time-consuming of these incidents, but the more numerous cases of stalled vehicles, roadway debris, and other incidents also contribute significantly to the problem. ITS technologies can be used to dramatically reduce the duration of traffic incidents, and thereby reduce the amount of wasted fuel associated with traffic congestion.

Example: The Georgia NaviGator incident management program is estimated to save 5.17 million gallons of gasoline and 1.66 million gallons of diesel per year, based on the measured delay reductions and average vehicle fuel consumption.*

¹ TRB Special Report 290. Potential Impacts of Climate Change on U.S. Transportation.

² All references were obtained from the ITS Benefits Database (www.itsbenefits.its.dot.gov/) unless otherwise noted. The extent of benefits realized from traffic signal retiming depends on various factors including the quality of existing timing plans, street network configuration, and traffic patterns.

*[The data cited has not been scientifically peer reviewed, does not address induced travel impacts, and only assesses short-term or isolated emission reductions. Annual emissions reduction estimates were based upon vehicle-hours of incident delay and average tons per hour of emissions.]

• Work Zone Management Systems

ITS solutions enable the deployment of “smart” work zones that use technology to help manage traffic and mitigate impacts of lane closures, detours, and other work zone related factors. Work zone ITS typically includes components for traffic surveillance, traffic detection and traveler information that are used to enhance traffic and incident management capabilities in work zones. Examples include traveler information/portable dynamic message signs (DMS), dynamic lane merge systems, variable speed limit systems, and portable traffic management systems. ITS may also be used to manage traffic along detour routes during full road closures.

Example: A combination of before and after measurements and simulation modeling concluded that an automated work zone information system deployed near Los Angeles, California, on Interstate 5 between Magic Mountain Parkway and Rye Canyon Road reduced freeway delay by 46 percent.*

*[The data cited has not been scientifically peer reviewed, does not address induced travel impacts, and only assesses short-term or isolated emission reductions.]

• Transit Management

Applications supporting transit operations and fleet management provide substantial cost savings to transit operators, reduce transit vehicle emissions and energy consumption, and improve traveler mobility. Automated vehicle location (AVL) technology and computer-aided dispatch (CAD) systems, transit signal priority, and transit fare payment systems can improve both the experience for transit riders by reducing passenger wait times and the efficiency of transit operations. Information on current vehicle location and schedule status can also support transit signal priority (TSP), which is a cost-effective method to make bus-based transit service more reliable. Environmental benefits to the system include fuel consumption and emissions reductions.

Example: Simulation of a transit signal priority system along a heavily traveled corridor in Arlington County, Virginia found a two to three percent reduction in fuel consumed by buses across a number of priority scenarios.

• Traveler Information and Transportation Management

ITS technologies that provide information, such as those that demonstrate to commuters how their efforts are lowering emissions and reducing their fuel consumption may encourage travelers to make “greener” decisions, whether by encouraging mode shift to transit, adjusting their travel times, or changing routes; ITS tools facilitating a “green” route may further encourage this shift.

Example: Britain’s Transport Direct journey planner provides estimates of CO₂ emissions and fuel cost for each itinerary and generates a CO₂ emissions table for the trip, comparing transport by car (small or large), train, bus, and plane.

Q2. *The Center for Climate Change’s Strategic Plan 2006–2010, published in 2006, identified three goals to minimize greenhouse gas emissions in the transportation sector and prepare for the impacts of climate change. The plan also identified several strategies to meet these goals, such as research and policy analysis and State and local planning initiatives. Where does the Center stand on implementation of the specific strategies in the Strategic Plan and what activities have been undertaken with respect to the implementation strategies? Also the Plan notes that the Center will face significant near-term challenges in part because of funding structure limitations. What are these structural limitations?*

A2. The Center has made excellent progress toward fulfilling all of the goals outlined in the strategic plan. My staff would be happy to provide more detailed information about any particular strategy in which you have an interest. Most notably, the clearinghouse for transportation and climate change is now available on our website at www.climate.dot.gov, and the Gulf Coast Study Phase I is now complete with plans to begin Phase II soon. DOT has made significant contributions to the U.S. Government effort to study ways to reduce greenhouse gas emissions and provide information to stakeholders, so that they can better incorporate climate change into their decisions. For example, FHWA has worked with MPOs and State DOTs to collect lessons learned and best practices for addressing climate change in planning decisions.

DOT proposed funding for the Center in the latest surface transportation reauthorization, and such funding was not included in the enacted legislation. Currently,

Center activities are conducted through voluntary contributions from modal administrations.

Q2a. Your testimony states that the DOT Center will undertake drafting a new strategic plan. When will this be completed?

A2a. The effort to draft a new strategic plan is not yet underway, as it is important that the new Administration's leadership be in place prior to action.

Q3. The DOT Center for Climate Change has performed approximately 20 studies related to the adaptation of the transportation system and transportation infrastructure to climate change. How are these studies used by the transportation community? Please describe any tools or products that have been generated since the Center was established.

a. Please describe the process by which stakeholders contributed to the prioritization of the Center's projects.

A3. Most of the studies to date related to climate change adaptations have focused on assessing the impacts of climate change on transportation infrastructure and operations. This area of research had been largely unstudied and had many different components, given the varying effects on different modes of transportation and in different regions of the country. The studies have been used to inform State and local transportation authorities and other transportation stakeholders of the potential impacts of climate change on transportation infrastructure and operations. For example:

- The study on Impacts of Climate Change and Variability in the Gulf Coast Region has been used to inform State and local officials in the Gulf Coast to potential changes in climate that could disrupt transportation services. The report stressed the need to take climate change impacts into account as transportation plans are developed and investment decisions are made, a lesson that is transferable to other parts of the country facing climate impacts.
- The results of the mid-Atlantic sea level rise study were reviewed to help assess the potential impacts of sea level rise on a proposed transportation project along the North Carolina coast. The maps contained in the study provided an estimate of areas where transportation infrastructure could be affected by different sea level rise scenarios.
- A workshop conducted in 2002 by the U.S. DOT generated a series of short papers on the potential impacts of climate change on transportation systems around the country and related subjects. This work set the stage for development of the Gulf Coast study and other efforts at USDOT.
- FHWA has convened a series of peer exchanges on adaptation with State and local stakeholders, and has used some of the information gained from these studies to inform the exchange.
- The studies have been presented at transportation stakeholder conferences both nationally and internationally, to further the state of knowledge on the impact of climate change on transportation.

Some of these studies have produced maps of modeled potential impacts that can be used in planning future transportation projects. Using its research on impacts, the Department intends to develop risk assessment tools that can be used to identify existing vulnerable infrastructure and operations and to better plan future infrastructure to adapt to climate change. For example, the Federal Highway Administration is developing an Adaptation Framework that will help shape future surface transportation decisions to account for climate change by applying vulnerability and risk assessment tools and methods. The Department is also embarking on Phase II of the Gulf Coast Study, which will provide more detailed information on infrastructure impacts that can be used as a basis to revise design criteria where needed. Phase II will also produce a risk assessment tool to be used by transportation planners to evaluate and respond to potential climate change risks as they plan our future transportation systems.

Q4. How is the DOT reacting to address the research and data needs identified by the other witnesses? Also, these research needs have a large social science component. How does the DOT currently address social science needs related to transportation and how will the Department address social science in the future?

A4. The witnesses identified several research and data needs. The Department is working on many of the areas. Further information on DOT activities is provided in an attachment.

Modeling/Tools/Data

The Department agrees with the need to improve travel models and data, as mentioned by Ciarlo, Rilett and Winkelman. This need is also supported by the National Academy of Sciences Special Report 288: *Metropolitan Travel Forecasting: current Practice and Future Direction*, funded by in part by the Federal Highway Administration (FHWA). Currently FHWA has efforts underway to develop improved travel forecasting methods through the Exploratory Advanced Research Program, the TRANSIMS program and through the development of Dynamic Traffic Assignment. FHWA, through the Travel Model Improvement Program (TMIP) and the Freight Model Improvement Program (FMIP), is making significant efforts to improve the state of the practice in travel modeling. While FHWA is making major improvements to both the state of the art and state of the practice in travel modeling, improved modeling also requires that data collection be improved in terms of both the quantity and quality of data collected. Improved data will require significant additional funding at the federal, State and local levels.

The Federal Aviation Administration (FAA) is a leader in this area. To address inter-dependencies between noise and emissions, and amongst emissions, the FAA is investing in developing next generation models to better characterize and analyze aviation noise and emissions that influence air quality and climate—and understand their inter-dependencies. The goal is to be in the position to better understand potential trade-offs between fuel consumption, noise, and emissions to better inform decisions of how we anticipate aircraft to be designed and operated to minimize environmental impacts—and better target our resources in effective mitigation strategies. Until recently, technology, policies, and standards for noise and emissions tended to be “stove-piped”—both in industry and in government. However, there is an increased recognition that a more complete understanding of the complex inter-dependencies that exist is required for designing and regulating aircraft.

The suite of models FAA is developing comprises the Environmental Design Space (EDS), Aviation Environmental Design Tool (AEDT), and the Aviation Environmental Portfolio Management Tool (APMT). Each model in the suite provides a key component of a valuable integrated decision-making capability. EDS generates performance, cost, source noise and exhaust emissions data under an aircraft design environment capable of simulating future aircraft characteristics. AEDT computes and identifies interrelationships between noise, fuel consumption, and emissions at the local, regional, and global levels for base years and future forecasts and scenarios. Using data from EDS and AEDT, APMT provides the capability to compute economic, climate and health impacts, while assessing the cost-benefit of mitigation strategies. Individually, these tools provide critical data, but as an integrated suite, they can aid government and industry in considering technological, operational, and regulatory measures to more effectively control aviation fuel consumption, noise and emissions.

Pavements

FHWA has ongoing research and technology implementation activities in the area of warm-mix asphalt, recycling of asphalt pavements, and perpetual pavement design and construction. These are preliminary efforts to advance the technologies. Past experience with the implementation of *Transportation Research Board (TRB) Strategic Highway Research Program* findings demonstrated that it can take 10 to 15 years to make changes in the typical practices used by State and local highway agencies. The efforts Mr. Acott lists are similar to those identified by FHWA as critical to improving the environmental sustainability and overall performance of the Nation's highways, but it will take a sustained effort to complete the research and implement the technologies.

Non-Motorized Travel

Much of what will influence concerning climate change mitigation pertains to human behavior and the types of decisions people make. These types of decisions vary and include how far from work people decide to live; what mode of transportation (e.g., drive, transit, carpool, walk, or bike) to take; what type of car to own; and decisions made by transportation professionals and policy-makers. The Department has activities underway to address these different types of decisions as they relate to walking and bicycling.

Currently several of the Non-Motorized Transportation Pilot Program (Sec. 1807 of SAFETEA-LU) communities are using an approach modeled in Portland to increase rates of walking and bicycling. Findings from the Pilot Program will be released in the future. The Federal Safe Routes to School Program is also collecting data that can be used to evaluate behavioral changes related to trips to and from

school. FHWA plans research to improve travel modeling for walking and bicycling trips.

FHWA funds and manages several information clearinghouses including the Pedestrian Bicycle Information Center and the National Center for Safe Routes to School. These resources provide information to the general public, transportation professionals, and decision-makers about how to increase rates and safety for walking and bicycling.

Climate Change Mitigation and Adaptation

The Department has a number of activities and research projects under way relating to climate change mitigation and adaptation, sustainability, and sequestration. These are described in an attachment.

Outreach and Public Education

Education of stakeholders and the general public will provide input for actions to meet U.S. emission reduction goals. Outreach is critical to enhanced understanding, changes in attitudes, changes in behaviors/choices, and cooperation to reach long-term policy objectives.

With regard to the social sciences and transportation, the Department recognizes that there is not just a single discipline involved. Transportation research has expanded to incorporate this variety of disciplines. For example, the FAA funded and Transportation Research Board managed the Airport Cooperative Research Program, which provides a venue to address issues related to airports and associated social behavior. Other work in the arenas of land use, system efficiencies, and travel behavior throughout the entire Department work on social science endeavors.

Q5. In Mr. Winkelman's testimony, he mentions a new DOT/Housing and Urban Development (HUD) Partnership to Promote Sustainable Communities. When will the DOT/HUD partnership have completed the development of performance metrics identifying research and data needs? What types of performance metrics is the interagency Partnership considering? How far along are DOT and HUD in this process?

A5. It is important to clarify Mr. Winkelman's testimony, as he refers to two separate Department of Transportation efforts. Mr. Winkelman first references the recently announced HUD/DOT partnership that seeks to provide better access to affordable housing and transportation. The partnership will identify strategies to give American families:

- More choices for affordable housing near employment opportunities;
- More transportation options, to lower transportation costs, shorten travel times, and improve the environment; and
- Safe, livable, healthy communities.

The HUD/DOT collaboration would provide incentives for regional and local efforts to integrate housing/transportation and would support development of metrics and evaluation tools.

The Federal Transit Administration (FTA) has begun implementing the action plan in the 2008 FTA–HUD report to Congress, "Better Coordination of Transportation and Housing Programs to Promote Affordable Housing Near Transit." This report outlines strategies to continue and expand coordination in the areas of mixed-income and affordable housing choices near transit. In addition, FTA and HUD have been working as partners to continue development of coordinated, integrated strategies, methods and policies to promote the role of public transportation in affordable housing. FTA is developing a Best Practices Manual—a multi-scenario "how-to" manual—for promoting development of mixed-income housing near transit.

The current HUD/DOT partnership is still developing and will build upon the FTA–HUD collaboration.

The second initiative Mr. Winkelman references is the interagency working group, led by DOT. The Federal Interagency Working Group on Transportation, Land Use and Climate Change is working to develop a list of collective research and data needs. This information will be coordinated with the Secretary's Livability initiative, the HUD–DOT Sustainable Communities Initiative and transportation reauthorization efforts.

Q6. You testified that \$41 million was spent in FY 2008 by the DOT on climate change related research. What projects did that money fund? How are these projects integrated into the DOT's Climate Research agenda?

A6. This figure encompasses a broad range of activities across DOT's modes and includes both projects and programs that have direct and indirect climate change benefits. As transportation both contributes to and is affected by climate change, the Department's research has focused both on mitigation of transportation's contributions to greenhouse gas emissions and adaptation to potential impacts on infrastructure. The Department's mitigation strategies include examining the most effective approaches to improve vehicle fuel economy, reduce the growth of vehicle-miles traveled (VMT), develop alternative fuels, and improve system efficiency. The Department's adaptation strategies include examining opportunities to protect transportation investments in infrastructure, such as identifying vulnerabilities at the regional level and providing tools for transportation planners to use. Examples of such projects include the Gulf Coast study, which analyzed the risk to transportation systems and infrastructure due to the impacts of climate change, FAA's implementation of technologies to reduce fuel consumption, FTA's fuel cell bus grant program, alternative fuels safety research, and many others.

DOT has a Research, Planning, and Coordination program that coordinates, facilitates, and reviews research and development activities. The program was established to ensure that DOT is making the most of its \$1 billion annual investment in research and technology. DOT's RD&T Strategic Plan explicitly lists climate change research as an area in which more study is needed, and I anticipate that it will feature prominently in the next RD&T strategic plan.

Additionally, the DOT Center for Climate Change is the focal point for climate change research and policy within the Department. The activities of the Center feed into DOT's larger RD&T strategy and guide multi-modal efforts in the transportation sector to mitigate and adapt to climate change. The Center consulted with a range of stakeholders representing transportation and environmental interests and various levels of government when it developed its strategic plan for the Center.

The Department also participates in the larger federal structure of climate change research coordination under the Interagency Working Group on Climate Science and Technology. This group coordinates climate change work being done across the entire Executive branch.

The Surface Transportation Environmental and Planning Cooperative Research Program (STEP) established by SAFETEA-LU supports environmental and planning research. STEP research priorities are consistent with the overall priorities set in a Transportation Research Board (TRB) special report. The process for selecting projects to be funded each year is an open process requesting suggested research emphasis areas and activities. DOT also coordinates more generally with various stakeholders, including the TRB of the National Academies of Science, which has several committees that work on projects and issues related to climate change.

Questions submitted by Representative Adrian Smith

Vehicle Miles Traveled (VMT) Based Financing

Q1. Please clarify the Administration's position regarding proposals to transition away from the fuel tax to a vehicle miles traveled (VMT) based financing mechanism. If the Administration is not currently opposed to moving to a VMT-based system, does it plan to undertake policy research on (a) the impact of (and options to mitigate the impact of) a VMT system on existing incentives to purchase more fuel efficient vehicles; or (b) the economic and behavioral impacts of a VMT-based system on rural areas?

A1. Looking ahead to the upcoming reauthorization, the Administration is committed to working with Congress to maintain the short-term solvency and long-term sustainability of the Highway Trust Fund. We will need to explore a range of funding sources for surface transportation, possibly including VMT-based user charges. The Administration has no plans to conduct policy research on the impact of a VMT based user fee on existing incentives to purchase more fuel efficient vehicles, but looks forward to working with Congress to ensure that any research gaps are addressed in the surface transportation bill. We are aware that some studies have examined VMT-based user fees and identified ways to mitigate adverse impacts, including having differential rates based on the fuel efficiency of the vehicle.

The Department is sensitive to concerns about potential adverse impacts of a VMT-based funding mechanism on rural areas as well. Impacts would depend on the specific rate structure of a VMT fee and cannot be analyzed in isolation from other aspects of such a funding mechanism. Again, we look forward to working with Congress in development of surface transportation authorization.

DOT Research Priority Setting

Q2. How does DOT set transportation research priorities across its agencies and programs? What goals or objectives guide R&D budget development and prioritization? What if any changes does the Administration plan to make with respect to processes under which DOT research planning, coordination, and budget development is carried out?

A2. The DOT has two governing bodies—the Research, Development and Technology (RD&T) Planning Council and RD&T Planning Team—that have a role in setting the research priorities across the agencies and programs. The Planning Council members are the heads of the Operating Administration (OA) and meet quarterly to define goals and priorities and set the strategic direction for R&D across the Department. The Planning Team members are the Associate Administrators of R&D from each OA and meet monthly to provide status and review R&D program areas. This RD&T Planning Process is led by the Research and Innovative Technology Administration (RITA).

DOT R&D budget formulation is guided by Secretarial and Administration priorities and goals. Specifically, the operating administrators identify R&D priorities and goals, in addition to defining program areas that address the Office of Science and Technology Policy (OSTP) R&D priority areas.

The Research and Innovative Technology Administration (RITA) is implementing a process agreed upon by the Planning Council last September. The Research Planning and Investment Coordination process joins strategic planning and budget life cycle activities in an effort to increase information sharing, awareness, coordination and joint efforts across the DOT's R&D programs.

The work, recommendations and priorities of other parts of DOT, including the climate center, feed into the R&D planning process.

Transportation Research Agenda

Q3. Does DOT support development of a comprehensive research agenda for transportation? What about a climate-focused research agenda for transportation?

A3. Yes, in fact, the Department established the Research and Innovative Technology Administration in order to better coordinate a comprehensive research agenda. Climate change research will be an aspect of that agenda and contribute to the larger research goals.

Cap-and-Trade

Q4. In response to a question asking how costs of the Administration's cap-and-trade program would be absorbed by consumers, you responded that "We understand that technology, we expect to play a major role in helping to promulgate the efficiencies that are really needed to make these reductions . . . that's primarily what we are looking at."

a. Please clarify this response. Does the Administration believe that technological advances will eliminate the economic costs of cap-and-trade on consumers? If not, is it your expectation that the prices for vehicles, fuel, and goods transported by vehicle (i.e., groceries, manufactured items, etc.) will increase as a result of cap-and-trade? If so, is DOT studying how these energy price increases may uniquely impact the transportation sector and related industries, such as trucking and the increased cost of shipped goods such as groceries? If so, please describe the scope and objectives of such research.

A4. The Department believes that technological advances will ameliorate, but not eliminate, the costs of any cap-and-trade program. Technological advances will be essential in order to achieve the deep, long-run cuts in global greenhouse gas emissions that will be required to stabilize the climate.

While prices for fuels and perhaps vehicles may rise, the Administration advocates cap-and-trade because cap-and-trade provides greater certainty in the level of greenhouse gas emissions than tax mechanisms, and programs can be effectively integrated into other countries' programs to promote broad clean energy approaches to cutting emissions. These benefits include reducing the economic cost and national security consequences of our dependence on imported oil, avoiding the damage to the economy from volatility in oil prices; the environmental benefits of addressing climate change; reduced emissions of urban air pollutants, and positioning U.S. industry and the U.S. economy to address the requirements of the 21st century. The costs of inaction may be greater than the costs of action.

DOT has not yet undertaken any specific study of how energy price increases may affect the transportation sector, however the impacts on the sector will be important to understand.

Questions submitted by Representative Ben R. Luján

Q1. You responded in the hearing that DOT does coordinate energy and environment related programs, like battery research and hydrogen fuel cell technology, with the Environmental Protection Agency (EPA) and the Department of Energy (DOE). Could you please provide the Committee with the specific research, development, and technology programs on which the DOT coordinates with the EPA and the DOE? For each of these projects, what is the specific role of the DOT, and what level of funding does the DOT contribute?

A1. Biobased R&D:

SAFETEA-LU authorized annually \$12.5 million in funds to be equally divided and available to carry out biobased research of national importance at the National Biodiesel Board and at research centers identified in section 9001 of the *Farm Security and Rural Investment Act of 2002* (7 USC 8109), known as the Sun Grant Universities. The sun Grant Initiative is a national network of land-grant universities and federally funded laboratories working together to further establish a biobased economy. DOT oversees the grants and work performed; DOE, EPA and USDA participate in program/project review meetings.

Hydrogen Power Research:

SAFETEA-LU authorizes DOT to provide annually \$750,000 in funds to the University of Montana for use in carrying out the Hydrogen Powered Transportation Research Initiative. DOT coordinated with DOE specifically on Hydrogen Safety Training initiatives.

The Operating Administrations also work closely with DOE and EPA. For example, FTA works with the National Renewable Energy Laboratory of the Department of Energy to assist in the development and evaluation of FTA's National Fuel Cell Bus Program.

DOT coordinated and conducted the Hydrogen Road Tour in August 2008 with DOE as a sponsor. Additionally, DOT, in coordination with DOE, is developing a report to Congress on the Hydrogen program which will address the challenges with building and implementing an infrastructure to support hydrogen fuel.

Report to Congress on Transportation's Impact on Climate Change and Solutions

The *Energy Independence and Security Act of 2007*, signed into law in December 2007, mandates that the USDOT produce a report to Congress on transportation's impact on climate change and solutions for reducing this impact. The study is also to consider co-benefits of fuel savings and air quality improvement. The report is to be completed in coordination with the EPA and the U.S. Global Change Research Program, which includes both EPA and DOE. Operating administrations are providing resources and technical expertise to the USDOT Climate Change Center in order to complete the report.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Catherine Ciarlo, Transportation Director, Office of Mayor Sam Adams, City of Portland, Oregon

Questions submitted by Chair David Wu

Q1. In Dr. Rilett's testimony, he mentioned the travel model TRANSIMS. To what extent are sophisticated, simulation-based travel models available for use by Metropolitan Planning Organizations (MPOs)? What are the barriers that prevent MPOs from using the most state-of-the-art travel models? What needs to be done to make these models more accessible?

A1. Before I get to barriers and suggestions for improvement, I will first address the extent to which models like TRANSIMS are used in metropolitan areas.

Sophisticated travel models

There are two key areas where modeling improvements are required for the larger MPOs. The first of these is the implementation of tour-based models (demand models) that track the travel of individuals through the day. This is critical for proper model response to stimuli such as roadway reliability, dynamic tolling, variable ramp meters, ITS and TSMO intervention, etc. Current models can provide some guidance in these areas, but tour based models have clear advantages.

The second area of improvement is in the field of trip routing (assignment models). Current models assume rather aggregate network attributes (e.g., general capacity, speed degradation algorithms) and vehicle flows that are applied in large blocks of time (one or two hours). The shortcoming of this approach is the fact that traffic dynamics operate at a much smaller time scale. One needs to define travel in much smaller increments to better capture delay metrics.

Availability of modeling tools

Demand models (as described above are operating in a few regions (Sacramento, San Francisco County, Manhattan) and are under development in others (Portland, Denver, Atlanta). These modeling tools are generally difficult to transport between regions due to the special policy levers that must be included in the model for it to be responsive to regionally significant issues.

Assignment models such as TRANSIMS, Dynasmart, VISTA, Transmodeler, Dynameq, and others are available. These tools can route trips in very fine incremental units (second-by-second in some cases). This approach is much better for capturing congestion and traveler information effects in the path choice. Some of these assignment models are open-source; some are commercial products (thus, a purchase fee is required).

Barriers preventing use of state-of-the-art models

There are many barriers that make it difficult for an MPO to implement more sophisticated models.

1. *Staff expertise.* It is difficult to keep staff knowledgeable regarding advanced modeling methods. Training and travel dollars are often limited at the MPO level. The new web-based training techniques are a great help in trying to address this issue—but they are just a start.
2. *Limited time to implement new modeling methods.* Staff are typically fully engaged in project work. Project issues and requirements are becoming more complex. Consequently, more time is needed to complete the work. It is a struggle to find time for staff to even *maintain* the current models.
3. *Risks.* An agency faces risks and uncertainty when the modeling system is changed. If the risks are high enough, they may act as a barrier. Examples of uncertainty include:
 - Model development time—How long will it take? Years? Will it work?
 - Model results—Will the results be similar to the “old” model? If not, how do I know if the results are “better”? What if the new emission estimates no longer meet the conformity budget (where applicable)? What if my New Starts project no longer meets the funding criteria?
 - Hardware/software—Will the new model run on my current computer? If not, what do I need? Do I need to learn new software? How difficult will that be? What if I need to change something—will I need to hire a consultant again?

4. *MPO finances.* Travel modeling requires expertise to understand the model, data to validate the tool, maintenance to keep it viable, and development to make sure it is sensitive to policy questions. The typical MPO struggles to find funds to do all of these elements well given the competing demands for dollars.
5. *Diverse needs.* Models have many “specialty” areas that need to be addressed: trucks, transit, external flows, airport passengers, emissions, land use allocation, non-motorized travel, etc. In addition data needs are critical—traffic counts, household surveys, on-board transit surveys, freight surveys, etc. These are all competing areas for limited research and application dollars.

It should be noted that Association of Metropolitan Planning Organizations will be conducting a MPO survey in the near future, with the goal (among others) of identifying barriers to the use of sophisticated models.

Making sophisticated models more accessible

In order to address the more complex questions emerging in project analysis, more complex models are required. Getting these models into practice is extremely challenging given the items mentioned above. A few action items to facilitate the introduction of more sophisticated models are discussed below.

1. *Grant dollars for implementing advanced models.* Federal dollars should be made available to MPOs to implement advanced models. These funds would help to defray consultant expenses and other associated expenses required to make the transition. The C-10 element of the Strategic Highway Research Program is a good start in providing research funds to develop advanced methods. Funding will be required to help other MPOs to implement those concepts.
2. *Education to modelers.* Web-based training to the Nation's modelers is effective and should be continued. However, MPO training dollars are very limited. The financial means to send staff to the TRB Annual Meeting, Innovations in Travel Demand Modeling Conference, and other venues are not always available. These conferences are noted for the discussion of new ideas.
3. *Mitigation of risks.* A list of issues relating to risk and uncertainty were provided in an earlier section. The Federal Government should work as a partner to the MPO to facilitate the mitigation of the risks. Education and discussion forums can address most of the risk factors. However, there may be some situations where resolution between federal agencies is required.

Please do not hesitate to follow up with clarifying questions.

Q2. How do Metropolitan Planning Organizations (MPOs) use the Household Travel Survey or any other product produced by the Bureau of Transportation Statistics (BTS)? You also mention the need for better data. What types of data should be gathered and who should gather it?

A2. From Metro's perspective, the National Household Travel Survey and other BTS products provide useful aggregate statistics. The BTS data serves as a good resource to analysts looking for comparative information between regions. Thus, it does have value.

However, for model building purposes it not as useful. The national survey provides national averages. It is essentially a summary survey. Model building requires a behavior survey. A behavior survey captures very disaggregate data—information that an analyst can statistically use to determine why a certain choice was made.

Consequently, Metro uses BTS data only when regional comparisons or aggregate statistics are required.

Other data requirements

A significant amount of data is needed in transportation analysis. This data is focused on local conditionals, thus it is best if collected collaboratively by the region. Examples of such data include:

- Household travel behavior survey data
- Traffic (vehicle and truck) count data
- Travel time and speed data
- Auto occupancy data
- External travel data

- Goods movement data
- HOV lane use
- Transit on-board surveys
- Stated preference survey data (auto acquisition, residential choice, value of time, etc.)

Q3. *You recommend research to establish the effectiveness of easy to implement transportation demand and system management strategies like providing travelers real-time information on traffic conditions and using marketing to increase transit and bicycle use. What type of specific research is needed to establish their effectiveness and encourage their adoption? Who would be best suited to perform this research? What are the impediments to implementing these strategies now?*

A3. This question touches on what we hope to see addressed in the next transportation bill. Demand and system management are important tools for combating climate change, and the City of Portland believes national research on the following topics could improve mobility choices, reduce public and private transportation costs and provide substantial environmental benefits.

With specific direction from Congress, the Transportation Research Board could administer a research program with university transportation research centers partnering with local municipal governments.

We believe better data collection would provide the foundation for model improvements, forming the basis for developing and establishing national standards to improve transportation planning, project management and operations.

Data collection needs

- Longitudinal trip characteristic and corridor-specific mode split and VMT data, including sensitivity to pricing, land use, and other variables
- Corridor-specific changes in mode split and VMT following TDM and TSM strategies
- Emission factors from a wider range of vehicles and fuels.

Modeling improvements

- Project Level: develop more reliable model(s) to project TDM and TSM outcomes in specific corridors
- Project Level: integrate TDM and TSM projections into corridor-level traffic models
- Methodology to compare project-level strategies at various investment levels to reduce GHGE and petroleum consumption (highway v transit v bike/ped v TDM v TSM)
- Methodology to project mode split and VMR resulting from various mixes of TDM strategies in different locations (e.g., land use density and mix of uses, proximity to transit/bike/ped facilities)
- Develop methodology to monetize benefits of trips not taken and costs of climate pollution
- Develop mode neutral life cycle cost-benefit analysis
- “tour models” to better predict responses to pricing and congestion
- “Land Use allocation” models more sensitive to impacts of induced demand
- Strengthen models to project non-motorized travel and commercial and freight traffic.

Developing and establishing standards

- Develop mode neutral performance standards for federally funded capacity investments over 30–50 year life cycle: person delay (before, during and after construction), GHGE (construction & operations), land use impacts, cost (public and private, full life cycle), health (physical activity, air quality), energy consumption (construction and operations, public & private sector)
- Mode neutral NEPA alternatives analysis requirements (e.g., must analyze all strategies for contribution to person capacity, GHG, energy, air quality, etc.)
- Robust and reliable multi-modal LOS standards
- Methodology for establishing corridor-level mode split and VMT goals to reduce person-delay and meet GHG reduction targets

- Methodology for projecting “induced demand” from modal capacity investments
- Least Cost Planning scenario planning tool to compare ranges of demand side and supply side investments to meet access, energy, economic and environmental objectives.

This research is probably best done by university staff in conjunction with TRB. The primary impediments to the research projects above are targeted research funding along with requirements and/or incentives to collect data, develop models and propose standards at the federal level.

We appreciate your interest in the Portland metropolitan area's accomplishments and perspectives and would welcome continued collaboration to develop and implement transportation efficiency research concepts.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Laurence R. Rilett, Keith W. Klaasmeyer Chair in Engineering and Technology; Director, Mid-America Transportation Center; Director, Nebraska Transportation Center, University of Nebraska–Lincoln

Questions submitted by Chair David Wu

Q1. In your testimony, you mention the need for making more data available to researchers. What types of data would be useful to researchers? What role should the Federal Government have in collecting this data and making it available to researchers? How should it be collected and disseminated in a form easily used by researchers and others in the transportation community? How useful has the data collected by the Bureau of Transportation Statistics been to addressing the issues you raised in your testimony?

Q1a. What types of data would be useful to researchers?

A1,1a. With respect to 1) modeling and monitoring transportation-related climate impacts, and 2) estimating/identifying the effects of different policies, there are three broad categories of data required.

The first category is data required to model the demand for transportation. In this case the questions that need to be answered are related to 1) where do people choose to live and why 2) where are their activity locations (particularly flexible decisions such as shopping and leisure) 3) how do they choose when to travel, what mode do they take, what route to take, etc. In this situation researchers require data on the various choices available to each decision-maker, the attributes of the decision-makers, the attributes of the alternatives, etc. There is a definite need to accurately identify how people make activity and travel choices which results ultimately in the demand for transportation services.

The second data required is related to the supply characteristics of the transportation networks. Transportation planning models are increasingly becoming simulation based and consequently detailed information on the transportation systems topology (links, control devices, lanes, lane widths, turn bays, transit bus vehicles, schedules, etc., are required). This information is useful for modeling and/or estimating transportation supply or capacity.

It should be noted that, from a practical perspective, it is impossible to model supply and demand separately when analyzing the effects of broad based policy decisions such as those related to climate change—at these scales demand depends on supply and supply is a function of demand. Transportation models typically model the interaction between demand for and supply. In this way policy decisions can be analyzed in a consistent manner for a given urban region.

The third type of data required is empirical emission data. Current environmental models are based on a very limited amount of data based on typical driving cycles. It would be useful to have access to observed point location data and/or tail pipe data. The former would be obtained from pollutant measuring equipment placed throughout a network and the latter would portable emissions measuring devices located on vehicles. This type of data would be useful for developing detailed emissions models that would complement the detailed demand and supply models that are currently being developed.

Q1b. What role should the Federal Government have in collecting this data and making it available to researchers?

A1b. Having a database for these types of data would be extremely helpful to researchers who are working on the next generation of transportation models that are designed to answer the questions posed by the Subcommittee on Technology and Innovation. A detailed database format along with detailed information from specific households in specific cities would be particularly useful. Note that the most useful databases will be “consistent” in the sense that the data will be for the same households across multiple decisions. Given the Federal Government’s current role in collecting census data and transportation data I would envision this as consistent with what is already taking place. I doubt that any local or State agencies would have the resources to undertake a comprehensive data base of the type discussed in these hearings.

Q1c. How should it be collected and disseminated in a form easily used by researchers and others in the transportation community?

A1c. Intuitively having easy Internet access to the data bases should be encouraged as this would make it easily accessible to as wide a range as possible. The data that

is collected, its format and its level of detail could be decided through consultation with researchers who are working on these difficult modeling questions.

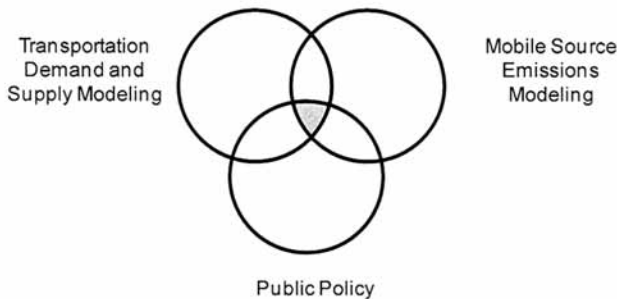
Q1d. How useful has the data collected by the Bureau of Transportation Statistics been to addressing the issues you raised in your testimony?

A1d. In my experience the BTS data has been very useful on many of the research projects that I have been involved in. The issue is really that we are now being asked to answer questions to a level of detail that our current models were not designed to answer (e.g., climate and transportation related). More problematic is that the detailed data required to develop highly accurate models that predict traveler changes (and hence affect on climate) to critical public policy decisions does not currently exist.

Q2. Which disciplines should be covered under a multi-disciplinary research agenda that, as you suggest in your testimony, would be comprehensive enough to create information and tools decision-makers can use to fully be able to predict and understand the impacts of transportation climate change mitigation and adaptation strategies? What should the role and application of social science be in such a research agenda?

Q2a. Which disciplines should be covered under a multi-disciplinary research agenda that, as you suggest in your testimony, would be comprehensive enough to create information and tools decision-makers can use to fully be able to predict and understand the impacts of transportation climate change mitigation and adaptation strategies?

A2,2a. As was discussed during the hearing the problem is so complex that no single discipline can solve them on their own. The simplified schematic shown below captures the essence of the problem.



The transportation supply modeling is related to the physical network and historically has been the purview of scientists and engineers. Similarly the mobile source emissions field is dominated by the physical sciences. The demand modeling is related to activities of individuals and households—by definition this is a social science field with a heavy influence of psychology and economics. The public policy options are derived from a variety of disciplines including business, economics, urban planning and engineering—as well, as from the decision-makers themselves. The only way the goals, as outlined by the Committee, can be achieved is if the models encompass all components—and this is represented by the shaded portion of the diagram.

It should be noted that the above conceptual model feeds transportation related information to other models that forecast climate change effects.

Q2b. What should the role and application of social science be in such a research agenda?

A2b. As indicated above the social sciences are critical for answering the questions posed by the Committee. For example, the modeling of individual and household activities, and hence their need or demand for transportation, is critical. In addition, knowing how these individuals and households react to various policy initiatives (e.g., a congestion tax) within the context of their own households is critical if reliable public policy information is required. The fact that all of the components are interrelated (e.g., congestion taxes affect not only the individual making a decision but all other decision and these need to be accounted for) ensures that only multi-

disciplinary teams with a strong social science component will have the greatest likelihood of success.

Q3. The definition applied for sustainability will determine the objectives of transportation decision-makers, and, as your testimony further notes, to understand the trade-offs between the various goals of safety, congestion relief, and minimal environmental impact need to be explicitly and empirically accounted for in the decision-making process. Do adequate tools exist to account for these tradeoffs? If they do not, what types of R&D should be performed to create these tools? Who should perform this research?

A3. There are analysis and forecasting tools for each of these areas. However, these models were developed in isolation and used data of widely differing accuracy. Similar to the transportation planning issues discussed in questions 1 and 2 many of these tools are inadequate for the types of questions that are of interest to policy-makers. For example, while there has been significant work on accident safety models it is also generally accepted that the quality of the data is such that the models are not as comprehensive as they should be. It is doubtful whether the existing models could be patched together to answer the type of multi-dimensional questions (e.g., what is trade-off between safety and environment for policy option X) discussed in the hearing.

A more comprehensive question is related to the inter-relationships/interconnectedness between the different systems and how these affect the decision-maker's objectives. For example, reducing NO_x through engine emissions tends to increase CO emissions, all else being equal. However, improving fuel efficiency through aerodynamic improvements reduces both types of emissions. Reducing fuel efficiency through the use of lighter vehicles could potentially reduce safety to occupants. To date there are no comprehensive tools which can explicitly identify the tradeoffs and which can provide the information required by decision-makers.

Similar to before this interconnectedness means the problem is very complex and will require a multi-disciplinary solution. In my experience the best way to address these complex problems is through centers that have faculty from multiple areas working together collaboratively.

Q3a. You also mention the need to monitor key performance indicators for sustainability. Could you please provide some examples of potential indicators and how they might be measured?

A3a. The metrics that are required by decision-makers are, not surprisingly, related to the goals of the decision-makers. This is why I often stress that it is important to talk about the overall goals before collecting data and/or deciding on performance indicators. Table 1 list some key sustainability objectives and relevant metrics. This list is by no means exhaustive but it does indicate the scale of what might be required.

Objective:	Performance measures:
• Maximize accessibility • Maximize comfort and convenience • Maximize economic benefit • Maximize equity • Maximize livability • Maximize mobility • Maximize pedestrian and bicycle usage • Maximize productivity • Maximize reliability • Maximize safety • Maximize security • Maximize transit usage • Minimize air pollution • Minimize private vehicle (auto) usage • Minimize capital costs • Minimize congestion • Minimize displacement • Minimize ecosystem impacts • Minimize energy consumption • Minimize noise impacts • Minimize operating costs • Minimize travel cost • Minimize travel time	• Number of travel objectives that can be reached within an acceptable travel time • Frequency of service • Jobs added • Percentage of population within walking distance to transit services • Number of major services within walking distance of residents • Travel rate • Quality of pedestrian and bicycle environment. • Operating cost per passenger trip • Variance of point-to-point travel time • Accident rate • Incidents of crime • Mode split • Concentration of HC, NO_x, and CO emissions • Vehicle-miles of private vehicle (auto) travel • Capital cost • Total delay • Acres of land acquired • Area of wetlands taken • Per capita fuel consumption • Noise levels • Operating cost • Point-to-point out of pocket travel cost • Point-to-point travel time

In general, there are a number of key attributes to consider when choosing a performance measure. Attributes of a “good” performance measure include:

- Acceptable to the decision-maker
- Accurate within the decision context
- Affordable
- Measurable
- Relevant
- Sensitive
- Timely
- Understandable

This list is not exhaustive but it is clear that the attributes can conflict so picking the “best” performance measure is not always straightforward. For example, a highly accurate measure might not be affordable. As discussed in the hearing it is difficult to identify the best measures without a thorough understanding of the decision context. However, it can be stated that the data that is required to calculate many of the sustainability measures is not currently available.

Q4. You mention that Intelligent Transportation Systems (ITS) can play an important role for both data collection and reducing the energy consumption of freight movement. What are some examples of these applications? Are they currently being employed? If not, what are the barriers to using these technologies?

A4. ITS data collection systems can be broken down into three types. The first are collected at point locations (e.g., volume, occupancy, speed). These systems are automatic in the sense that the data is not counted by a person—although they may require significant calibration which may include manual comparisons. This type of technology includes inductance loops, cameras, radar detectors, etc. Most cities have these systems and while the data is typically used for real-time operations they are often stored for later use (e.g., transportation models). The issue is that there is so much data that it is difficult to store the data in a user friendly manner. As well, because the data is not collected for modeling it often has errors which, while appropriate for real time applications, might be problematic for off-line applications.

The second type of data, and which is considerable more useful, is data on individual vehicles. Vehicles that have GPS units installed can provide very detailed information on their movements—needless to say this detailed information, such as acceleration profiles and route choices, would be useful for modeling supply relationships as discussed in the answer to question 1. The biggest barrier is related to privacy—while data from publicly owned vehicles can be obtained privately owned vehicle data, both passenger and freight, is difficult. As aside transportation related data from cell phones has great potential and there are numerous projects underway to use this data—the potential is large and some anticipate that standard data collection devices may become obsolete.

The last type of data comes is a cross between the previous two. This type of data comes from vehicles that are equipped with Radio Frequency Identification Devices (sometimes known as Automatic Vehicle Identification data) similar to that found on toll tags used on toll ways.

Readers located throughout the network can obtain vehicle and time information from the vehicles as they traverse the network. From this travel time can be calculated, routes identified, etc. The Nebraska Transportation Center at the University of Nebraska–Lincoln is studying the feasibility of using RFID technology in state license plates for commercial vehicles. There are numerous benefits to using this technology including law enforcement, logistics support, data collection, etc.

The most useful data from a researchers point of view is the disaggregated or individual data (e.g., GPS/cell phone data from individual users that has not been averaged). The biggest issue is one of privacy—however, given the appropriate safeguards this data is extremely valuable for developing the models discussed in question 1 of this response.

Q5. In your testimony, you describe how current emissions models are not compatible with detailed, simulation based transportation models. What work needs to be done to improve their compatibility? Who should perform this work?

A5. As discussed earlier much of the transportation modeling work is related to simulation based models. These models have the potential for providing second by second vehicle trajectories. Because the relationship between fuel consumption, emissions, etc., is highly non-linear with speed it is critical to have accurate speed profiles in order to have accurate emission estimates. Unfortunately both the state-of-the-art and state of the practice emission models use standard driving profiles—from this data models of emissions for different speeds are provided. There are very few models developed based on empirical measurements of tailpipe emissions and acceleration profiles—and those that are based on a very limited amount of data. If a comprehensive data set were available then emission models that are compatible with traffic simulation models could be developed.

Because of the complexity of the work a multi-disciplinary approach would be required and these efforts are typically best done by centers. For example, experts on emission measurements, statistics, traffic, etc., would need to work on this topic.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Steven Winkelman, Director of Transportation and Adaptation Programs, Center for Clean Air Policy (CCAP)

Questions submitted by Chair David Wu

Q1. You recommend that Congress require greenhouse gas (GHG) emissions measurement for major projects and metropolitan transportation programs to assess the climate impact of federal infrastructure investment. How would these emissions be measured, reported, and compared if current emissions models cannot account for the complexities of transportation-based emissions? What more needs to be done to enable reliable measurement?

A1. Regular measurement of key transportation variables at multiple scales will enable effective tracking and reporting of the GHG impacts of transportation projects and Transportation Improvement Programs (TIPs).

- a) The most fundamental information we need to track GHGs as well as calibrate and improve travel models is **more frequent and better measurement of metropolitan and State travel activity**.
- b) States and Metropolitan Planning Organizations (MPOs) should **measure and report annual transportation GHG emissions** using the best available data.
- c) **States and MPOs should estimate the projected GHG emissions impacts of their State Transportation Improvement Programs (STIPs), TIPs & Long Range Transportation Plans (LRTPs)** using the best data and models they have available.

In addition to the benefits of measuring GHG emissions, these measures would also help track progress on a number of policy priorities such as accessibility/mobility, system preservation, safety and energy security. Below I provide some comments on each of these issues. Funding for these measurement, modeling and reporting activities could be accomplished with the one percent of federal funding applied to measurement and evaluation, as I recommended in my written testimony.

- a) There are a few high priority steps for improving the **quality and availability of metropolitan and State travel data** (additional recommendations are included in my written testimony):

1. *Conduct more frequent and better MPO travel surveys*

Metropolitan travel surveys provide core data for tracking travel behavior and calibrating regional travel models. MPOs typically conduct travel surveys only every decade and often face funding challenges to do even that. MPOs should update travel surveys more frequently, such as every four years consistent with their regular TIP & Long Range Transportation Plan (LRTP) updates. In addition to collecting data on passenger vehicle movements, survey updates should include stratified sampling focused on transit, pedestrian, bicycle and telecommuting data.

2. *Collect and analyze odometer data and retail fuel sales data*

Geographically specific travel and retail fuel sales data can help track local and regional travel behavior, improve our understanding of land use influences on travel behavior, help establish GHG baselines, aid policy evaluation and improve predictive capabilities of travel models. The **Department of Transportation (DOT), Environmental Protection Agency (EPA), the Department of Energy (DOE) and the Internal Revenue Service (IRS) should cooperate to establish a program to help all states collect and analyze odometer data and local fuel sales data**. For states with existing vehicle inspection and maintenance programs, much of the odometer data are available and need to be processed and analyzed; for other states new collection efforts would be needed. More research and coordination is needed to assess how best to track retail fuel sales at the service station level.

3. *Collect and analyze electronic travel data*

Travel data derived from electronic collection tools such as transponders, GPS, and cell phones—following industry standards to protect privacy—would provide a valuable data stream for assessing real-time transportation system performance and associated GHG emissions. Pilot programs to in-

stall and test electronic data collection devices would jump-start the data gathering process.

- b) **States and MPOs should measure and report annual transportation GHG emissions** using the best available data. Current State and MPO vehicle miles traveled (VMT) measurements and estimates provide a strong starting point for calculating GHG emissions and will improve as travel data improve with the sources mentioned above.
- c) States and MPOs should **estimate and report the projected GHG emissions impacts of their STIPs, TIPs & Long Range Transportation Plans (LRTPs)** using the best data and models they have available. Current travel models provide a good starting point for estimating future transportation GHG emissions based on specific combinations of projects and policies. States and MPOs should document and attempt to account for known shortcoming in their models that would affect GHG estimation. At a minimum, they should qualitatively note likely directional effects, such as where their models may over- or under-predict specific elements of travel behavior (e.g., freight, induced demand, micro-level land use). States and MPOs should also attempt to quantitatively address shortcomings via analytical techniques (e.g., model “post processing”) tapping the latest technical research literature. As part of their efforts to improve travel modeling, DOT and EPA should provide guidance to states and MPOs on these qualitative and quantitative approaches. As data, measurement, travel models, and modeling capacity improve, we will have increasing confidence in modeled GHG projections.

The metropolitan scale is most appropriate for tracking system-wide GHG performance. However, for **large-scale transportation projects**, analysis of GHG impacts with and without the project would be appropriate. Project GHG impacts should be projected using travel models as well as calculated from measurement of key variables (VMT, transit use, mode split, etc.) before and after project implementation at the appropriate geographic scale (e.g., site, corridor, city). Before/after analysis is necessary but insufficient to determine impacts with/without the project—adjustments may be needed to account for changes in regional factors (e.g., economic growth) or travel behavior in ‘control’ areas with similar transportation and demographic characteristics.

Q2. Many note the need for a performance-based approach to transportation policy. In your testimony, you suggested a research program to develop these metrics. What are some of these metrics? What would be the timeframe to develop these and who is best suited to develop them? How can they influence transportation policy in the short-term, particularly in the context of reauthorization?

A2. Transportation performance metrics should cover the key goals of a national transportation such as maximizing: accessibility/mobility, safety, reliability (state-of-good repair), environmental protection, energy security, economic efficiency and equity. Good metrics should allow decision-makers to evaluate the trade-offs among goals in selecting policy packages that meet national priorities. Performance measures must also be practical—based on available data, and effective—to measure as directly as possible the desired policy outcome. Finally, we should minimize the number of metrics to maximize the efficiency of data collection; metrics that measure multiple goals at the same time could achieve this.

With this in mind we recommend the following measures:

- Total GHG emissions and GHG emissions per capita
- Total VMT and VMT per capita
- Regional accessibility
- Bicycle/pedestrian accessibility

The most direct climate protection measure is total GHG emissions. GHG per capita is also a proxy measure of transportation system efficiency because an inefficient network wastes fuel. Transportation GHG emissions can be estimated with geographically specific data on fuel use, or by a calculation based on VMT and fuel economy data. Wholesale fuel sales data are currently available at the State level, and, as I mention in response to Question 1, retail fuel sales data should also be assembled. Fuel economy data are available from EPA, and should be improved via real-world measurement as suggested in the “CCAP Recommendations to Improve Travel Data and Modeling to Support Climate Policy and Performance-Based Transportation Policy” (recommendation number 4). VMT data are currently available at the metropolitan and state levels and are the only available measure of in-state and

in-region GHG-emitting transportation activity (because fuel sold in one state can be consumed in another).

Total VMT and VMT per capita are critical metrics as they map to several policy goals. For example, lower VMT means not only fewer GHG emissions, but lower fuel use, less exposure to death and injury through crashes and less wear and tear on the system. Also, recent CCAP research indicates that integrated transportation, land use and pricing policies, which are a key way to lower VMT, lead to net economic benefits due to reduced infrastructure costs, consumer fuel savings and increased local tax revenues.¹

To complement VMT measures we also need accessibility measures, which capture the time and cost of the travel for households and businesses to meet their daily needs. Regional accessibility addresses the distance and time needed to travel to jobs and other regional destinations. Bicycle/pedestrian accessibility measures the ability to satisfy daily needs safely within a short distance without using motorized transportation. Both of these types of measures require further research and development to operationalize effective metrics.

Short-term priorities

- Total VMT, VMT/capita, total GHGs and GHG/capita can be measured or calculated by most MPOs right now. Each state DOT and MPO should report total VMT, VMT/capita, total GHGs and GHG/capita on an annual basis, and calculate them in TIPs and LRTPs, subject to guidance from DOT and EPA.
- DOT, with EPA assistance, should study accessibility measures so that they can be incorporated into performance metrics within the next one to two years.
- This year, EPA and DOT should calculate the GHG, VMT and economic impacts of a variety of surface transportation bill configurations, including consideration of smart growth and travel demand management policies, induced demand and net economic co-benefits such as avoided infrastructure costs and local economic development.

Q3. You mentioned the new DOT/Housing and Urban Development (HUD) Partnership to Promote Sustainable Communities, which, lead by DOT, is developing performance metrics and identifying research and data needs to support an integrated regional planning framework. What types of performance metrics is the interagency Partnership considering?

A3. My understanding is that DOT and HUD are in the early stages of their discussions on performance measures as part of an Interagency Work Group on Transportation, Land Use and Climate Change. I am not aware that any work on performance measurement under the DOT/HUD Sustainable Communities Initiative is underway.

Q4. In your testimony you recommended that the Transportation Research Board (TRB) conduct a study and develop recommendations on the highest priority data and modeling improvements for climate-related performance-based transportation systems. Why should TRB do this instead of the Federal Highway Administration or the DOT Center for Climate Change? Also, given that this study will not be completed in time for this reauthorization, what would you recommend for data and modeling investments for the next five years?

A4. The mission of the Transportation Research Board is to “provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multi-modal.”² TRB is a logical choice for this effort given its strong reputation and long history of data research. In fact, this summer TRB will release a report on a recommended research program on transportation GHG mitigation, a draft of which proposes forming a panel to develop recommendations for improving travel data to support GHG reduction planning and policies.

In the CCAP Travel Data and Modeling Recommendations, we call for a study to “develop recommendations on the highest priority data and modeling improvements with recommendations for, and participation from, Federal, State, MPO and local

¹ S. Winkelman and A. Bishins, “Growing Wealthier: The Economic Benefits of Smart Growth (sneak preview),” Transportation Research Board Annual Meeting, January 2009: [http://www.ccap.org/docs/resources/567/Winkelman%20%20Growing%20Wealthier%20\(TRB%20Jan%202009\).pdf](http://www.ccap.org/docs/resources/567/Winkelman%20%20Growing%20Wealthier%20(TRB%20Jan%202009).pdf)

² http://www.trb.org/news/blurp_detail.asp?id=8037

governments, as well as experts from the private sector, academia and NGOs.” That would certainly include DOT as well as EPA and DOE.

FHWA plays a critical role in collecting and improving travel data and its expertise should be tapped in this process. The DOT Center for Climate Change has conducted high quality research in spite of limited funding and would also be an important partner in this work given its multi-modal perspective. EPA will be an important partner given its work on tracking emissions, developing emissions models and researching transportation GHG mitigation strategies on all three ‘legs of the stool’ (vehicles, fuels and VMT). DOE and the Energy Information Administration have expertise in tracking and modeling fuel use and therefore also have an important role to play.

Over the next five years, we will need to:

- **Collect passenger and freight travel data of higher quality, at finer geographic resolution and more frequently than before.** All levels of government will need to be part of the data collection:
 - At the local and MPO level we need to collect:
 - Travel demand utilization data (e.g., household travel surveys, transit surveys, freight commodity data, and traffic counts);
 - Transportation system data (e.g., roadway center line, transit lines and traffic signal timing);
 - Land use data, including (e.g., parcel GIS data files, housing and jobs inventories); and
 - Demographic data (e.g., census data monitoring, analysis and integration).
 - At the State Level we need to collect:
 - Odometer and retail fuel use data.
 - At the National Level we need:
 - Guidance to states and MPOs on GHG measurement;
 - Increased transparency on how federal transportation funds are spent by investment type for specific geographic location;
 - Increased frequency of the National Household Travel Survey (NHTS);
 - Improvement of the Highway Performance Monitoring System (HPMS);
 - To establish a program to help states collect and analyze odometer data and local fuel sales data;
 - To develop a national rotating panel on vehicle and fuel use;
 - To pursue electronic data collection tools;
 - To reinstate the Vehicle Inventory and Use Survey (VIUS);
 - To expand coverage and the detail on the Commodity Flow Survey;
 - Improvement of intercity passenger travel data; and
 - Improvement of the availability of high-resolution data from the Census Transportation Planning Package (CTPP).
- **Develop more accurate travel models** that can address issues such as pricing, freight, land use effects and non-motorized travel, drive cycle impacts on GHGs, plus improved staff modeling capabilities. To achieve this, DOT and EPA should:
 - Expand travel model improvement programs;
 - Provide technical guidance on transitioning to state-of-the-art modeling practice; and
 - Provide guidance and training on transportation, land use and housing scenario analyses.

Q4a. In your view, what is the role of the Bureau of Transportation Statistics in collecting and analyzing travel data?

A4a. The Bureau of Transportation Statistics (BTS) is the logical entity for collecting and analyzing travel data. It will likely need increased funding and time to increase staff capacity. BTS will also need to better integrate into DOT functions so that it can achieve its long sought role as the hub of data and information for the Department. The Needs Assessment that was mandated in SAFETEA-LU but

not yet carried out should be funded with an added criteria to address GHGs and VMT.

Q5. What should the role and application of social science be in such a research agenda?

A5. Social science is critical for understanding how and why people decide where to live and work or make travel decisions. Such research can inform which combinations of policy tools may be most effective at reducing GHGs, including pricing strategies, increased travel choices and educational campaigns. Market, demographic and sociological research on tipping points as to how and when specific vehicles or communities become popular will be important for understanding the barriers to and estimating the market penetration of, for example, smaller vehicles and walkable communities.

Q6. In your testimony you suggest a national rotating panel on fuel use. Who should be involved in this and what would be the panel's activities?

A6. A rotating panel is a sample of persons, households or establishments selected to participate at a particular point in the longitudinal sequence of a survey; for example, the Consumer Expenditure Survey. In a rotating panel survey the sample units have a fixed duration. As they leave the sample, they are replaced by new units which are introduced at specific points in time.

In a national rotating panel on vehicle fuel use, a random sample of households would report odometer readings and fuel purchases on a regular basis, with a portion rotated out periodically and replaced with new, randomly selected households. For example a sample of 5,000 households could report monthly, for 12 months, with a percentage of the panel rotated out based on proven statistical methodology (e.g., 25 percent of the panel rotated out every quarter, or the entire panel replaced every year). This could also be coupled with GPS or travel diaries to provide richer temporal and geospatial detail on travel behavior.

Q7. You mention the need for applied research on smart growth planning. Who should be involved in developing this research agenda and what would it entail?

A7. Key parties that should be involved in this developing this research agenda include:

- Federal agencies: EPA: Smart Growth Office, Office of Transportation and Air Quality; DOT: Federal Transit Administration, Federal Highway Administration; HUD
- Leading university transportation planning departments (e.g., University of California, MIT, University of Utah)
- Leading State air and transportation agencies (e.g., California Air Resources Board, California DOT), MPOs (e.g., in the follow regions: Portland, Oregon (Metro); Sacramento (SACOG); San Francisco (MTC); and Seattle (PSRC)), local governments (e.g., NYC, San Francisco, Seattle, Chicago) and transit agencies (e.g., New York Metropolitan Transit Authority, Bay Area Rapid Transit)
- Leading research organizations (e.g., Urban Land Institute, Smart Growth America, the Center for Transit Oriented Development, the Center for Neighborhood Technology, CCAP, the American Public Transit Association, TRB)

Key elements of the applied research agenda include:

- Designing implementation projects conducted in partnership with expert researcher teams aiding with project/policy design, monitoring and evaluation.
- Assessing travel behavior of residents/workers/shoppers in recent smart growth developments
- Assessment of induced travel consequences of highway investments and transit investments
- Assessment of synergies between pricing and location efficiency policies
- Assessment of implementation and market barriers such as:
 - "NIMBY" use of environmental review process (e.g., fighting local density without considering regional transportation and GHG efficiency)
 - Fiscalization of local land use decisions (e.g., seeking to attract big box retailers for the tax revenues without consideration of traffic and GHG impacts)

- Conducting a national inventory of places with potential for redevelopment, measured in both real estate market terms and transportation energy intensity, such as:
 - “Greyfield” sites with no rail transit, but strong access to major employment centers (e.g., Southside—Greensboro, NC; Downtown Hyannis—Barnstable, MA; Old Town Wichita, KS)
 - Under-utilized parcels near existing or planned rail transit stations
 - Vacant suburban retail sites with the strongest redevelopment potential (e.g., closed car dealerships and major retailers)
- Among the top 100 places with the most potential a related set of research could evaluate the capacity of local street, sewer, water and other critical indicators of what would be needed to develop compact mixed-use projects
 - This could lead to development of place-specific rating system for allocating infill development incentives including factors such as GHG savings, implementation costs and benefit streams (fuel savings, avoided infrastructure, increased tax revenues)

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mike Acott, President, National Pavement Association

Questions submitted by Chair David Wu

Q1. After re-using or recycling asphalt material into new pavement once, can that same material be re-recycled? Of the 60 million tons of reclaimed material that is reused or recycled directly into new pavements every year, how much has been re-recycled?

A1. A pavement containing reclaimed asphalt can be recycled again and again back into the asphalt pavement. There is no technical limitation to re-recycling, and the economic feasibility of using reclaimed asphalt pavement does not change. Assuming a recycling rate of about 50 million tons of asphalt pavement per year from 1980, and assuming about a 20-year cycle of replacement, and assuming about 10 percent RAP usage, NAPA estimates that about 45 to 50 million tons of HMA have been re-recycled since 2000.

Q2. According to your testimony, warm-mix asphalt, and other environmentally sensitive asphalt paving materials have been successfully deployed. What are the barriers to further deployment of these technologies? What would be the specific components of an applied research program to overcome these barriers? Who should perform this research?

a. *What have been the findings of the Recycled Asphalt Pavement (RAP) Expert Task Group (ETG) in terms of obstacles to increasing the content of recycled asphalt in pavement and eliminating those obstacles?*

A2. While barriers exist to the full implementation of all the strategies listed, most can be overcome through a systematic approach to research and education. The research should be awarded through a process of competitive proposals in which the researcher is selected primarily on the basis of the quality of the proposal and qualifications as judged by a panel of agency, academic, and contractor representatives. Barriers to the deployment of technologies and research to address these for each technology discussed in the testimony include the following:

Perpetual Pavement

Barriers: Although Perpetual Pavements are generally acknowledged as achievable, designers in U.S. agencies look to the use of standard materials and pavement sections. While these serve well in the current environment, it is possible that innovation could lead to more efficient designs through the use of innovative materials such as high-modulus materials and longer-lasting pavement surfaces.

Research Needs: An investigation is needed to explore the use of stronger materials deep in the pavement structure which would allow for thinner sections, thus conserving resources and energy in the initial construction. Research into longer-lasting pavement surfaces would reduce the frequency with which resurfacing is done, reducing traffic congestion and the consumption of resources over the life cycle.

Warm-Mix Asphalt

Barriers: While many agencies have developed permissive specifications for warm-mix asphalt, others have not embraced the new technology completely. Concerns about the long-term performance of the material are among the reasons for not moving forward. However, the country cannot afford to wait twenty years for the deployment of warm-mix.

Research Needs: The assurance of long-term performance and durability to agencies which are reluctant to implement warm-mix are the most important issues to be addressed, and there are two approaches needed. First, a laboratory assessment of warm-mix performance properties, including moisture susceptibility, in comparison to hot-mix asphalt will be very compelling in proving the durability. Secondly, a program of accelerated pavement field testing of warm-mix asphalt mixtures under traffic will give a quick turnaround that is needed by the industry while providing agencies with the proof needed of field performance.

Increased Use of Reclaimed Asphalt Pavement

Barriers: The RAP Expert Task Group has identified the following as some of the primary reasons for limiting or not allowing the use of reclaimed asphalt pavement in asphalt mixtures: 1) Uncertainty about the effect of higher RAP on binder prop-

erties, 2) Concern about the variability of RAP and its impact on performance, and 3) Past performance (10 or more years ago) of RAP-bearing mixtures.

Research Needs: The development of performance-based tests and acceptance procedures would address the concerns listed above because a producer would be tasked to meet a particular performance measure rather than worrying about the specific recipe being used to formulate his mixture. While these performance-based tests and criteria are crucial to increasing the use of RAP in asphalt mixtures, they would serve a broader purpose in encouraging innovation in the design of all asphalt mixtures.

Porous and Open-Graded Asphalt Pavements Barriers: Some local authorities allow the construction of porous pavement but require complete redundancy of the stormwater mitigation process, making porous pavement unattractive economically and consuming resources unnecessarily. In addition, some federal, State, and local authorities do not acknowledge porous pavement as a bona-fide water treatment process.

Research Need: More work is needed to document the efficacy of porous pavement in pollutant removal, water quality restoration, and stream flow mitigation. This documentation could then be translated into standards for agencies that have not yet adopted a policy of allowing porous pavement to stand as a runoff mitigation procedure.

Again, thank you for this opportunity to respond to the questions raised during the Subcommittee hearing. The National Asphalt Pavement Association looks forward to working with you as you draft the research title to the next transportation reauthorization bill.