

U.S. Department of Transportation

Research, Development, and Technology Strategic Plan

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Research and Innovative Technology Administration

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List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADA	<i>Americans with Disabilities Act</i>
ANSP	Air Navigation Service Providers
APTA	American Public Transportation Association
AST	Office of Commercial Space Transportation
ATC	Air Traffic Control
CAAFI	Commercial Aviation Alternative Fuels Initiative
CAFE	Corporate Average Fuel Economy
CESTAC	Center of Excellence for Commercial Space Transportation Advisory Committee
CLEEN	Continuous Lower Energy Emissions and Noise
CMV	Commercial Motor Vehicle
CO2	Carbon Dioxide
COE CST	Center of Excellence for Commercial Space Transportation
COMSTAC	Commercial Space Transportation Advisory Committee
CVISN	Commercial Vehicle Information Systems and Networks
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DSA	Detect, Sense, and Avoid
EAR	Exploratory Advanced Research
EDC	Every Day Counts
EEA	Engineering/Economic Analysis
EPA	Environmental Protection Agency
ESC	Electronic Stability Control

FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMVSS	Federal Motor Vehicle Safety Standards
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FY	Fiscal Year
GAO	Government Accountability Office
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPRA	<i>Government Performance and Results Act</i>
HERS-ST	Highway Economic Requirements System - State Version
HUD	Housing and Urban Development
ICAO	International Civil Aviation Organization
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
LTPP	Long Term Pavement Performance
MAP-21	<i>Moving Ahead for Progress in the 21st Century</i>
MARAD	Maritime Administration
MPO	Metropolitan Planning Organizations
NAARP	National Aviation Research Plan
NAS	National Airspace System
NCHRP	National Cooperative Highway Research Program
NEI	National Emissions Inventory
NextGen	Next Generation Air Transportation System
NHS	National Highway System

List of Acronyms (continued)

NHTSA	National Highway Traffic Safety Administration
NSF	National Science Foundation
ORTA	Office of Research and Technology Applications
OST	Office of the Secretary
P3	Public-Private Partnership
PHMSA	Pipeline and Hazardous Materials Safety Administration
PL	Public Law
PTC	Positive Train Control
RD&T	Research, Development, and Technology
REDAC	Research, Engineering, and Development Advisory Committee
RITA	Research and Innovative Technology Administration
RT&E	Research, Technology, and Education
SHRP2	Second Strategic Highway Research Program
SLSDC	Saint Lawrence Seaway Development Corporation
SUV	Sport Utility Vehicle
TFHRC	Turner-Fairbank Highway Research Center
TRAC	Transit Research Analysis Committee
TRB	Transportation Research Board
USC	United States Code
USCG	United States Coast Guard
UTC	University Transportation Center
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VALE	Voluntary Airport Low Emission

Executive Summary

The United States Department of Transportation's (DOT's) Research and Innovative Technology Administration (RITA) supervised the preparation of the U.S. DOT Strategic Plan for Research, Development, and Technology (RD&T Strategic Plan) for fiscal years 2013 – 2018. This RD&T Strategic Plan is required by Congress; Section 52013 of *Moving Ahead for Progress in the 21st Century (MAP-21)* amends Title 23, United States Code (USC) Section 508, "Transportation Research and Development Planning," and states that the Secretary shall develop a five-year DOT strategic plan for research, development, and technology activities.

The *MAP-21* amendment to 23 USC § 508 requires that the DOT's primary purposes for transportation research and development be described and, at a minimum, focus on the following:

- Promoting safety
- Reducing congestion and improving mobility
- Preserving the environment
- Preserving existing transportation systems
- Improving the durability and extending the life of transportation infrastructure
- Improving goods movement

Recognizing that the previous DOT RD&T Strategic Plan¹ had expired in 2010, and anticipating that a strategic plan for RD&T would be required by a new surface transportation authorization bill, a draft plan was developed based on the five goals of the DOT Strategic Plan.²

- Safety
- State of Good Repair
- Economic Competitiveness
- Livable Communities
- Environmental Sustainability

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Within this document, the five DOT goals are merged with the critical issues as outlined by Congress. The sections on research priorities group similar issues or goals. For instance, the goals titled “State of Good Repair,” “Preserving existing transportation systems,” and “Improving the durability and extending the life of transportation infrastructure” are combined in a section entitled “State of Good Repair – Preserving the Existing and Extending the Life of Future Transportation Systems.”

For each research priority area, the RD&T Strategic Plan summarizes expected DOT research outcomes, describes research priority areas for achieving the desired outcomes that are modal-specific or cut across all operating administrations, and lists performance measures to determine the effectiveness of the research.

This RD&T Strategic Plan is based on input from other operating administrations through the RD&T Planning Team and RD&T Planning Council, and from multiple external stakeholders through a period of public comment prior to the development of the plan. In accordance with 23 USC § 508(c), “National Research Council Review,” a completed draft of this plan was reviewed by the National Research Council/Transportation Research Board (TRB) Committee for Review of the U.S. DOT RD&T Strategic Plan. Information and comments from all of these sources have been considered in the development of this plan.

Even though the RD&T Strategic Plan will be applied over a five-year period, it is critical that the RD&T Planning Team reviews it annually—in particular the performance measures—and revises the research strategies as needed. Throughout the writing of this plan, the operating administrations have interacted, through the Planning Team and under the auspices of RITA leadership, to share best practices, innovative research practices, and success stories; going forward, the operating administrations will be asked to continue to provide insights to each other that will help them to successfully manage their own research programs. Through such interaction, the Department’s overall research effort will be strengthened.

It is also important to recognize that the DOT’s research vision cannot be limited to a five-year term. The transportation systems of future generations will be based on research that is defined and initiated today.

The DOT operating administrations will use the RD&T Strategic Plan internally to refine their agency RD&T strategic plans. Externally, the DOT will use it as a critical presentation to Congress when requesting research funding during the annual budgeting process and through various authorization bills. The RD&T Strategic Plan is also expected to initiate a discussion of research priorities among transportation community stakeholders. This discussion will play a key role when selecting specific research projects for achieving the outcomes listed in the RD&T Strategic Plan.

Introduction

Research is an essential part of a robust national transportation system. The development and application of new technologies, designs, processes, and materials are critical to an effectively functioning system. It is through research that the critical issues of the day—transportation injuries and deaths, greenhouse gas (GHG) production, failing infrastructure, accessibility, and economic growth—can be resolved.

At this time of limited resources, research can close the investment gap that exists between available funds and the funds needed to improve our transportation system,

or even maintain the status quo.

Funding research is an investment that pays off through the application of concepts that are proven, via research, to be effective, resulting in a more efficient, durable, and convenient national transportation system.



U.S. Department of Transportation Strategic Goals

This document is the U.S. Department of Transportation (DOT) Strategic Plan for Research, Development, and Technology (RD&T Strategic Plan) covering fiscal years (FY) 2013 – 2018. This RD&T Strategic Plan is aligned with, and supports, the DOT's five strategic goals:

Safety: Improve public health and safety by reducing transportation-related fatalities and injuries.

State of Good Repair: Ensure the U.S. proactively maintains critical transportation infrastructure in a state of good repair.

Economic Competitiveness: Promote transportation policies and investments that bring lasting and equitable economic benefits to the Nation and its citizens.



Livable Communities: Foster livable communities by integrating transportation policies, plans, and investments with coordinated housing and economic development policies to increase transportation choices and access to transportation services for all users.

Environmental Sustainability: Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources.

Congressional Priorities

This RD&T Strategic Plan also incorporates the research, development, and technology priority issues as outlined by Congress in *Moving Ahead for Progress in the 21st Century (MAP-21)*, sec. 52013:

- Promoting safety
- Reducing congestion and improving mobility
- Preserving the environment
- Preserving existing transportation systems
- Improving the durability and extending the life of transportation infrastructure
- Improving goods movement

The five DOT Strategic Plan goals and six congressional research, development, and technology priority issues have been combined into five RD&T priority areas:

- Promoting Safety
- State of Good Repair – Preserving the Existing and Extending the Life of Future Transportation Systems
- Economic Competitiveness and Improving Goods Movements
- Livable Communities – Reducing Congestion and Improving Mobility
- Environmental Sustainability – Preserving the Environment

The funding and implementation of research based on these five priority research areas must be transparent and accountable to the American public, performance-based, and focused on achieving the desired outcomes while maximizing the value of public investment.

As these priorities are met, our Nation's transportation infrastructure will be transformed into a truly multimodal, integrated system that provides the traveling public and

U.S. businesses with safe, convenient, efficient, affordable, and environmentally sustainable transportation choices.

21st Century Challenges

During the 20th century, U.S. highway, transit, maritime, and aviation networks fueled unprecedented economic prosperity and individual mobility by connecting our Nation's cities, towns, and regions to the rest of the world. The U.S. has been well served by our transportation infrastructure, which includes highway, aviation, and railway networks, as well as ports, waterways, pipelines, and transit systems.

In the 21st century, the U.S. transportation system must begin to adapt to changing social, environmental, energy, and economic challenges. Federal transportation programs face unprecedented fiscal challenges, with current dedicated revenue sources no longer adequate to operate and maintain our existing infrastructure or to fund future investments.

Strategic, cross-cutting research can result in new technologies and practices in materials, designs, operations, and maintenance, etc. When these technologies and practices are properly implemented and leveraged across the transportation system through improved coordination and collaboration, they can help close the funding gap by using dedicated funds more efficiently.

Supporting Cross-Cutting Research

The DOT's RD&T efforts span all modes of transportation, covering improvements to the Nation's transportation system and supporting data-driven decision making that addresses national priorities. This RD&T Strategic Plan for FY 2013 – 2018 takes a Department-wide, systems-level view of the multimodal transportation system and presents strategies for each of the research priority areas that go beyond a modal-oriented and modal-funded perspective. The priority areas, outcomes, and performance measures described in the RD&T Strategic Plan are designed to guide the investment of RD&T in ways that will result in measurable improvements to our Nation's transportation system.

The DOT's Research and Innovative Technology Administration (RITA) supervised the preparation of this RD&T

Strategic Plan with input from all of the DOT operating administrations and the Office of the Secretary; the RD&T Planning Council, made up of the heads of the operating administrations, the Under Secretary for Policy, and other senior DOT leaders; and the RD&T Planning Team, including the operating administrations' Associate Administrators for RD&T or equivalent. The result is a cross-modal development of research strategies and collaboration at the highest levels of the DOT.

The DOT operating administrations are:

- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Administration (FTA)
- Maritime Administration (MARAD)
- National Highway Traffic Safety Administration (NHTSA)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Research and Innovative Technology Administration (RITA)
- Saint Lawrence Seaway Development Corporation (SLSDC)

Each operating administration receives funding designated for RD&T. Table 1 shows RD&T funding by operating administration. The DOT operating administrations receive RD&T funding through annual appropriations or multiyear funding authorizations. Some operating administrations receive funding through a combination of annual appropriations and multiyear authorizations. MARAD and SLSDC do not receive funding for RD&T and are not included.

The Role of Federal Transportation RD&T

Transportation RD&T has the potential to unlock transformative solutions that can lead to dramatic improvements in our Nation's transportation systems. Federal investment in transportation RD&T has led to the development of new materials, innovative production methods, and powerful design and planning tools. It also provides decision makers with information and knowledge to make better decisions, and provides operators with technologies and tools to solve problems and enhance system performance.

Because the Federal Government owns and operates only limited portions of the Nation's transportation system, RD&T investment represents one of the most effective ways the Federal Government can contribute to the improvement of our transportation system.

Table 1. RD&T FUNDING FY 2010 – 2014*

Admin.	FY 2010 Actual (\$000)	FY 2011 Actual (\$000)	FY 2012 Actual (\$000)	FY 2013 Enacted (\$000)	FY 2014 Pres. Bud (\$000)	Annual App.	Multi Year Auth.	Comb.
FAA	398,535	325,776	357,451	315,891	328,050			X
FHWA⁺	434,315	430,135	410,665	365,352	374,000		X	
FMCSA	9,391	6,959	6,959	8,526	9,000		X	
FRA	37,613	35,030	35,000	34,930	90,000	X		
FTA[§]	65,770	58,882	44,000	41,694	49,000			X
NHTSA	68,432	66,674	65,282	62,832	73,725			X
PHMSA	8,584	8,567	8,636	8,639	14,530		X	
RITA	6,036	1,433	1,407	1,333	2,618			X

*RD&T administrative expenses are excluded from the table above.

+Includes funding for three programs administered by FHWA (Highway Research and Development, Technology and Innovation Deployment, and Training and Education), as well as two programs administered by RITA (Intelligent Transportation Systems and University Transportation Centers).

§Includes funding in FY 2010 – 2012 for the University Transportation Centers Program, administered by RITA.

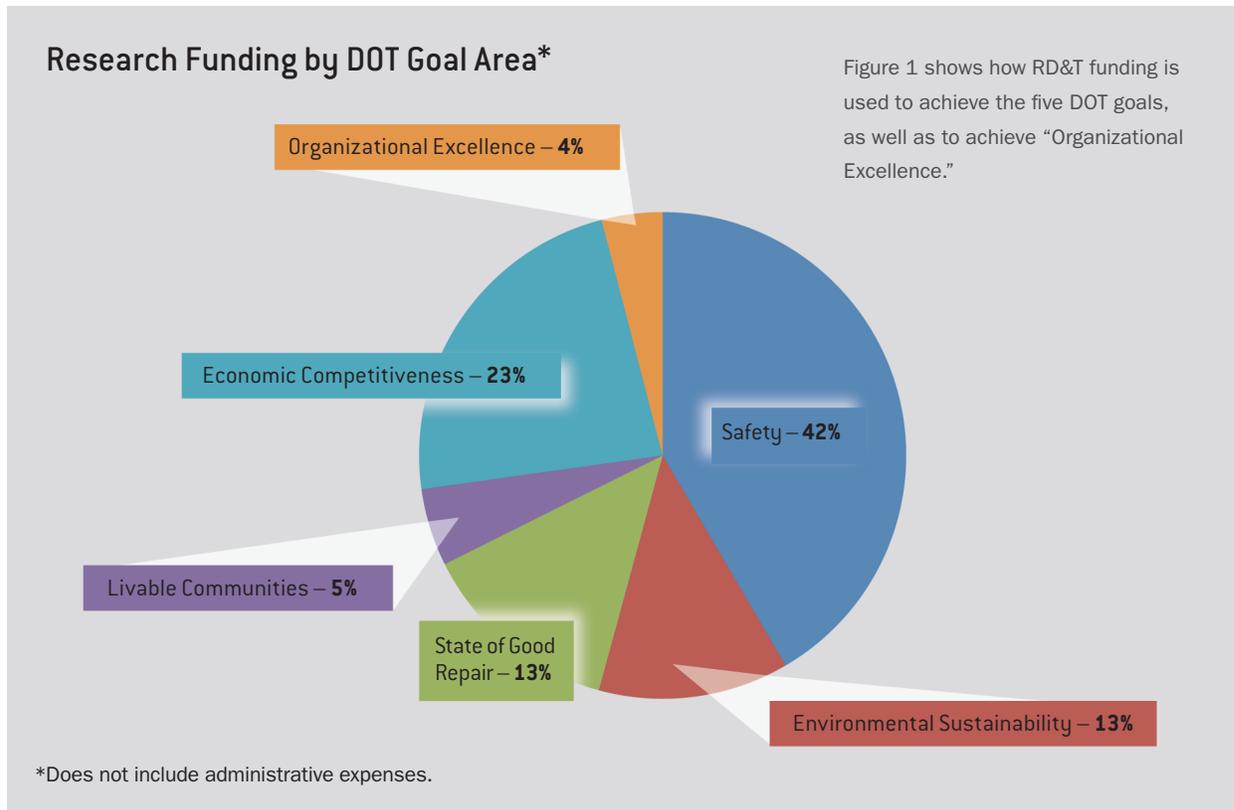


Figure 1. Research Funding by DOT Goal Area

Federal RD&T programs have a unique and critical role to play in overcoming the challenges that face our Nation’s transportation system. Key responsibilities include:

- Developing transportation research policy;
- Creating incentives for collaborative cross-modal research, focusing on the topics common to multiple modes;
- Preparing the future transportation workforce to face the challenges of the 21st century transportation network;
- Encouraging multidisciplinary research;
- Stimulating innovation in transportation services and products;
- Supporting long-term, exploratory research as well as short-term applied research;
- Identifying, facilitating, and supporting the deployment of emerging technologies and best practices; and,
- Developing and disseminating tools and techniques that foster greater, more efficient use of technology and innovation.

Collaboration

The National Surface Transportation Policy and Revenue Commission recommended that “dedicated funding of RD&T be provided and be subject to careful planning and review by the transportation industry.”³ Collaboration, accountability, and effective performance measurement are essential to successful research, especially research that cuts across each of the transportation modes. These principles are promoted within this RD&T Strategic Plan. They are not specific to any one operating administration, but shape the way the DOT operating administrations carry out their research activities. To this end, the DOT is instituting an enhanced collaborative process for

coordinating and facilitating its research and development programs and activities. This process will allow the DOT to better:

- Document the alignment of research with national transportation goals;
- Track performance and net benefits of the DOT RD&T funds invested;
- Enhance visibility and transparency for all directed and discretionary research funding;
- Reduce redundancies and duplication of effort;
- Maximize use of available research resources, including those within the DOT, at University Transportation Centers (UTCs), at the State level, and with many other partners; and,
- Focus on the *people* managing and conducting the RD&T as well as the *products*.

A driving principle of the DOT's collaborative process is to set performance-based outcome measures and to conduct retrospective reviews of all RD&T. The DOT will engage in a collaborative process to establish relevant performance measures for each relevant research area. Research planning should include a peer review of likely outcomes and benefits. Early in the process, project plans should also incorporate how they will identify and reconcile likely factors that could affect eventual deployment. The goal is to measure the effectiveness of implementing research in the private sector, State DOTs, other system operators, or other Federal agencies. If implementation is not an appropriate measure for the research, researchers should use an alternative performance outcome. Finally, all research should include a retrospective look at how effective it was. For those projects that result in deployment, did the technology actually improve an outcome? For example, after accounting for other factors that cause accidents, did a technology deployment improve safety?

By including cross-cutting RD&T priority areas, this RD&T Strategic Plan supports an approach to research that encourages collaboration across operating administrations and government agencies and promotes consultation and partnership with stakeholders in

industry and academia. The development of cross-modal research projects requires stakeholder discussions, rigorous examination of cross-cutting transportation issues and problems, and incorporating ideas from peers and experts within the research, asset owner/operator, and user communities.

The DOT will continue to collaborate with other agencies, such as the Environmental Protection Agency (EPA) and the Departments of Energy (DOE), Housing and Urban Development (HUD), Homeland Security (DHS), and Defense (DOD) (including the U.S. Army Corps of Engineers), to provide the most effective transportation system for our Nation. While each agency and DOT operating administration has research priorities that are unique to its mission, there are many areas where the subject matter is cross-cutting, such as alternative fuels, human factors, simulation, pavement, and structures. Collaborative work that supports multiple Federal agencies is the most effective route to successful solutions.

In addition to collaborating with its Federal partners, the DOT collaborates and performs joint research with stakeholders and partners across the entire transportation sector, including State and local agencies, academia, industry, and not-for-profit institutions, such as the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the American Public Transportation Association (APTA). The DOT will continue to consult and coordinate with transportation research partners and the general public to promote an integrated and effective transportation system that takes full advantage of all modal resources.

The *Norman Y. Mineta Research and Special Programs Improvement Act* created RITA and made it responsible for coordinating and facilitating collaborative cross-modal RD&T programs and activities within the DOT.⁴ The DOT, supported by RITA, is enhancing the transparency of its research programs and creating additional opportunities for stakeholder communication and input. By providing greater visibility and transparency into its research

programs, the DOT aims to foster greater collaboration and leveraging of resources with transportation research stakeholders.

Collaboration Tools

RITA, in partnership with the DOT operating administrations, has created an online searchable database of transportation RD&T activities: the DOT Research Hub.

The tool assimilates RD&T data that are currently stored among many agencies into one database as recommended in the Government Accountability Office (GAO) report *Transportation Research: Opportunities for Improving the Oversight of DOT's Research Programs and User Satisfaction with Transportation*.⁵ The database allows policymakers, program managers, researchers, partners, stakeholders, Congress, and the public to search for RD&T information by research topic, funding level, research description, contractor or grantee, State, and more. The tool will create an efficient national transportation research enterprise by encouraging collaboration and reducing duplicate research.

RITA has also initiated a refocused technology transfer program to support using the *Technology Transfer Commercialization Act of 2000* and the *Stevenson-Wydler Technology Innovation Act of 1980*.⁶ Technology transfer can be best described as the process of transferring research and scientific information to stakeholders and users who may further develop it for public or private needs. The technology transfer program supports activities within the operating administrations, such as the deployment of emerging technologies and dissemination of innovative tools and techniques. The intent of the program is to ensure the full use of the DOT's investment in research and development and to protect intellectual property by securing patents and issuing licenses.

The organization of the DOT into operating administrations, each with its own statutory requirements and missions, requires special interagency agreements to facilitate collaborative cross-modal research. Federal policies for surface transportation, aviation, pipeline, maritime, and rail sectors are established through separate legislation

and draw funding from separate sources. Many operating administrations must allocate a substantial share of their RD&T budget to research supporting their internal regulatory rulemaking activities. The RD&T Strategic Plan recognizes the structural limitations to cross-modal research and emphasizes strategies that use existing resources and structures, and that facilitate cross-modal research cooperation and collaboration.

Informing Transportation Policy Through Research

Research projects that support the priorities discussed in the following chapters can have short- or long-term policy implications. Research results can inform policymakers about costs and benefits of the DOT actions, and can help shape policy initiatives that last decades and affect millions of lives.

For example, safety-related research can result in the development of cost-effective methods of reducing incidents. In turn, these methods can shape future regulations and alter investment decisions. Similarly, research on measuring the benefits of investments that improve freight flow and reliability can provide the economic justification to make major investments that improve the Nation's economic competitiveness.

As the DOT promotes reducing congestion and improving mobility, research results can provide insights into the benefits of transit-oriented development, resulting in more livable communities. This can help transform the way Americans live, work, and spend their leisure time. Research results can also shed light on different techniques and models for measuring cost-effective construction and maintenance practices, and better ways of prioritizing investments to preserve and extend the life of future transportation systems.

Research results can help the DOT find innovative and cost-effective ways of meeting performance measures for research priority areas. Given scarce budgetary and staff resources, effective research can help policymakers prioritize resources more effectively. For example, effective research can result in practical asset management tools

that help State DOTs and transit agencies allocate their scarce resources where they are most cost beneficial.

RD&T Priority Areas for Supporting Transportation Policy

The RD&T priority areas for supporting transportation policy are:

- Policies to promote a better integrated National Transportation System;
- Policy decisions regarding future funding mechanisms for system development and maintenance;
- National transportation energy policies to support decisions for efficient utilization of domestic energy resources for energy independence, and to foster the growth of the domestic transportation energy infrastructure; and,
- National transportation environmental policies to support decisions that minimize the impact of transportation on the natural environment.

Research Priorities, Outcomes, and Performance Measures

Priorities and Outcomes

The DOT priority research areas, research outcomes, and performance measures described in the RD&T Strategic Plan are grouped to combine the DOT's strategic goals and research priority issues described in *MAP-21*. Each priority area contains an overview followed by cross-cutting RD&T research and modal-specific research priorities. All priority areas intend to achieve the prescribed outcomes and conclude with performance measures related to the research outcomes.

Performance Measures

Quantifiable, objective performance measures are necessary to gauge the DOT's progress in meeting the RD&T strategic outcomes. The data collected through these performance measures may also identify areas in the RD&T Strategic Plan where the Planning Team needs to make adjustments during its annual review process.

Even though quantifiable performance measures of RD&T strategic outcomes, such as annual highway fatalities or injuries, are essential to determine the long-term impact of research, it may be difficult to determine how well current research programs are using these data. Therefore, it is critical to have performance measures in place that also determine quantifiable milestones for achieving a strategic outcome. For example, the number of times a specific driver-assistance technology is used in vehicles would be a milestone toward reducing highway deaths and injuries. Including this type of data as a measure will be useful in identifying needed adjustments not only to the RD&T Strategic Plan, but also to research programs specific to individual operating administrations.

Performance measures directly related to strategic outcomes and to measuring quantifiable milestones for achieving a strategic outcome are listed in the following sections for each of the DOT research priority areas. ●

Research Within the U.S. DOT



Federal Aviation Administration

The mission of the Federal Aviation Administration (FAA) is to provide the safest, most efficient aerospace system in the world. The FAA's R&D mission is to conduct, coordinate, and support domestic and international R&D of aviation-related products and services that will ensure a safe, efficient, and environmentally sound global air transportation system. The FAA supports a range of applied research activities, from materials and human factors to the development of new products, services, and procedures.

The FAA's key research stakeholders include Congress; the Research, Engineering, and Development Advisory Committee (REDAC); and the airline industry. REDAC was established by Congress under the House Committee on Science, Space, and Technology in 1989 to advise the

FAA on research and development issues. The committee considers aviation research needs in air traffic services, airport technology, aircraft safety, aviation security, human factors, and environment and energy. Representatives from the airlines and the airline industry are often participating members of the REDAC and the Commercial Space Transportation Advisory Committee (COMSTAC). With their participation and direct knowledge of their industry, they provide input into the research that contributes to the development of new and future technology, the development of rules and regulations, and rule-making activities that affect the industry.

The majority of FAA research is used internally by FAA sponsors and lines of business to develop rules, regulations, and advisory materials to make aviation systems

safer and more efficient. The Technical Strategies and Integration Division is responsible for transferring technology and information to other government organizations, academia, and industry through partnership agreements and outreach activities.

The National Aviation Research Plan (NARP) is the FAA's performance-based plan to ensure that R&D investments are well managed, deliver results, and sufficiently address national aviation priorities. The NARP integrates the FAA R&D programs into a portfolio that addresses the near-, mid-, and far-term research needs of the aviation community. The NARP features R&D principles and goals that support the strategic visions laid out by President Obama, the Secretary of Transportation, and the FAA Administrator. This approach enables the FAA to address the current challenges of operating the safest, most efficient air transportation system in the world, while building a foundation for the future in an environmentally sound manner. In conjunction with the NARP, the FAA's business plans address how the FAA performs based on the goals and measurements set forth in FAA's Strategic Plan to transform the Nation's aviation system by the year 2025.

Office of Commercial Space Transportation

The Office of Commercial Space Transportation (AST) within the FAA is responsible for judiciously regulating the commercial space sector and enhancing the viability of a safe and successful commercial space industry. Balancing these roles is a complex task. The AST performs research in four areas with distinct objectives:

- 1. Space Traffic Management & Operations:** Ensure the safe integration of air and space traffic management by supporting the development and optimization of technical and regulatory provisions and processes used to oversee, coordinate, regulate, and promote safe and responsible commercial space activities between space and Earth.
- 2. Space Transportation Operations, Technologies, and Payloads:** Improve vehicle safety and risk management, including knowledge of all safety-critical components and systems of the space vehicles and their operations, so as to better identify potential hazards and to better identify, apply, and verify hazard controls.
- 3. Human Spaceflight:** Ensure human safety of those on board during space vehicle operation and those involved with spaceport operations.
- 4. Space Transportation Industry Viability:** Increase industry viability, including economic, legal, legislative, regulatory, and market analysis and modeling.

The AST R&D is funded primarily using annual appropriations from the FAA Operations budget. Supplemental funding has been received through the utilization of unspent R&D funds from other lines of business within the FAA.

Research funded by AST is selected based on the level of interest to industry and/or AST. All research tasks are screened to appropriately and accurately identify any International Trade in Arms Regulations considerations. The FAA Center of Excellence for Commercial Space Transportation (COE CST) conducts a majority of the research funded by AST. The COE CST Advisory Committee (CESTAC) is an R&D industry advisory group comprised of individuals from the commercial space transportation industry. The CESTAC attends the annual COE CST technical meeting and provides a written report with its judgments of the work being conducted and recommendations for improvement from the committee's perspective.

The AST works closely with the COE CST to make research products readily available on the web and produces annual reports that include detailed information about research tasks and outcomes achieved during the previous year of operation.⁷

The AST follows a Commercial Space Transportation Research Roadmap that was developed by the COE CST in 2011 and includes contributions from government, industry, and academic members interested in the research areas. This document will be updated with more detail and further refined in calendar year 2013 with a goal to solicit input from more community members than during the initial round. Ultimately, the goal of this activity is to create a National Commercial Space Transportation Research Plan.

FAA: Aviation Fire Safety

The FAA is conducting applied research into fire prevention and mitigation technologies to reduce the risk of fires on aircraft. As described below, the FAA is researching a number of issues including lithium battery fire safety, the flammability of thermal acoustic insulation used to soundproof aircraft cabins, and the use of nitrogen gas to reduce the risk of fires in airplane fuel tanks.

Over 50 aviation fire incidents have been caused by lithium batteries, which are believed to have been factors in fatal freighter fire accidents. Past FAA research on lithium battery fire safety resulted in the ban of lithium metal (non-rechargeable) battery shipments in passenger-carrying airplanes (2007), two FAA Safety Alerts for Operators (SAFOs) highlighting the dangers of lithium battery fires (2010), and effective methods for extinguishing laptop fires with lithium batteries in thermal runaway (2009). Most recently, the ICAO Dangerous Goods Panel issued improved Technical Instructions requiring that previously excepted small lithium batteries be declared hazardous materials (2013). Currently, the FAA is conducting unique full-scale fire tests in a 727 freighter to characterize the cargo compartment and cockpit environment created by a fire involving a large shipment (5,000) of lithium batteries, including both metal and ion (rechargeable) types, in order to pinpoint fire safety improvements. Also, the FAA is examining the effect of battery state-of-charge on thermal runaway propagation; improved passive methods for shipping lithium batteries, including incorporating a means of safely venting the pressure build-up in a sealed battery container or package; fire hardened cargo containers or ULDs; and cost-effective fire suppression systems.

The FAA developed a practical and cost-effective onboard system that uses nitrogen gas extracted from air to render an airplane's fuel tanks nonflammable. The FAA design was validated by flight testing and led to a final rule in 2008. Boeing has installed over 1,000 of these FAA-designed nitrogen inert systems in commercial transport airplanes.

Research by the FAA on the flammability of thermal acoustic insulation used to insulate and soundproof aircraft cabins resulted in (1) an Airworthiness Directive requiring the retrofit of over 700 airplanes that contained insulation blankets made with polyester film, (2) a Final Rule in 2005 requiring a more stringent flammability test method incorporating radiant heat, and (3) a Final Rule in 2009 requiring thermal acoustic insulation with an order of magnitude greater burn-through resistance in the event of a post-crash fire.

Federal Highway Administration

The Federal Highway Administration (FHWA) Research, Technology, and Education (RT&E) Program addresses current issues and emerging challenges, and provides information for policy decisions. The program conducts, sponsors, sustains, and guides highway research to develop and deliver innovation. Through the program, FHWA conducts advanced and applied research, facilitates national and international coordination and collaboration to leverage knowledge, and develops and delivers solutions to address highway transportation needs.

FHWA is in a unique leadership position to identify and address highway issues that require high-risk, long-term

research, and research on emerging issues of national significance, as well as to build effective partnerships and to maximize the total Federal Government RD&T highway investment.

The primary goal of the RT&E program is to sustain a research agenda that focuses Federal policymakers and the research community on critical knowledge gaps, collaboration methods, and accelerated innovation to meet current and future highway transportation needs. The RT&E program seeks to generate new solutions, provide better decision-making information and tools, and build more effective partnerships that will allow our Nation to make optimal investments in the transportation

system. The entire innovation life cycle is covered under the RT&E program umbrella, including agenda-setting, conduct of research and development, technology testing and evaluation, and the deployment and evaluation of market-ready technologies and innovations.

FHWA strives to be customer and stakeholder driven. Staff from FHWA participate on all AASHTO and TRB highway-related committees and subcommittees, and on cross-cutting groups. As part of this effort, FHWA has published and sought input on program area R&D roadmaps. A national collaboration website that summarizes the entire RT&E program is being developed. The website will inform parties of the FHWA RT&E program and seek input from stakeholders. FHWA is committed to working collaboratively with its partners to define the direction of R&D roadmaps needed to achieve results, especially since these partners may at times be responsible for implementing the technologies and innovations that were developed.

Six National Highway Challenges, Objectives, and Focuses

These FHWA programs will apply innovative technologies to construct and maintain the Nation's roads, bridges, and tunnels, keeping the highway system in a state of good repair. In addition, these programs will generate economic growth by helping deliver transportation projects more quickly and encouraging innovation.

Advancing Highway Safety

Safety is the DOT's highest priority. It is the common thread that runs through FHWA's research areas. Research by FHWA is leading the way, providing a diverse suite of programs and initiatives that address the full spectrum of safety-related issues.

Research and development activities sponsored by FHWA are designed to support comprehensive and sustainable safety programs. They emphasize data-driven analysis of roadway-related safety considerations and specific improvement in four crash areas: roadway departure, intersection, pedestrian, and speeding. To determine what safety improvements can be expected with the introduction of countermeasure designs or operations, FHWA safety programs conduct rigorous evaluations. All design or operational changes are assessed from a human factors perspective to eliminate or minimize unexpected

consequences of change. In cooperation with the National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA), FHWA works to develop tools and technologies to reduce crashes and improve highway and intermodal transportation safety.

Improving the Mobility of People and Goods

A growing economy depends on safe and reliable transportation that gets people and goods where they need to go, on time, and with a level of reliability. FHWA's research programs are providing the tools, information, and technology to support the Nation through the research, development, and deployment of innovations that improve mobility, reduce costs, and advance the Nation's economic competitiveness.

FHWA conducts research on the application of cutting-edge technologies to move people and goods better, quicker, safer, and more reliably. The primary focus of these research efforts is on congestion relief solutions. This work will identify ways to mitigate the impacts of recurring congestion and deal more effectively with non-recurring events that cause congestion. FHWA conducts applied research to develop the next generation of traffic management systems and models. For example, through connected vehicle research, conducted through the Intelligent Transportation Systems (ITS) program in collaboration with RITA and NHTSA, FHWA is studying how technologies such as advanced wireless communications, onboard computer processing, advanced vehicle sensors, global positioning system (GPS) navigation, and smart infrastructure can be applied to improve traffic signal control, traveler information, and traffic modeling. FHWA is also conducting research on freight management and operations to increase freight productivity and economic competitiveness by improving freight movement, reducing freight-related congestion throughout the network, evaluating impacts of vehicle size and weight, advancing freight operations and technology, and developing freight performance measurement and management systems.

Maintaining Infrastructure Integrity

Keeping roadway pavement and structures in good condition requires continual monitoring, periodic maintenance, and effective repairs. FHWA is reducing the cost, time, and frequency of these tasks with new technologies and systems.

FHWA sponsors problem-focused research, development, and communications to preserve the existing investment in our Nation's highway infrastructure and to build for the future through the application of advanced technologies that improve infrastructure integrity. Infrastructure-related research focuses on three major areas: pavements, bridges and structures, and asset management. This work includes (a) development of metrics to assess the performance of infrastructure over the longer term; (b) research and development of technologies and techniques to assure that our Nation's infrastructure is world class from a standpoint of longevity, safety, performance, climate-change mitigation, and sustainability; and (c) leadership to ensure effective follow-up and deployment of the improvements developed, particularly those that will speed construction and reduce congestion caused by construction.

Enhancing System Performance

Improving system performance requires choosing and measuring key indicators that provide objective, actionable information. Across the spectrum of highway research, FHWA is providing the tools needed for effective, standardized measurement and data-driven decision making. Policy decisions require the collection of data on motor fuels, motor vehicles, licensed drivers, roadway characteristics, pavement conditions, travel trends, and travel behavior. Policy data collection and forecasting efforts provide the foundation on which program administration, policy analysis and implementation, and legislative support all rely.

FHWA sponsors research to analyze emerging issues in the transportation community, including climate change, public-private partnerships, highway revenues, performance management, and a host of other policy issues. For example, FHWA is researching methods to improve the analysis of innovative finance and program delivery strategies. The goal of this research program is to identify both new possibilities to extend the transportation community's fiscal resources and the strategies for turning those possibilities into accepted business practices. Because the successful deployment of these strategies requires public sponsors to develop extensive analytical and transactional skills, significant capacity building and technical assistance efforts occur alongside the research activities. The rigorous and consistent analysis of the benefits and costs of public-private partnerships comprises a major focus of this research.

Promoting Environmental Sustainability

Environmentally friendly transportation networks have benefits that go beyond traditional highway systems. They save money through energy efficient practices, support public health by improving air quality, and protect natural spaces and resources that are critical for the Nation's wildlife.

Activities in this area include carrying out short- and long-term livability and sustainability initiatives to improve project delivery and enhance communities that are impacted by surface transportation projects; developing comprehensive strategies to minimize the environmental impact of transportation investment; developing capabilities to adjust to changing climate conditions; advancing state of the practice for data collection, geographic information systems (GIS) applications, and travel forecasting; and providing technical assistance and forums, best practices, and training to assist States, metropolitan planning organizations (MPOs), local public agencies, and other partners and stakeholders in planning and delivering surface transportation projects.

Preparing for the Future

FHWA's vision for the Nation's roadways extends beyond the horizon of today's immediate challenges, anticipating the emerging issues of tomorrow. Changes in technology, the economy, demographics, and climate are certain. What is not certain is how fast and how much change will occur.

To meet this challenge, FHWA is forecasting future passenger and freight transportation needs for a range of scenarios to help visualize the possibilities. In order to track new scientific discoveries early in their development, and to identify their potential for addressing transportation challenges, FHWA develops strong relationships with basic and applied research professionals. The Exploratory Advanced Research (EAR) Program conducts long-term, high-risk research with the potential for dramatic breakthroughs in surface transportation. Key elements of the EAR Program are to obtain information from the very large number of basic and advanced research and development activities outside of the highway R&D community for possible exploitation, adaptation, and eventual application to the highway industry.

How FHWA Does Business

The FHWA RT&E program is a competitive, peer-reviewed program that has a multiyear authorization and funds that are appropriated annually. FHWA's Office of RD&T is

located at the Turner-Fairbank Highway Research Center (TFHRC), a federally owned and operated national research facility in McLean, Virginia. The TFHRC houses more than 20 laboratories, data centers, and support facilities, and conducts advanced and applied research. The laboratories at the TFHRC provide a vital resource for advancing the body of knowledge that has been created and developed by researchers. TFHRC staff administers the vast majority of FHWA's research and development activities. Research is primarily conducted by contractors located at TFHRC or off-site. Research in areas of policy, innovative program delivery, planning, and the environment is primarily conducted by FHWA offices located at DOT Headquarters.

The FHWA RT&E program is closely coordinated with R&D conducted through the UTC program, the ITS program, the National Cooperative Highway Research Program (NCHRP), and State-based R&D initiatives. In addition, FHWA RT&E develops joint strategies to address Departmental goals with modal stakeholders, including FTA, FRA, NHTSA, FAA, and FMCSA. For example, FHWA, in cooperation with FRA, FAA, and RITA's Bureau of Transportation Statistics (BTS), is conducting research to measure and model long-distance passenger traffic using new technology and scientific approaches.

FHWA has a long history of strong partnerships with the States, Federal agencies, academia, and private industry. Examples of active FHWA partnerships include:

- National Science Foundation (NSF) support of the EAR Program on cyber physical systems;
- National Institute of Science & Technology on cement hydration modeling;
- DOD on automated vehicles and corrosion prevention;
- Department of State on design of difficult to build anti-ram barriers for embassy protection;
- HUD and EPA for Sustainable Communities and FHWA's Livability Initiative;
- AASHTO support of the State Planning and Research Program and the NCHRP;
- RITA to design, review, and implement the UTC program;
- Industry through Cooperative Research and Development Agreements;
- TRB to fund, coordinate, and implement products

FHWA: Improving Goods Movement

Through an exploratory advanced research project, FHWA has demonstrated mobility and fuel efficiency of vehicles using advanced communications technologies to form well-coordinated platoons of vehicles. The California PATH project at the University of California, Berkeley, the current lead University for the Region IX UTC, works with the California Department of Transportation to:

- Improve traffic flow by calculating and communicating speed guidance directly to individual drivers;
- Achieve closer coordination, shorter vehicle separation gaps, and higher effective lane capacities through vehicle-to-vehicle communication, vehicle-to-infrastructure communication, and cooperative adaptive cruise control; and,
- Improve heavy-truck fuel consumption and double the capacity of truck-only lanes by forming and maneuvering automated three-truck platoons.

A platoon is a group of vehicles traveling together. Platoons form naturally as faster vehicles approach slower vehicles. Platoons can also form and travel with increased safety, mobility, and fuel efficiency through the use of sensor, communication, and control technologies. Such platoons can significantly reduce congestion. Field tests showed both the effectiveness of the technology as well as driver acceptance when driving to work. During field tests in the State of Nevada, it was demonstrated that when tractor trailer trucks are platooned, significant fuel savings are achieved.

from the second Strategic Highway Research Program (SHRP2); and,

- International agencies, such as the Forum of European Highway Research Laboratories to "cost share" on specific projects.

FHWA leverages these partnerships to identify current and emerging highway transportation challenges,

coordinate and collaborate on the conduct of research, and deploy innovation.

Federal Motor Carrier Safety Administration

The Federal Motor Carrier Safety Administration (FMCSA) was established within the DOT on January 1, 2000, with the mission of promoting safe commercial motor vehicle (CMV) operations and reducing large truck and bus crashes, injuries, and fatalities. The FMCSA accomplishes its mission through education, regulation, enforcement, research, and innovative technology, thereby achieving a safer transportation environment.

FMCSA: North American Fatigue Management Program

The North American Fatigue Management Program (NAFMP) was developed by a consortium of government, insurance, and commercial vehicle associations for the purpose of reducing fatigue in commercial vehicle drivers, thereby reducing highway collisions related to fatigue. The NAFMP was available to motor carriers, drivers, government safety administrators, and insurance companies for their use effective June 2013. The NAFMP, the culmination of several years of research, development, and field trials in a live commercial vehicle operating environment, is a proven, feasible, and effective means of managing fatigue in commercial vehicle drivers. The NAFMP includes 10 learning modules with voice narration, graphics, and a Learning Management System with interactive tests to support subject understanding. The learning modules contain information on fatigue recognition, health and wellness, medical screening for sleep disorders and treatment, scheduling, and fatigue detection technologies. The modules are presented for various audiences, including drivers, drivers' families, dispatchers, safety supervisors and managers, and company executives. The materials and guidance are available on www.nafmp.com free of charge to any individual or organization.

The FMCSA's research program focuses on safety risk factors and safety technology to inform and enhance FMCSA's programs and priorities by:

- Expanding research on CMV driver risk factors to support rulemaking and to promote a health, wellness, and safety culture in motor carriers and drivers;
- Identifying, testing, and deploying smart roadside technologies in partnership with Federal, State, and local CMV safety agencies; and,
- Accelerating the deployment of on-board safety systems by promoting the benefits to fleets and insurance carriers and testing next-generation on-board safety systems in partnership with technology providers and other DOT agencies.

The FMCSA's research program consists of applied research projects that are conducted both in-house and through contractors. The program is congressionally funded under a multiyear authorization with annual appropriations.

FMCSA's stakeholders include:

- Congress
- The motor carrier industry
- State CMV agencies, including departments of public safety, motor vehicles, transportation, taxation and revenue, hazardous materials, and public utility commissions
- Safety advocacy groups
- National, regional, and State-level truck and bus industry trade associations
- Technology providers
- Truck and bus manufacturers
- The insurance industry
- The medical profession
- The academic research community

These stakeholders provide input to the FMCSA's RD&T plan and its research agenda through a variety of activities, including:

- The agency's statutorily mandated Motor Carrier Safety Advisory Committee;
- The annual FMCSA Analysis, Research, and Technology forum at the TRB Annual Meeting;

- TRB technical committees; and,
- Public listening sessions.

The FMCSA engages its stakeholders during the research agenda planning stages and keeps its focus on the end-user throughout the research to facilitate deployment and implementation. The FMCSA builds relationships with its stakeholders and disseminates its research studies via technical conference presentations, website, research hub, and other means. The FMCSA implements the results of its research and technology projects through rulemaking, outreach and education, promotion of safety technologies to fleets, and funding smart roadside technologies at the State level through the Commercial Vehicle Information Systems and Networks Deployment Grant Program.

An example of current FMCSA research that directly supports the DOT's safety goal and requirements under *MAP-21* is research assessing whether a required 34-hour rest period impacts driver fatigue.

Federal Railroad Administration

The Federal Railroad Administration's (FRA) mission is to enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future. FRA's research objectives are to support FRA's mission through basic and applied research, and to develop innovations and solutions. Through its research, FRA ensures the best available scientific and technical foundation for its development and regulatory activities.

FRA's R&D program covers basic and applied research, and development of innovations and solutions, taking projects through to prototype demonstration in the railroad operational environment. FRA focuses on implementation from the early stages of research projects. End-users are typically involved in feasibility studies and proofs of concept, and suppliers are identified at the prototype development stages for future commercialization. Research work is almost exclusively performed through grants and contracts and is funded through annual appropriations.

FRA's R&D stakeholders help identify and prioritize research needs, co-sponsor projects of mutual interest, and avoid duplication of efforts. Internal stakeholders are FRA's Office of Railroad Safety and Office of Passenger and Freight. External stakeholders include the Association

of American Railroads, individual passenger and freight railroads, States, labor organizations, manufacturers, and industry associations.

FRA: Track Buckling

Railroad track can buckle or kink in the summer heat when rail temperatures surpass a critical threshold. Through a grant agreement with the University of California at San Diego, FRA's Office of R&D has developed a device that fits to the rail and predicts when track buckling is likely. This information allows the railroad to take corrective action and avoid the buckle before it occurs. Avoiding track buckles in service will have a significant effect on improving safety by reducing train derailments. It will also improve the industry's economic competitiveness by reducing service delays.

Federal Transit Administration

The Federal Transit Administration (FTA) provides grant funding to State and local governments, public and private transit operators, and other recipients to construct new public transit systems, purchase and maintain transit vehicles and equipment, subsidize public transit operations, and support regional transportation planning efforts. To improve public transportation services, FTA undertakes nationally significant research, development, demonstration, deployment, and evaluation projects.

Although many entities such as universities and MPOs participate in transit research, FTA has the unique perspective of addressing the needs of the public transportation industry from a national perspective. FTA supports research activities that improve the safety, reliability, efficiency, and sustainability of public transportation by investing in the development, testing, and deployment of innovative technologies, materials, and processes. FTA research is focused on applied

FTA: Transit Track Worker Safety Protection Demonstration

This project seeks to improve the safety of rail transit workers through innovative use of advanced technologies to reduce the hazards associated with working on or around the right-of-way (ROW). According to FTA's National Transit Database, between 2003 and 2008, 53 percent of the rail transit worker fatalities reported were ROW worker incidents. This project will demonstrate an innovative turn-key solution using radio frequency identification technology to track the location of mobile track workers and a series of warning lights and horns to notify track workers and train operators when rail equipment and ROW workers are in proximity. The system design makes it effective for both normal operating routes and reverse moves, and it will detect the presence of passenger trains and non-revenue work equipment. This technology will greatly increase track worker safety by preventing incidents; saving lives; and avoiding injuries, litigation, insurance losses, and disruptions to revenue service. This project is an active demonstration of the innovative track worker safety system pioneered by Bombardier in partnership with Georgia's Metropolitan Atlanta Rapid Transit Authority (MARTA) heavy rail system. It is anticipated that this technology will be made commercially available by Bombardier to U.S. transit agencies shortly after completion of the demonstration project with MARTA.

research activities due to its limited research budget, the immediate pressing needs of the transit industry, the lack of significant research capacity at many transit agencies, and the need to have solid data and recommendations for capital and operational decision making.

FTA sponsors research that is primarily carried out by contractors working closely with transit authorities, not in-house staff. These contractors are typically private sector corporations, universities and other educational institutions, and non-profit organizations. This research is overseen by experienced FTA staff with professional backgrounds in engineering, public administration, planning, and other related fields. Once research and

demonstration projects have been completed, FTA assists in the dissemination of these efforts into the transit industry.

FTA's research program is authorized, but not funded, by large, multiyear surface transportation authorization bills. Funding for FTA's research budget is provided on an annual basis by congressional appropriations from the General Fund.

While the general public is ultimately the beneficiary of Federal investments in public transportation, the immediate beneficiaries of FTA research and demonstration investments are largely the entities that operate public transportation, such as transit agencies and State DOTs. These entities are uniquely positioned to implement the results of research efforts in order to improve safety, increase operating efficiencies, increase transit ridership, address environmental sustainability, and reduce capital, operating, and maintenance costs.

The transit industry's research interests are represented, in part, by the TRB Transit Research Analysis Committee (TRAC), which includes senior staff and management at transit agencies, representatives of organized labor, researchers from academic institutions, and other such organizations. This committee provides an independent review and assessment of the research needs of the public transportation industry that could be met through future investment in a national research and technology program. TRAC provides useful information to FTA as the agency develops a strategic agenda for transit research and assists in identifying the roles that FTA and industry stakeholders can play in carrying out that agenda.

Maritime Administration

The Maritime Administration (MARAD) is responsible for improving and strengthening the U.S. marine transportation system—including the ships and mariners of the U.S. Merchant Marine, shipbuilding, and port operations—to meet the economic, environmental, and security needs of the Nation.

MARAD has no formally coordinated program or authorized budget for RD&T activities; nevertheless, it works with other agencies, academia, and industry partners to initiate and accomplish RD&T activities that have a positive benefit for the maritime industry. MARAD contributes to the application of technology in the U.S.

MARAD: Ballast Water/Aquatic Invasive Species Initiative

MARAD's ballast water efforts began several years ago. The overall goal of this effort has been to assist the maritime industry in addressing invasive species in ballast water. The effort began with testing of promising treatment technologies aboard MARAD vessels in cooperation with the National Oceanic and Atmospheric Administration and U.S. Fish & Wildlife Service. The initiative has grown to become a multistate and multi-agency cooperative effort that includes development of technical and scientific protocols for technology testing and verification; development of independent testing facilities to provide the needed data for ultimate certification of technologies to International Maritime Organization and U.S. Coast Guard standards; and technology testing.

MARAD was asked by Congress to provide technical assistance regarding the current state of ballast water treatment technology development; what would be needed to ensure that the infrastructure was available in the U.S. to provide for independent verification and certification of ballast water treatment systems to international and national standards; and ways to speed the approval of treatment systems for use in the U.S. Discussions centered on an initial multiyear (approximately five-year) effort that would focus first on ballast water, but include other maritime environmental issues, such as air emissions, oily water discharges, and the like.

maritime industry by identifying and focusing on specific industry research needs. The majority of resources in recent years have been in support of environmental sustainability, but other studies have addressed safety, economic competitiveness, and infrastructures issues. In addition, MARAD staff have built strong relationships throughout the industry that position the agency to accomplish valuable RD&T initiatives with exponentially beneficial paybacks from the resources applied.

The majority of research undertaken by MARAD is applied specifically to evaluate the effectiveness of technologies and concepts. The studies performed focus on the identification of problems and potential solutions, and/or forecasting the future direction and demands on the maritime industry. For the most part, research is accomplished through contracts or cooperative agreement with industry partners and academia. MARAD works closely with industry to identify research needs, formulate research initiatives to address specific issues, and then transfer findings to the industry. Since MARAD is primarily a promotional agency, its influence regarding regulatory issues is limited.

National Highway Traffic Safety Administration

The National Highway Traffic Safety Administration's (NHTSA) primary mission is to save lives, prevent injuries, and reduce economic costs due to road traffic crashes. Through its vehicle and behavioral safety programs, NHTSA develops and implements data-driven approaches to address road traffic crashes, the leading cause of death for Americans aged 5–24 years.⁸ One of the ways in which NHTSA carries out its safety mandate is to develop, issue, and enforce Federal Motor Vehicle Safety Standards (FMVSS). Through these standards, NHTSA strives to reduce the number of crashes and minimize the consequences of crashes that do occur. NHTSA's mission also includes issuing Corporate Average Fuel Economy (CAFE) standards under the *Energy Independence and Security Act of 2007*. Increasing fuel economy not only contributes to energy security, but also addresses climate change by reducing tailpipe emissions of carbon dioxide.

NHTSA supports the development of workable and self-sustaining highway safety programs by providing grants to State and local communities, sponsoring research and demonstration projects, and funding countermeasure programs to prevent motor vehicle crashes and reduce their economic costs. These programs help States and local communities reduce the threat of drunk drivers, promote the use of safety belts, and improve the use of child safety seats.

Additional key functions that NHTSA performs include investigating safety defects for motor vehicle recalls, investigating odometer fraud, establishing and enforcing vehicle anti-theft regulations, and providing government

safety ratings and other types of consumer information on motor vehicle safety topics.

NHTSA conducts behavioral and vehicle safety research to develop and evaluate the most efficient and effective means of bringing about safety improvements. NHTSA's primary objective is to implement research programs that produce research findings that support agency decisions and actions in the areas of vehicle and behavioral safety. In the vehicle safety area, the primary focus is to produce research findings that support Federal motor vehicle safety standards, regulations, and consumer information. In the behavioral safety area, the primary objective is to develop, implement, test, and demonstrate tools and countermeasure programs for use by the States, local communities, and other safety organizations to reduce crashes, deaths, and injuries. These efforts focus on the major causes of crashes, deaths, and injuries and include impaired driving, seat belt use, child passenger safety, speeding, pedestrian and bicycle safety, motorcycle safety, and the safety of young, novice drivers and older drivers.

By meeting key research objectives, NHTSA assures that research products and findings directly relate to the

agency's mission and support current or potential future rulemaking decisions. For example, NHTSA's behavioral safety research programs led to the widespread adoption of many effective programs by the States, including:

- Training programs for law enforcement
 - Standardized Field Sobriety Tests
 - Drug Evaluation and Classification Program
 - Advanced Roadside Impaired Driving Enforcement Program
- More effective highway safety laws
 - Primary seat belt laws
 - Administrative license suspension for impaired driving
 - Zero tolerance laws for underage drivers
- Graduated driver licensing programs
- National high-visibility enforcement mobilizations
 - *Click It or Ticket*
 - *Drive Sober or Get Pulled Over*

For the most part, NHTSA's vehicle research is applied regulatory support research. Some recent examples include NHTSA's work on stability control for light and heavy vehicles, improving the ability of light vehicles to withstand roof crush during rollovers, and improvements in child safety seat designs. Some research is less directly tied to regulation, however, and conducted through the DOT's ITS program. For example, in the late 1990s, NHTSA worked within the DOT's ITS program to perform research of Forward Crash Warning and other crash avoidance technologies, which facilitated their development and deployment in industry. Once these technologies became more mature, NHTSA focused more of its effort on applied research to develop test procedures and performance criteria that could be used for a regulatory decision. Also, NHTSA conducted significant biomechanics research to understand the human tolerance of crash forces, which will eventually lead to better metrics that can evaluate a vehicle's ability to protect occupants during a crash.

The Driver Alcohol Detection System for Safety (DADSS) research program, a joint research partnership between NHTSA and the auto industry, offers another type of advanced technology. This research is focused on detecting an impaired driver and preventing him or her from operating a vehicle. Developing a voluntary standard

NHTSA: Crash Avoidance Research

In the area of crash avoidance research, NHTSA conducted and continues to produce significant research results with respect to vehicle systems designed to avoid crashes. For example, NHTSA performed significant research to develop objective test procedures and associated pass/fail criteria for Electronic Stability Control (ESC) systems for both light and heavy vehicles. A significant output of this research was to support a final rule on light vehicle ESC (FMVSS 126) and a Notice of Proposed Rulemaking (NPRM) on heavy vehicles. The agency estimates that ESC will reduce single-vehicle crashes of passenger cars by 34 percent and single vehicle crashes of sport utility vehicles (SUVs) by 59 percent, with a much greater reduction of rollover crashes. NHTSA estimates ESC would save 5,300 to 9,600 lives and prevent 156,000 to 238,000 injuries in all types of crashes annually once all light vehicles on the road are equipped with ESC.

for seatbelt interlocks represents another promising research avenue. Given that 30 percent of all motor vehicle fatalities involve an impaired driver, and that 50 percent of people killed in crashes are unbelted, these technologies could potentially save thousands of additional lives each year if fully realized.

Because of the enormous potential of advanced technologies, NHTSA implemented a “Significant and Seamless Initiative” in August 2013. The initiative will create a three-year research and prioritization plan to forward research on DADSS, seatbelt interlocks, and Forward Collision Avoidance and Mitigation (FCAM). These technologies all address a broad-based safety threat, and equally important, they require no or minimal intervention by the driver.

In the driver distraction area, NHTSA is currently conducting field tests of a statewide demonstration program of a high visibility enforcement (HVE) program to reduce the use of hand-held cell phones in States with laws banning their use while driving.

NHTSA also conducts basic and applied research to develop and test the effectiveness of tools and countermeasure programs for State and local use. This includes problem identification research to better understand the behavioral causes of crashes and to have a sound empirical basis for developing effective behavioral change programs that will prevent crashes. For example, careful study of pedestrian crashes has led to a crash typology and distinct countermeasures for the distinct types of pedestrian crashes.

NHTSA’s research is funded through annual appropriations. Research is done in-house, through contractors, and with universities. Research may also be done cooperatively with other Federal agencies, countries, technology suppliers, and vehicle manufacturers.

Key stakeholders interested in NHTSA research include the U.S. Congress; States; vehicle manufacturers; automotive suppliers; advocacy and consumer information groups; organizations that represent various industry, consumer, and safety advocacy constituencies; law enforcement personnel and emergency medical services providers; and university research institutes. This group of stakeholders contributes in several ways. For example, NHTSA collects crash data from the States, which contrib-

utes to identifying key crash problems. Manufacturers and system suppliers provide information on emerging safety technologies, and advocacy groups provide additional information and feedback on key safety issues. NHTSA also seeks public comment on research and rulemaking priorities every three years.

Stakeholders contribute through public comments either in response to a written notice from the agency seeking comment and/or comments received during a public meeting. Public comments are one mechanism used by the agency to refine its research and rulemaking priority plan. This plan is an internal management tool as well as a means to communicate to the public regarding NHTSA’s highest priorities to meet the Nation’s motor vehicle safety challenges. The current plan, which runs through 2013, lists the priority programs and projects the agency anticipates working on.⁹

NHTSA routinely conducts demonstration programs in selected States to show the effectiveness and cost-benefit of behavioral programs developed and/or recommended to the States. NHTSA also disseminates information about effective programs through regional offices, non-technical publications (Traffic Tech), and a continuing series of publications titled *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*.

Pipeline and Hazardous Materials Safety Administration

The vision of the Pipeline and Hazardous Materials Safety Administration’s (PHMSA) RD&T Program is to support the agency’s mission, which is to protect people and the environment from the risks of hazardous materials transportation. The mission of PHMSA’s Pipeline Safety RD&T Program is to sponsor research and development projects focused on providing near-term solutions that will improve the safety, reduce the environmental impact, and enhance the reliability of the Nation’s pipeline transportation system. PHMSA-sponsored research provides enhancements in technology and knowledge so that pipeline operators can better meet or exceed promulgated safety regulations.

The mission of PHMSA’s Hazardous Materials Safety R&D Program is to implement research and development

PHMSA: Smart Pipeline Inspection Gauges

Since the 1960s, maintenance workers have used “smart” pipeline inspection gauges, or PIGs, to find rust, weak seams, thinning walls, and other indicators that a pipe needs repair or replacement. However, a significant portion of the Nation’s pipelines are unpiggable because current PIG technology cannot navigate through the pipelines to inspect them. A public/private partnership grant awarded by the DOT/PHMSA led to the development and commercial deployment of the first ever robotic inspection platform (Explorer) and integrated sensor capable of internal unpiggable gas pipeline inspection. The Explorer robots are untethered, modular, remotely controllable, self-powered inspection robots for the visual and nondestructive inspection of natural gas transmission and distribution pipeline systems.

projects to mitigate risks associated with transporting hazardous materials.

PHMSA’s research objectives are:

- Developing Technology – Fostering the development of new technologies so that pipeline operators can improve safety performance and more effectively address regulatory requirements;
- Strengthening Consensus – Standards targeting and feeding new knowledge into the process of keeping standards relevant to their purpose;
- Promoting Knowledge – Generating and promoting general knowledge to decision makers; and,
- Identifying Emerging Risks – Understanding factors contributing to future safety risks.

Research investments are both intermural with other Federal agencies and extramural with engineering contractors and academics. Funding for PHMSA research comes from both a user fee pool and from the Oil Spill Liability Trust Fund.

PHMSA stakeholders include:

- The public
- Other Federal and State agencies

- Pipeline operators
- Pipeline operator trade organizations
- Standards-developing organizations
- Academics and researchers
- Technology service providers

Finding, improving, and applying technology to affect improvements in pipeline safety helps define the performance goals for the PHMSA Pipeline Safety R&D Program. The R&D program collaborates and coordinates with U.S. government agencies (Federal and State), pipeline industry trade organizations, and research organizations throughout the research evaluation process.¹⁰ A periodically held public event announced in the Federal Register facilitates stakeholder involvement.

PHMSA enters into public/private partnerships to deploy needed solutions for pipeline safety challenges. Several measures are factored in and implemented to maximize the agency’s contractual authority and raise the likelihood that investments will produce desired outputs/outcomes.¹¹ These program measures are factored systematically throughout PHMSA’s management process, such as the following for technology development:

- Plan for technology transfer while identifying the right research priorities;
- Involve end users (i.e., regulators, pipeline operators, and service providers) into the research gap analysis and road mapping activities; and,
- Utilize technology demonstrations in front of potential service providers and other end users to qualify/quantify technology readiness.

Research and Innovative Technology Administration

The Research and Innovative Technology Administration (RITA) manages the UTCs, ITS program, and Alternative Fuels programs; houses the BTS, Volpe National Transportation Systems Center (Volpe Center), National Transportation Library (NTL), DOT Research Hub, and Transportation Safety Institute (TSI); and represents the DOT on all position, navigation, timing, and spectrum management issues.

Additionally, one of RITA's key roles is to coordinate and encourage collaborative research across all the operating administrations of the DOT, hence RITA's role as the convener and supervisor of this RD&T Strategic Plan.

The key research components within RITA include the UTC, ITS, and Alternative Fuels programs, as well as the Volpe Center, which is a fee-for-service entity. Much of the research described by the modes within this plan will take place at the Volpe Center, as its clients include most of the operating administrations, as well as other public-sector entities.

The UTC program is a competitive, multiyear grant program that is renewed under each new surface transportation authorization bill, with funding flowing through FHWA. These centers not only conduct research related to the many transportation modes of highway, transit, rail, and freight; they provide critical workforce development for future transportation professionals.

The ITS program is also renewed through surface transportation authorization legislation, with funds flowing through FHWA. This program is a very good example of a cross-modal collaborative effort between FHWA, NHTSA, FMCSA, and RITA. This program is discussed further under the FHWA and NHTSA sections.

The Alternative Fuels program examines safety issues involving alternative fuels and how to utilize alternative fuels as a bridge to reaching energy independence and reduced GHG production in this country.

Though BTS and NTL do not perform research, these organizations, along with the DOT Research Hub, provide information to researchers that can assist their efforts, encourage collaboration, and reduce unnecessary or repetitive research.

TSI is a fee-for-service training facility that offers course work to all the operating administrations and the private sector.

As manager of the UTC and ITS programs, RITA's list of research stakeholders is a very long one and includes

international partners, academia, State DOTs, industry, governmental entities, and end users. Because of its research coordination responsibility, RITA interacts with other Federal agencies by serving on several interagency working groups, like the Biomass Research and Development Board (chaired by the Department of Agriculture) and the Senior Strategy Group of the Cyber-Physical Systems program within the NSF. RITA also represents the DOT's research interests on the Joint Transportation Research Centre (a joint International Transport Forum and Organization for Economic and Cooperative Development effort). It is through these types of activities that RITA stays attuned to national and worldwide research needs and interests. ●

RITA UTC Program: The Future of Intersection Management

Assuming the technologies mature and connected vehicles hit the market, a valid question is whether traditional intersection control mechanisms are still needed. For example, how will the existence of advanced cruise control systems affect intersection performance? To address these types of questions, the Connected Vehicle/Infrastructure University Transportation Center (CVI UTC) is funding a project at Virginia Tech's Center for Sustainable Mobility to develop a futuristic intersection management system that prevents crashes and reduces the total intersection delay. It is anticipated that vehicles will ultimately be automated to some extent—and their movements in the transportation network will need to be managed. Accordingly, this research attempts to develop a framework for intersection control that communicates with equipped vehicles and adjusts their speeds within the intersection area. The main purpose of the proposed system is to prevent collisions at intersections and minimize the total intersection delay using advanced cruise control technology.

Research Priorities



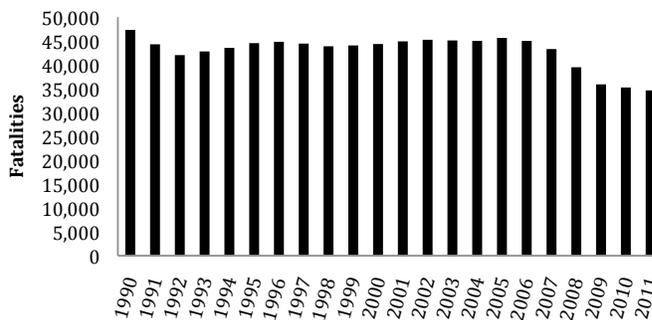
Promoting Safety

“Improve public health, safety, and security by reducing transportation-related fatalities and injuries.”

— DOT Strategic Plan, FY 2012 – 2016¹²

Improving safety is the primary goal of the DOT, with an ultimate goal of a perfectly safe transportation system. The DOT and its partners have made significant progress in reducing the number of transportation-related fatalities and injuries across all modes of transportation over the past decade. The DOT will continue to work to find solutions to the transportation safety challenges that face all operating administrations.

The overall method to making these improvements can be realized by a comprehensive approach that strives to make vehicles, transportation infrastructure, transportation systems, and operators safer. Figure 2 shows the total transportation fatalities for all modes in the U.S. from 1990 to 2011.



Source: Bureau of Transportation Statistics, National Transportation Statistics, “Table 2-1, Transportation Fatalities by Mode,” and NHTSA, “Traffic Safety Facts – 2011 Data.”

Figure 2. Total U.S. Transportation Fatalities – All Modes

Strategic Outcomes for Safety Research

- Reduction in transportation-related fatalities; and,
- Reduction in transportation-related injuries.

Cross-Cutting RD&T Priority Areas for Promoting Transportation Safety

The DOT can promote transportation safety by using a system-wide approach to collecting and evaluating multi-modal safety data. By managing the collection of these data, the DOT will be able to standardize data collection, utilize resources for processing and performing data analysis, and ultimately make data-driven decisions to

improve transportation safety. With insight from cross-modal safety data, there will be benefits in such areas as operator fatigue, safety culture, distracted vehicle operation, heavy vehicular safety issues, and hazardous material transportation. These insights could ultimately lead to zero deaths.

The DOT RD&T multimodal safety priority areas are:

- Advance research into the causal role of human factors in safety issues, specifically impairment issues such as alertness, operator capability and readiness, and fatigue;
- Advance vehicle system design to avoid collisions through advanced technologies, and mitigate safety consequences of unavoidable collisions;
- Design a transportation system that will improve safety and efficiency, focusing on safety risk, detection, and warning system reliability;
- Standardize transportation safety data collection and terminology;
- Develop a multimodal DOT safety incident and close call data collection system to help evaluate and analyze transportation safety performance and address transportation safety issues;
- Plan freight and hazardous material cargo routing to improve safety and reduce environmental risks; and,
- Ensure radio frequency spectrum is protected from harmful interference, especially in critical safety of life applications.

RD&T Priority Areas for Promoting Safety on Highways and Roadways

Highway travel in the United States is the safest it has been since the 1950s, although motor vehicle crashes remain the leading cause of death among Americans aged 5–24 years.¹³ Nationwide, the cost of motor vehicle crashes is estimated to be more than \$230 billion per year.¹⁴

NHTSA: *Crashworthiness Research*

In crashworthiness research, NHTSA completed a study that led to a 2010 final rule on ejection mitigation. This research developed a new component test procedure and performance measures to evaluate ejection mitigation countermeasures such as side window curtains. This final rule is now being phased-in and is expected to save 358 lives and 438 serious injuries annually.

The DOT RD&T highways and roadways safety priority areas are:

- Reduce driver distraction issues associated with vehicle and highway design, and operations;
- Identify innovative highway safety countermeasures that can be implemented by State, Tribal, and local highway safety, enforcement, and advocacy organizations to reduce motor vehicle fatalities and injuries associated with roadway departures, intersections, pedestrians and bicyclists, impaired driving, speed, motorcycles, rural and local roads, and limited visibility;
- Develop intelligent transportation systems designed to monitor vehicle and infrastructure conditions and facilitate communication between vehicles and infrastructure in order to avoid or reduce the risk and severity of collisions;
- Research the efficacy, reliability, and security of next generation technology systems that enable vehicles to communicate with each other, their environments, and their operators to avoid collisions;
- Advance technologies that enable State, Tribal, and local highway agencies to make more effective and strategic data-driven safety investment

FMCSA Distracted Driving Research: A Catalyst for Change

FMCSA-sponsored research into driver risk factors found that truck drivers who text while driving have a crash risk 23 times greater than those who do not text and drive. This finding in the summer 2009 was the catalyst for a national awareness campaign on the dangers of texting while driving led by Secretary of Transportation Ray LaHood. Distracted driving became his signature issue as Secretary. The impacts were many: FMCSA issued new regulations prohibiting texting while driving; thanks to the efforts of the Secretary and NHTSA, a majority of States now have laws prohibiting texting while driving; national advertising campaigns targeting younger drivers were launched with strong private-sector involvement and support; and NHTSA research in two cities—Syracuse, New York, and Hartford, Connecticut—identified that a combination of tough laws, strong enforcement, and ongoing public awareness saves lives. The data shows that both handheld cell phone use and texting behind the wheel have declined by 32 percent in Syracuse. In Hartford, handheld use dropped by 57 percent, while texting behind the wheel dropped by nearly 72 percent.

decisions by improving the quality of data, enhancing analytical tools, and promoting more rigorous evaluation methods; and,

- Implement safety research results from SHRP2.

Performance Measures

- Completion of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications systems research progress sufficient to support a 2013 NHTSA decision on vehicle communications for light vehicles and a 2014 agency decision for heavy vehicles;

- Number of technologies adopted in an operational setting to reduce fatalities and injuries (e.g., adopting the Safety Edge in highways);
- Number of planned countermeasures States implement from the Strategic Highway Safety Plans; and,
- Deployment of electronic data exchange and number of smart roadside technologies deployed.

RD&T Priority Areas for Promoting Safety of Commercial Motor Vehicles

About 12 percent of all motor vehicle fatalities in the U.S. involve crashes with large trucks.¹⁵ Driver-related factors are a primary concern for the DOT. In fatal crashes involving large trucks, driver-related factors were recorded for 34 percent of large-truck drivers.¹⁶ The DOT RD&T commercial motor vehicle safety priority areas are:

- Support partnerships that support FMCSA's mission to promote safe CMV operations through education, regulation, and enforcement;
- Identify CMV driver risk factors, such as distracted driving, driver fatigue, inattention, and other driver conditions and impairments to support rulemaking and promote a health, wellness, and safety culture in motor carriers;
- Deploy onboard safety systems, promoting benefits to fleets and insurance carriers and testing next generation onboard safety systems in partnership with technology providers and other DOT agencies;
- Study CMV industry demographics and market segmentation related to crash causation and safety data analysis;
- Deploy the Commercial Vehicle Information Systems and Networks intelligent transportation technologies for State CMV agencies and motor carrier companies; and,
- Identify, test, and deploy smart roadside technologies in partnership with Federal, State, and local CMV safety agencies.

Performance Measures

- Number of fleets incorporating a driver-focused safety culture centered on driver risk factors, including health, wellness, safety, and fatigue management programs; and,
- Market penetration of onboard safety systems (e.g., adaptive cruise control, forward collision warning, lane departure warning, crash imminent braking, and stability control systems).

RD&T Priority Areas for Promoting Safety of Transit Systems

Public transit is one of the safest modes of transportation per passenger-mile. In 2011, a total of 278 fatalities occurred in all modes of transit.¹⁷ The challenge for the DOT is to further reduce the number of transit-related fatalities and injuries even as the total number of people using transit increases. The passage of *MAP-21* directed the DOT to take on increased responsibilities overseeing public transportation safety. Among these responsibilities was the creation of a national transit safety plan and safety certification training program, as well as a local requirement to develop transit safety plans. In addition, *MAP-21* provides an expanded transit safety oversight role for the DOT.

The DOT RD&T transit safety priority areas are:

- Study materials and technologies to reduce transit fatalities and the number and severity of transit-related injuries;
- Improve operational practices to reduce transit fatalities and the number and severity of transit-related injuries;
- Develop transit safety standards;
- Deploy a standard transit safety certification process to ensure consistent local oversight of transit safety; and,
- Quantify safety benefits of rail transit, including barriers to its expanded use and approaches to overcome those barriers.

FAA: Traffic Alert and Collision Avoidance System

The FAA's Traffic Alert and Collision Avoidance System Program Office has funded the development of a new approach to airborne collision avoidance for the past four years, called Airborne Collision Avoidance System X (ACAS-X). The ACAS-X approach takes advantage of recent advances in dynamic programming and other computer science techniques to generate alerts using an off-line optimization of resolution advisories. The approach uses extensive actual aircraft data to generate a highly accurate dynamic model of aircraft behavior and sensor performance.

Performance Measures

- Reduced number of injuries on transit systems; and,
- Reduced number of fatalities on transit systems.

RD&T Priority Areas for Promoting Safety of Aviation Systems

The aviation industry has reached unprecedented levels of safety: in calendar year 2010, there were two fatalities on scheduled and nonscheduled Part 121 carriers (commercial and transport), and 17 nonscheduled Part 135 (charter and on-demand operations) fatalities. General aviation showed continued improvement as the number of accidents and fatalities has dropped 25 percent since 2000.¹⁸

The DOT RD&T aviation safety priority areas are:¹⁹

- Develop technologies for using U.S. airspace in safer, more efficient, and more environmentally sound ways;

Delineate roles and responsibilities between pilots and controllers and between humans and automation for implementing the Next Generation Air Transportation System (NextGen);

- Establish Minimum Operational Performance Standards (MOPS) for both a robust Detect and Avoid (DAA) and secure Command and Control (C2) Data Link capability to safely integrate unmanned aircraft systems into the national airspace;
- Prevent and mitigate potential accidents within the airport operational environment through improved safety training, airport design, and advanced technology implementation; and,
- Improve aircraft separation processes associated with current generalized and static Air Navigation Service Providers' (ANSP) wake turbulence mitigation separation standards.

Performance Measures

- Improved understanding of aerospace vehicle design, structure, and subsystems to reduce the potential for accidents and incidents and support the development of standards, policies, methodologies, and tools for certification;
- Improved knowledge of the human-system interface and a reduction in accidents and incidents through enhanced aerospace vehicle, air traffic, and technical operations that adapt to, compensate for, and augment the performance of the human;
- Improved understanding of factors that influence human physiology and performance in aerospace environments and guidance and tools that enhance human safety, protection, and survival during civil aerospace operations; and,
- Improved system-wide access and sharing of aviation safety data and analysis tools within the aviation community, providing safety resources that are integrated with operations of aviation industry stakeholders.

RD&T Priority Areas for Promoting Safety of Rail Systems

Every day, trains in America travel more than 1.4 million miles, safely transporting passengers to their destinations and delivering goods to the marketplace.²⁰ Data collected by FRA show that rail safety continues to improve, with a 32 percent decline in rail-related incidents from 16,919 in 2000 to 10,747 in 2012.²¹

The DOT RD&T rail safety priority areas are:

- Reduce derailments caused by equipment and infrastructure failures;
- Advance methods to reduce accidents at highway-rail grade crossings and to reduce trespassing on railroad property;
- Pursue pilot intervention projects, such as the Close Call Confidential Reporting System, to encourage the development of a positive safety culture within the railroad industry; and,
- Reduce the frequency and consequences of train collisions.

Performance Measures

FRA monitors the number and severity of accidents and incidents that occur along the railroad ROW. Railroads are required to report all such data when the monetary value of the damage caused exceeds a threshold, and when injuries or fatalities occur. The data is broken down into several hundred cause codes, which allows detailed analyses to be performed. RD&T performance is measured by the contribution it makes toward reducing the following:

- Grade crossing incidents;
- Track-caused train accidents;
- Equipment-caused train accidents;
- Signal-caused and miscellaneous accidents; and,
- Non-accident hazardous material releases

RD&T Priority Areas for Promoting Safety of Pipeline Systems and Hazardous Materials

Pipelines carry two-thirds of the Nation's energy supplies. Between 1992 and 2012, pipeline incidents involving fatalities or major injuries have declined by over 50 percent due to improvements in risk management and technology, such as integrity management, excavation damage prevention, and advances in pipeline materials.²² Pipelines continue to have a low-probability of failure and are the safest mode for transporting the enormous quantities of gas and liquid hydrocarbons the Nation requires. The risk of low-probability, high-consequence accidents, however, is of particular concern for hazardous materials transportation.

The DOT RD&T pipelines and hazardous materials safety priority areas are:

- Prevent damage to pipelines from excavation and identify critical pipeline defects before failure;
- Support remote condition assessment of pipeline defect severity;
- Prevent hazardous material incidents resulting from package handling or packaging failures;
- Investigate the role of human factors in incidents involving the transportation of hazardous materials; and,
- Identify emerging technologies to improve hazardous materials safety and minimize risks.

Performance Measures

- Number of commercialized new or improved technologies;
- Number of revised or new nationally recognized standards; and,
- Amount of reduction in deaths, injuries, and incidents involving hazardous materials.

RD&T Priority Areas for Promoting Safety of Maritime Systems

Over the past century, maritime safety has progressively improved with reduced sinkings, groundings, shipboard fires, and port and shipyard safety incidents. In addition, improved equipment on ships, in ports, and in shipyards along with improved safety systems and procedures have contributed to improved safety. Although many safety improvements have been realized over the years in the maritime industry, the lack of structured and standardized safety data makes it difficult to accurately measure progress and identify specific areas that need to be addressed to improve maritime safety.

The DOT RD&T maritime safety priority areas are:

- Reducing maritime-related fatalities, injuries, and accidents; and,
- Developing/refining safety standards and terminology to promote the exchange of safety information for better evaluation and analysis. ●

State of Good Repair



The condition of our Nation's transportation infrastructure falls short of a state of good repair. In an era with scarce resources, the DOT takes the position that stewardship of transportation infrastructure rises to the level of a strategic goal to draw attention to the need to preserve transportation reliability, capacity, and efficiency. The DOT works through its government and industry partners to proactively apply asset management principles and maintenance regimes to all transportation infrastructure assets and optimize existing capacity while conserving resources for infrastructure of critical importance. Improving the state of repair of our Nation's transportation infrastructure requires not only commitments from all levels of Government and the private sector, but also a dialogue about the trade-offs between building new infrastructure versus maintaining existing assets.

Preserving the Existing and Extending the Life of Future Transportation Systems

“Ensure the U.S. proactively maintains critical transportation infrastructure in a state of good repair.”

— DOT Strategic Plan, FY 2012–2016²³

A portfolio of research, development, and technology projects is essential in developing analytically sound mechanisms for setting targets and identifying which investments are the most useful for preserving the existing and extending the life of future transportation assets.

It is not practical or necessary to replace all infrastructure assets with new ones. RD&T investment must also focus on improved ways to repair and rehabilitate existing systems.

Modern inspection methods are required to determine the condition of assets in a cost-effective manner. Data from inspection systems are used by government regulators to check compliance with standards and by asset owners to inform maintenance and replacement decisions.

Cross-modal research activities have improved professionals' understanding of asset management strategies, tools, and resources. For example, FHWA's Long-Term Pavement Performance (LTPP) program, a 20-year effort to assemble comprehensive pavement performance data under a wide variety of conditions, is now providing objective and statistics-based analyses to help highway agencies select more cost-effective pavement designs for their applications.

The FTA has spearheaded an effort to systematically document current conditions and convene "summit" meetings to address using research findings and innovative approaches to asset management. The agency has identified broad categories of research—including engineering, best practices, and life cycle costs—and documented a need to investigate specific topics, such as improved and new materials, new generations of condition measurement systems, vehicle and rail systems equipment diagnostics, structural health monitoring technologies, and information technology systems for data management.

Building on current activities from multiple stakeholders and taking a cross-modal approach to RD&T investments related to conditions measurement, asset management, and system maintenance and repair can achieve positive impacts on the state of the entire transportation network.²⁴

Strategic Outcomes for Preserving the Existing and Extending the Life of Future Transportation Systems

- Increase the proportion of U.S. transportation infrastructure that is in good or better condition, including:
 - Highways and bridges
 - Transit systems
 - Aviation systems
 - Railroads and rail stations
 - Pipelines
 - Waterways and ports
- Improve asset management processes to maximize efficient use and maintenance of new and existing infrastructure.

Cross-Cutting RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Transportation Systems

- Technologies for both long- and short-term targeted sensing and monitoring, and for nondestructive inspection and evaluation of transportation assets;
- Economic analyses and alternative financing methods, including the economic benefits of utilizing asset management and maintenance tools;²⁵
- Performance-based methods for preserving and extending the life of our transportation facilities, including design and construction approaches and specifications that aim toward long-term performance;
- Implement new emerging technologies to improve project delivery times and superior project quality; and,
- Increase the longevity of transportation assets through more efficient use of the transportation system for heavy cargo.

RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Highways and Bridges

- Monitor, analyze, and improve highway infrastructure condition and durability through conduct of the FHWA Long-Term Bridge Performance (LTBP) program, LTPP, and other programs;
- National system performance indicators, focusing on the National Highway System (NHS), the Strategic Highway Network, and other major arterials and intermodal connectors;
- Develop a truck weight research agenda to study the trends in permits for weights in excess of legal limits and the pavement and bridge damage costs associated with those loads, and identifying feasible strategies to address this issue; and,
- Implement highway design and construction procedures, innovative quality assurance, performance-based contracting practices, innovative materials, and asset management practices to reduce the frequency and duration of onsite repairs and rehabilitation, reconstruction, and project life cycle costs, especially through the Every Day Counts (EDC) initiative.²⁶

FHWA: Condition Assessment of Concrete Bridge Decks

In collaboration with Rutgers University, current lead of the Region II UTC Consortium, FHWA envisioned, planned, designed, and constructed a robotic system for condition assessment of concrete bridge decks. The system combines and integrates the data from a variety of non-destructive evaluation technologies to provide a greater understanding of concrete bridge deck performance and deterioration. The robot, a research product under the LTBP, was tested and validated on a number of bridges in the States of Virginia and New Jersey. The robot also helped the National Park Service assess the condition of the deck on the Arlington Memorial Bridge. The robot will be deployed on a large number of bridges in the U.S. to collect data for the LTBP program with the goal of improving concrete bridge deck performance subjected to various environments, loads, and maintenance approaches.

Performance Measures

- Percentage of travel on NHS roads with pavement performance standards rated good (FY 2016 target is 63.8 percent); and,
- Percentage of bridges with deck area (the roadway surface of a bridge) rated structurally deficient (FY 2016 target is 9.1 percent).

RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Transit Systems

- Data collection and analyses of the condition of a cross section of the Nation's transit systems to determine the investment needed to bring transit infrastructure to a state of good repair;
- Management, maintenance, and financial practices that address the state of good repair of transit capital assets;

- Improved public transportation maintenance practices; and,
- Methods, tools, and guidance to improve capital asset assessment and maintenance management.

Performance Measures

- Improvements in average condition of rail vehicle fleet; and,
- Improvements in average condition of motor bus fleet.

RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Aviation Systems

- Standards and action plans for runway procedures (e.g., end-around taxiways) and databases and data collection tools to improve airport flight operations;
- Improve airport planning and design through the Airport Cooperative Research Program (ACRP);²⁷ and,
- Pavement standards that support safe international operation of next generation heavy aircraft and the availability of pavement design standards to users worldwide through the Airport Technology Research Program.

Performance Measures

- Maintenance, in good, fair, or excellent condition, of the pavements of at least 93 percent of the paved runways in the National Plan of Integrated Airport Systems;
- Availability of existing airport facilities protected and used as efficiently as possible, while making strategic investments in new facilities consistent with evolving aviation needs; and,
- Feasible procedures, operational methods, and technologically advanced systems that can decrease workload and increase efficiency of the National Air Space (NAS).

RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Rail Systems

- Improve inspection of railroad track and structures to allow defects to be detected before failure, a better understanding of defect formation and growth

FAA: Airport Pavement Maintenance Practices

FAA sponsored research through the ACRP Synthesis Program that documented how airports implement pavement maintenance management programs. The goals of the study were to document effective practices and differences in maintenance practices by pavement type, airport category, and geographical considerations [e.g., weather and availability of materials]. The report includes a literature review and survey of airport pavement maintenance program managers from medium and large air carrier airports, as well as State aviation officials. The target audiences for this report include airport pavement engineers, pavement maintenance managers, and personnel.

rates, and development of new concepts and tools to assess track condition;

- Design and maintenance guidelines related to shared-track usage between passenger and freight trains; and,
- Tools for the asset owner to monitor conditions and identify maintenance or replacement needs in advance.

Performance Measures

- Implementation of RD&T safety improvement projects that also preserve rail assets.

RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Pipeline Systems

- Pipeline facility integrity, enhanced design methods, improved construction quality and enhanced repair tools, materials, techniques, and processes; and,
- Technologies for remotely assessing pipeline condition.

Performance Measures

- Number of commercialized new or improved technologies; and,
- Number of revised or new nationally recognized consensus standards.

RD&T Priority Areas for Preserving the Existing and Extending the Life of Future Maritime Systems

- Facilitate research and studies that evaluate the potential for increased utilization of waterway transportation in an effort to increase the longevity of other surface transportation infrastructure.

Performance Measures

- Comparison of asset conditions before and after improvements using Federal funds; and,
- New research projects designed to increase utilization of maritime modal assets in transportation. ●

PHMSA: Bringing Pipelines Back Online Quicker

A public/private partnership grant awarded by the DOT/PHMSA led to improvements with an automated welding system. Welding done manually could take 2.5 hours total to make the entire fill pass at an estimated cost of \$280.85 per sleeve. The new automated system is approximately 2.3 times faster and 62 percent cheaper than manual welding while maintaining compliance with welding standards.



“Foster transportation policies and investments that serve the traveling public and freight movement, and bring lasting economic and social benefit to the Nation.”

— DOT Strategic Plan, FY 2012-2016 ²⁸

Economic Competitiveness

Improving Goods Movement

An efficient, reliable, robust, and adaptive transportation system is essential to maintaining the global competitiveness of our industries and continuously improving our citizens' standard of living.

The performance, connectivity, and effective use of our Nation's highways, ports, waterways, railways, airports, public transportation, and intermodal facilities directly impact the productivity of the U.S. economy and the costs of goods and services.

International trade is increasing and businesses are outsourcing supply, reorganizing logistics, and retailing directly to the consumer through the Internet. The value of U.S. international trade in goods more than doubled (in inflation-adjusted terms), between 1996 and 2012, rising to over \$3 trillion.²⁹

These changes have raised demand for reliable freight transportation, but the growth in freight movement is placing enormous pressure on an already congested transportation system. Congestion increases travel times and unreliability, drives up logistics costs, and imposes a high cost on the Nation's economy and productivity. Bottlenecks in managing high volumes of freight can cause significant delays in intermodal freight shipments by rail, truck, air, or in ports, as well as delays in moving goods between these modes.

These capacity constraints and bottlenecks affect all modes of transportation. For example, between 2000 and 2008, truck travel grew by more than 10 percent while lane-miles of public roads increased by only 3 percent.³⁰

In 2012, approximately 18 percent of all passenger flights failed to arrive at their destinations on time.³¹ The cost to the airline industry was an estimated \$8.3 billion in direct operating costs in 2007 (including labor, fuel, and maintenance costs).³² In FY 2011, about 20 percent of Amtrak trains arrived late.³³

There are indications that the Nation's deep-water ports and inland locks are also increasingly congested.³⁴ Freight transportation demand has outpaced growth in transportation supply, leading to rising shipping costs, increasing shipping times, increasingly unreliable travel times, and growing inventories that result in higher storage costs for freight customers, and ultimately for consumers.³⁵

National prioritization of specific modal improvements—such as high-speed and intercity rail and cross-cutting intermodal projects—can be the target of strategic investments in the RD&T portfolio. Research and development is required to develop the tools and resources for evaluating modal and multimodal opportunities with long-term capacity to cost effectively handle vastly increased movements of cargo and people.

Current projects, such as development of NextGen, are focusing on reducing gridlock, both in the sky and at air-ports, creating a competitive air transportation network. Other projects, such as the ITS Joint Program Office's (JPO) Connected Vehicle Program,³⁶ are engaging in high-level research and testing, development, and deployment of technologies that can improve safety and reduce roadway congestion (and by extension its economic costs).

Strategic Outcomes for Improving Economic Competitiveness and Goods Movement Research

- Maximize economic returns from transportation infrastructure investments;
- Improve operations of transportation systems in order to increase competitiveness and responsiveness to consumer needs;
- Advance U.S. transportation industry interests in targeted markets around the world;
- Expand opportunities for U.S. businesses in the

transportation sector, especially small, women-owned, minority, and disadvantaged businesses; and,

- Educate and develop a well-trained, diverse transportation workforce ready to address critical issues and operate next generation transportation systems.

Cross-Cutting RD&T Priority Areas for Improving Economic Competitiveness and Goods Movement

- Financial policies and practices that affect the overall efficiency and competitiveness of the transportation system;
- Freight transportation data collection and analysis to better inform freight time reliability and investment decisions, and to support projected capacity and resilience needs;
- Technologies and operational approaches to increase operational efficiency and improve multimodal connectivity of national freight networks, using all transportation resources and collaborating with freight systems owners and operators; and,
- Policies that encourage the most efficient use of transportation assets through comparisons of safety, fuel, and environmental benefits between and among modes.

RD&T Priority Areas for Economic Competitiveness and Improving Goods Movement Through Highways

- Operational strategies to reduce the impact of planned and unplanned events, including effective traffic incident management, improved traveler information systems, arterial, corridor, and network management, and technologies that manage the safety and mobility impacts of work zones and consider user impacts in engineering life cycle analyses; and,
- Allow State and Federal motor carrier regulatory agencies to perform their regulatory functions (compliance with size, weight, credentials, and safety requirements) while allowing CMVs to operate at highway speeds.

Performance Measures

- Harmonization of vehicle communication standards to support V2V and V2I safety applications across international vehicle manufacturers;
- Number of major projects assessed for appropriateness of innovative financing, procurement, or revenue-generating approaches;
- Number of projects that apply innovative technologies to improve project delivery times during project development, design, or implementation; and,
- Reduction in delay duration and variability throughout the freight transportation system.

RD&T Priority Areas for Improving Economic Competitiveness and Goods Movement Through Transit

- Improve transit services and increase transit capacity, such as improvements to bus and rail operations, vehicles and infrastructure, and transit industry analysis.

Performance Measures

- Improvement in access to employment opportunities via public transportation.

RD&T Priority Areas for Improving Economic Competitiveness and Goods Movement Through Aviation

- Investigate and demonstrate new airspace concepts and procedures to increase national aviation system capacity;
- Address human system integration and human performance issues related to improving controller efficiency to yield greater traffic throughput without a commensurate increase in the number of Air Navigation Service Providers personnel;
- Comply efficiently and quickly with regulatory environmental requirements on proposed airport capacity projects in metropolitan areas to enhance environmental sustainability while reducing total system delays;

- Demonstrate that the modernized system can handle anticipated growth and reduce gate-to-gate transit time;
- Develop and demonstrate NextGen capabilities according to the NextGen Implementation Plan, and continue ongoing efforts related to increasing airport capacity and reducing cost;
- Demonstrate wake turbulence avoidance technologies in order to ensure that aircraft are sufficiently separated from each other to minimize the risk of an aircraft encountering strong wake turbulence generated by the aircraft ahead;

FAA: Space Traffic Management and Operations

Centers of Excellence CST research conducted during the 2012-2013 academic year in the Space Traffic Management and Operations research area includes the following task to understand the impact of commercial space launches and reentries through the National Airspace System (NAS): “Unified 4-Dimensional Trajectory Analysis” is led by Principal Investigator Dr. Juan Alonso at Stanford University to develop requirements, architecture, and prototype implementations of simultaneous air/space traffic management procedures for commercial space transportation. The work leverages projected improvements derived from NextGen and will research and develop plausible architectures for an Integrated Airspace Management System (IAMS) based on time-space (4-D) probabilistic trajectories and safety assessments. Currently, the models, built on FACET, accept arbitrary thrust, weather, and failure profiles as inputs for Monte Carlo simulations of 4-D trajectories. The tool currently creates multiple 4-D polygonal envelopes around the trajectories (and debris) that represent a no-fly zone. Future plans are to generate realistic mission profiles for analysis, add capabilities to FACET to reroute aircraft around compact envelopes, and calculate added distance and time for impacted aircraft. Trade studies will be run to optimize architectures for probabilistic rocket trajectories that minimize impact on the NAS.

- Identify, define, and coordinate necessary NextGen-related research priorities with partner agencies for improvements in efficiency and capacity;
- Reduce weather-related delays to increase on-time arrival rate and reduce transit time; and,
- Establish requirements and standards for enabling availability and improving the quality and quantity of meteorological information to reduce impacts of adverse weather on rerouting, NAS capacity, and NextGen operational procedures.

Performance Measures

- Targets met for deployment and implementation of NextGen system components; and,
- Forty percent of all commercial aircraft from the top 25 aviation States are using fully interoperable NextGen technologies and capabilities by 2018.

RD&T Priority Areas for Improving Economic Competitiveness and Goods Movement Through Rail

- Methods for projecting freight traffic demand;
- Costs and benefits of alternative infrastructure investment strategies that would provide greater freight rail capacity;
- Develop a domestic passenger rail equipment manufacturing base; and,
- Make improvements to the environmental review process to allow faster deployment of new technologies or construction of new facilities.

Performance Measures

- Implementation of RD&T safety improvement projects that also improve economic competitiveness and goods movement.

RD&T Priority Areas for Improving Economic Competitiveness and Goods Movement Through Maritime Transport

- When resources permit, MARAD staff will participate in freight-related policy activities and studies, along with other focused research, where the maritime mode has the potential for contributing to increased economic competitiveness.

RD&T Priority Areas for Improving Economic Competitiveness and Goods Movement Through Education

- Successfully conduct competitions to award UTC grants and manage the UTC program effectively.

Performance Measures

- Number of graduate students supported by UTC grants graduated each year. ●

Livable Communities



Reducing Congestion and Improving Mobility



Fostering livable communities—places where transportation, housing, and commercial development investments are coordinated so that people have access to adequate, affordable, and environmentally sustainable travel options—is a transformational DOT policy shift.

During the past 50 years, U.S. transportation investment has frequently not been well coordinated with other infrastructure investments, such as housing and commercial development. This has contributed to the growth of low-density, scattered, automobile-dependent communities and disinvestment in many of our Nation's core urban centers. Single-use zoning that separates housing from shopping, work, and schools has intensified the trend. This type of zoning emphasizes wide streets, ample off-street parking, and large front and side yard setbacks.

“Foster livable communities by integrating transportation policies, plans, and investments with coordinated housing and economic development policies to increase transportation choices and access to transportation services for all.”

— DOT Strategic Plan, FY 2012-2016 ³⁷

Federal programs for road construction have also promoted broad, high-speed roadways, even in residential communities.

Livable communities have higher economic resilience and more economic opportunities through reliable and timely access to employment centers, educational opportunities, services, and other

basic needs. They provide expanded business access to markets—mainly through increased accessibility and mobility choices.

Many communities are located on navigable waterways. By using ferries and other maritime transportation, and ensuring there are convenient links to other modes of transit, it may be possible to relieve congestion on bridges, tunnels, and associated roadways and improve the mobility and quality of life for members of the community.

Seniors and others who cannot or choose not to drive face similar mobility limitations. According to U.S. Census projections, by 2020, 53 million Americans will be over the age of 65, and 25 percent of those seniors will be unable to drive,³⁸ making alternatives to driving indispensable for access to essential destinations (e.g., medical services, grocery stores, and retail locations).

The DOT, HUD, and EPA Interagency Partnership for Sustainable Communities has created a platform for high-level leadership in each agency to guide critical research efforts to understand the connections between transportation, housing, and community development initiatives and the use of land, energy, and water resources.

In 2006, the FTA and FHWA collaborated on revising the Statewide and Metropolitan Transportation Planning requirements that were part of a “livable communities” model implementation. These requirements were comprehensive and featured new components, such as the required coordination between human service agencies and transit service providers to ensure that underserved populations had adequate and expanded mobility options. Many of the proposed changes in the planning requirements were based on the DOT research studies.

A 2006 Non-Motorized Transportation Pilot Program funded four diverse communities to enhance bicycle and pedestrian infrastructure, planning, and public outreach activities.³⁹ Each pilot community used a share of available funding to rigorously evaluate the effect of the program on travel behavior. Pilot research projects like this can demonstrate the effectiveness of innovative transportation alternatives.

Strategic Outcomes for Livable Communities – Reducing Congestion and Improving Mobility Research

- Increase access to convenient and affordable transportation choices;
- Improve public transit and rail transportation experience;

- Increase networks that accommodate pedestrians and bicycles; and,
- Increase access to transportation for people with disabilities and older adults.

Cross-Cutting RD&T Priority Areas for Livable Communities – Reducing Congestion and Improving Mobility

- Access to human services and transportation providers for older adults, people with disabilities, low-income individuals, and suburban and rural residents, allowing them to live and travel independently;
- Transportation systems designed to promote connectivity and multimodalism;
- Technologies and systems that provide relevant information to transportation-system users and help them make informed travel decisions; and,
- Tools and information to enhance local planning processes for livability assessment, including synthesizing existing State and local measures and metrics on livability, especially those that quantify the non-transportation benefits of livability.

FHWA: Linking Drivers and Roads

Safety and Operations R&D are continuing research and development of technologies that will enable V2I and V2V communications in order to avoid collisions and achieve corollary benefits. See Linking Drivers and Roads: www.fhwa.dot.gov/publications/publicroads/13janfeb/01.cfm.

A cross-agency accessible transportation project will apply advanced technologies to enhance the mobility of travelers with disabilities. Upon completion, this project will demonstrate technologies that have the potential to provide users the capability to reliably, safely, and independently plan and execute travel.

RD&T Priority Areas for Livable Communities – Reducing Congestion and Improving Mobility Through Research in Highways

- Integrate bicycle and pedestrian pathways into vehicular and roadway design guidelines and standards;
- Develop a walkability index to rate an area's pedestrian friendliness and allow more effective funding decisions to enhance walking;
- Technical assistance to State, Tribal, and local agencies to enhance measurements of livability status and improvements; and,
- Develop a forecasting model of variables that affect an area's non-motorized trips.

Performance Measures

- Number of States with policies to improve transportation choices for walking and bicycling;
- Number of States and MPOs that address walking and bicycle activities in planning documents; and,
- Improvements in walkability index.

RD&T Priority Areas for Livable Communities – Reducing Congestion and Improving Mobility Through Research in Transit

- Increase access to convenient, connected, affordable, and extensive public transportation (coverage and interconnectivity);
- Improve public transportation convenience and reliability (service quality); and,
- Develop synergies between public transportation, land use, housing, and communities.

Performance Measures

- Improvement in transit boardings per transit market.

FTA: Rugged Long-Life Low-Floor Small Bus

The coordination of relatively long human service trips on poorly-maintained unpaved roads in rural counties requires a rugged, maneuverable, accessible, high-capacity vehicle capable of carrying 20+ passengers in order to minimize passenger trip costs. Ride Solution, the transit operator in Putnam County, Florida, knew they needed such a bus, but found the marketplace was not offering one. With the support of FTA's Office of Research, Demonstration, and Innovation, Ride Solution identified an advanced bus design, obtained rights, further developed the design, and built two prototype small buses. These buses incorporate conventional technologies in innovative ways, allowing unique combinations of low-floor for accessibility and unusually high passenger capacity of 25 passengers (or 5 wheelchair passengers) on a 26-foot vehicle. Patented drive technology allows very efficient packaging of the engine and transmission and locates the weight of these components just above and behind the rear axle for excellent traction. Ride Solution has been operating the first bus in revenue service since early 2010. Ride Solution has received expressions of interest from companies capable of manufacturing the new bus design in Putnam County, potentially bringing many jobs to northeast Florida.

RD&T Priority Areas for Livable Communities – Reducing Congestion and Improving Mobility Through Research in Aviation

- Improve access to surface transportation systems;
- Number of established requirements, policies, procedures, and resources to allow airports in the U.S. to become environmentally friendly neighbors;
- Develop technologies to reduce noise impacts on communities; and,
- Improve the understanding of aviation noise impacts on human health and welfare.

Performance Measures

- Maintenance of continuous air service at 98 percent of Essential Air Service eligible communities; and,
- Reduction in significant community noise impacts in absolute terms.

RD&T Priority Areas for Livable Communities – Reducing Congestion and Improving Mobility Through Research in Rail

- Determine potential negative impacts of rail service or expanded rail service on livability (e.g., vibration from passing trains, train noise, and grade crossings) and methods to address them;
- Develop methodologies to evaluate the costs, benefits, and feasibility of creating rail freight “bypasses” around cities and former freight routes for commuter or light rail service; and,

- Determine barriers to expanded commuter and light rail service and alternatives to address them.

Performance Measures

- Implementation of RD&T safety improvement projects that also reduce congestion and improve mobility.

RD&T Priority Areas for Livable Communities – Reducing Congestion and Improving Mobility Through Research in Maritime Transportation

- Leverage partnerships, opportunities, and resources when available in support of improved living condition for U.S. citizens; and,
- Investigate and pilot technology to reduce congestion and environmental impacts around maritime ports. ●

Environmental Sustainability

Preserving the Environment

“Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources.”

—DOT Strategic Plan, FY 2012-2016⁴⁰



The transportation of passengers and goods is central to our economy and quality of life; however, there are adverse effects on the environment from building, operating, and maintaining the transportation system. The DOT must work to achieve a balance between environmental challenges and the need for a safe and efficient transportation network. The transportation sector is a significant source of GHG emissions, accounting for 28 percent of total U.S. GHG emissions in 2012.⁴¹

Highway vehicles accounted for a large percentage of emissions in 2012 from the major criteria of air pollutants regulated by the EPA:

- 61 percent of carbon monoxide emissions
- 56 percent of nitrogen oxide emissions
- 23 percent of volatile organic compounds (VOCs) emissions⁴²

The transportation sector consumed 28 percent of U.S. energy in 2012, almost all of which was in the form of petroleum.⁴³ This share continues to grow rapidly compared to other major end-user sectors. Transportation accounts for 71 percent of U.S. oil consumption.⁴⁴ The extraction, distribution, refinement, and subsequent transportation of petroleum-based fuels and products contributes to spills, pollution, and adverse safety issues.

Over the past four decades, substantial progress has been made in reducing emissions of urban air pollutants, both nationally and from the transportation sector in particular. From 1970 to 2012, the U.S. reduced highway vehicle emissions for the following pollutants:

- Carbon monoxide by 85 percent
- Nitrogen dioxide by 69 percent
- VOCs by 88 percent⁴⁵

This decline is largely the result of progressively strengthening the regulations of emissions under the *Clean Air Act*

of 1963 and the *Clean Air Act Amendments of 1990*.

This is a significant achievement. During the same period, there was a 50-percent increase in the U.S. population, a tripling of gross domestic product (GDP), and a 150-percent increase in passenger-miles traveled.⁴⁶

Nonetheless, as of 2007, some 158 million Americans lived in counties or regions that exceeded health-based national ambient air quality levels for at least one regulated air pollutant.⁴⁷ Significant challenges remain, particularly as new national ambient air quality standards are revised to be more protective of public health. These challenges also apply to individual neighborhoods, travel corridors, and local facilities. Much like the Promoting Safety research priority area, solutions to these issues may be found in many places: laws, policies, economic systems, and often in innovative technologies and scientific advancements attained through research.

To encourage innovation, the DOT currently funds a number of RD&T programs that address environmentally sustainable transportation while maintaining a safe and efficient transportation network. Research in this area is improving our understanding of the broad environmental impacts of aviation, highway, transit, rail, pipeline, and hazardous materials transportation activities.

Federal RD&T programs are seeking ways to reduce the adverse impacts from transportation through mitigation measures and improvements to environmental standards, innovative planning tools, and engineering analyses that incorporate sustainability. RD&T programs are also proactively developing greener methods and materials for infrastructure construction.

In addition, we need to take a systems approach to reducing transportation environmental impacts and increasing our overall energy efficiency and independence. This includes research and development to generate tools and resources for evaluating modal and multimodal opportunities to better integrate modal shifts for improved environmental stewardship and energy efficiency.

Strategic Outcomes for Environmental Sustainability – Preserving the Environment

- Reduce transportation-related carbon emissions, improve energy efficiency, and reduce petroleum use in the transportation sector;
- Reduce transportation-related air, water, and noise pollution and impacts on ecosystems and human welfare; and,
- Increase the use of environmentally sustainable practices and materials in the transportation sector, especially for DOT-owned or -controlled transportation assets.

Cross-Cutting RD&T Priority Areas for Environmental Sustainability – Preserving the Environment

Develop infrastructure and distribution systems for advanced transportation energy sources, including electricity and alternative fuels, and research into energy generation and distribution through existing public ROW;

- Develop policy through the DOT Center for Climate Change and Environmental Forecasting to reduce the production of transportation-related GHG and mitigate the effects of global climate change on the transportation network;⁴⁸
- Develop materials, technologies, and practices to reduce energy consumed for, and the environmental impacts of, transportation vehicles and infrastructure construction and rehabilitation; this includes vehicle and construction material fabrication and placement; and,
- Develop policies and programs that encourage industry to develop and implement innovative technologies that are more sustainable, and apply life cycle analyses to products and systems.

RD&T Priority Areas for Environmental Sustainability – Preserving the Environment Through Highways

- Implement V2V and V2I technologies;
- Utilize data from vehicles on emissions and fuel consumption to better manage the transportation network to enable reduction in GHGs;
- Promote environmentally friendly highways through

use of recyclable techniques, renewable materials, permeable surfaces, and storm water runoff mitigation techniques; and,

- Provide educational materials, especially through the EDC Initiative, to ensure Federal, State, Tribal, and local partners have the capacity to address climate change in their transportation plans and programs, and to develop Agency Climate Action Plans.

Performance Measures

- Number of States, Tribal, or local agencies with a Climate Action Plan to reduce GHG emissions from transportation.

RD&T Priority Areas for Environmental Sustainability – Preserving the Environment Through Transit Systems

- Develop and implement technologies to reduce the energy consumption and GHG emissions of transit systems, including bus and rail electric drive technology, facility improvements, and alternative fuel technologies for buses;
- Improve and utilize alternative fuel buses, including hydrogen fuel cells, electric batteries, and hybrid electric propulsion systems; and,
- Develop cost-efficient alternative fuels infrastructure for transit and bus rapid transit systems across the United States.

Performance Measures

- Increase in the number of rail vehicles that incorporate electric drive technologies for propulsion; and,
- Increase in the number of rail systems that incorporate energy storage technologies.

FHWA: Partnering for Sustainable Highways

The Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) was developed by FHWA as a practical, web-based collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures, and practices) and projects. While the use of INVEST is voluntary, it can be used by transportation agencies, such as DOTs, MPOs, Councils of Government, public works departments, and their consultants and partners, to evaluate and aid the integration of sustainability into their programs and projects.

INVEST is an important part of FHWA's ongoing efforts to advance the triple bottom line of sustainability: economy, environment, and society. FHWA launched INVEST 1.0 in October of 2012. Subject matter experts at FHWA will monitor the criteria and scoring, stay abreast of the state of the practice, and advise the INVEST team of necessary updates. FHWA will also rely upon feedback from users to improve the tool, which will continue to evolve over time. More information is available at: www.fhwa.dot.gov/environment/climate_change/sustainability/self-evaluation_tool.

FTA: Sustainable Transit Buses

Rising gas prices and a focus on emissions increase the need to have low- or no-emissions buses that are reliable. Fuel cell-powered buses, electric battery buses, or other similar technologies could reduce the amount of carbon released for significant expenditures for fuel every year for the life of a vehicle. FTA has funded vehicles like these through the Transit Investments for Greenhouse Gas and Energy Reduction (TIGGER program). Some of these projects have included the demonstration and deployment of an American-built fuel cell bus at Sunline Transit, battery electric buses in San Antonio, Texas, and an inductive charging bus at the University of Utah. These demonstrations have allowed transit agencies and manufacturers to work together to test initial deployment of advanced vehicles that will eventually be adopted on a large scale, ensuring that future investments in new improved buses are made based on operational experience.

RD&T Priority Areas for Environmental Sustainability – Preserving the Environment Through Aviation Systems

- Develop international aircraft noise and emissions standards, and practices and guidance materials for solutions that are technologically feasible, economically reasonable, provide measurable benefits, and consider the interdependencies between emissions, noise, and fuel burn;⁴⁹
- Lower energy consumption, emissions, and noise through accelerated aircraft technology maturation and improved operational procedures; advance and demonstrate use of aviation alternative fuels through the Continuous Lower Energy Emissions

and Noise (CLEEN) Program and by continuing to support the Commercial Aviation Alternative Fuels Initiative (CAAFI);⁵⁰ and,

- Develop low-emission airport technology through the innovative Voluntary Airport Low Emission (VALE) program, ranging from alternative fuel vehicles and aircraft ground support equipment to various infrastructure improvements (like gate electrification) to reduce aircraft emissions at the gate.⁵¹

Performance Measures

- Reduction in impact of aviation emissions on air quality and global climate;
- Improvement in energy efficiency and assured availability of sustainable alternative jet fuels;
- Improvement in data and methodologies to support certification of alternative fuels for general aviation aircraft; and,
- Reduction in the number of people exposed to significant aircraft noise.

RD&T Priority Areas for Environmental Sustainability – Preserving the Environment Through Rail Systems

- Develop technologies that can be retrofitted to improve locomotive and power car energy efficiency while reducing harmful emissions;
- Utilize alternative fuels to lower locomotive energy for traction consumption and emissions;
- Develop electrically powered passenger and freight rail transportation; and,
- Reduce the number of hazardous material releases from tank cars.

Performance Measures

- Implementation of RD&T safety improvement projects that also preserve the environment.

RD&T Priority Areas for Environmental Sustainability – Preserving the Environment Through Pipeline Systems

- Reduce the volume of pipeline products released into the environment; and,
- Ensure safe transportation of alternative fuels through pipelines.

Performance Measures

- Number of commercialized new or improved technologies; and,
- Number of revised or new nationally recognized consensus standards.

RD&T Priority Areas for Environmental Sustainability – Preserving the Environment Through Maritime Systems

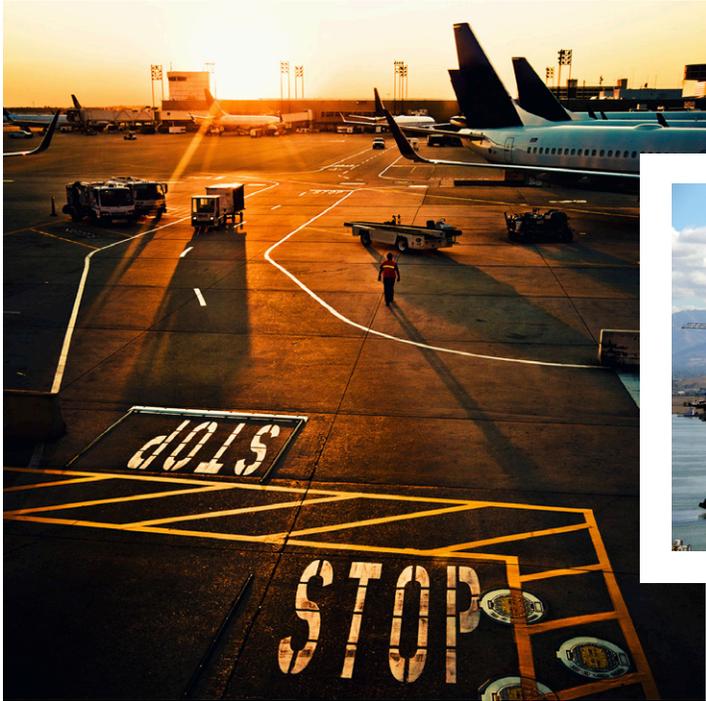
- Assist with the development/verification of technologies/treatments that mitigate introductions of nonindigenous (aquatic) species;
- Test air emissions reduction technologies;
- Determine viable alternative fuel types; and,
- Reduce ship-generated noise. ●

MARAD: Air Emissions and Energy

In 2012, MARAD completed a Great Lakes natural gas feasibility and conceptual engineering design study that looked at several parameters associated with using natural gas (LNG or CNG) as a main propulsion fuel for marine vessels transiting the Great Lakes. Results showed that using natural gas as a marine fuel is possible; however, gaps were identified that require further research.

MARAD also funded three vessel emission reduction projects in 2012 through a competitive request for proposals (RFP) process. The goal of the RFP was to support emission reductions and collect real-time emissions data to assist with determining Federal benefits. Two of the projects that were funded focused on the conversion of existing engines to more emission-friendly engines. The third project focused on engine conversion to a state-of-the-art hybrid system. All three projects highlighted excellent partnerships with local and State agencies.

Plan Implementation



The implementation, evaluation, and modification of this RD&T Strategic Plan is a four-step process:

1. **Identify program priorities.**
2. **Gauge success of research outcomes based on performance measures.**
3. **Modify Strategic Plan RD&T Priority Areas.**
4. **Update performance measures.**

By successfully carrying out this process, the DOT ensures that the RD&T program follows its commitment to (1) funding and undertaking relevant research; (2) carrying out high-quality, peer-reviewed research; (3) disseminating the results of research through technology transfer and stakeholder outreach; and, (4) helping implement successful new technologies or processes.

1. Identify Program Priorities

Based on the desired outcomes and global areas of research described in this RD&T Strategic Plan, each operating administration will develop its own strategic plans and/or roadmaps and use them as a guide in allocating research resources and initiating research programs.

The Planning Team will use the DOT Research Hub, RITA's cross-modal research collaboration tool, to help identify and facilitate multimodal research. The Planning Team will use the Research Hub where feasible in order to identify potential areas of multimodal research activity within the clusters. By facilitating multimodal research and identifying any unnecessarily duplicative efforts, the Research Hub will increase the efficiency of research programs within individual operating administrations.

2. Gauge Success of Research Outcomes Based on Performance Measures

Each year, the RD&T Planning Team will use performance measures listed in the RD&T Strategic Plan to review progress made toward meeting the strategic outcomes.

3. Modify Strategic Plan RD&T Priority Areas

As needed, the RD&T Planning Team will modify the RD&T Priority Areas based on their annual review of

the RD&T Strategic Plan. This may lead to changes in direction for research programs, particularly at the cross-modal level.

4. Update Performance Measures

The RD&T Planning Team will review and update performance measures when priority areas are modified or when new sources of data are developed or identified and used to effectively gauge the results of research outcomes.

Program Level Evaluation

Program evaluation is one of the mandatory elements of the *Government Performance and Results Act (GPRA)*. The statute calls for agencies to use program evaluations to assess the manner and extent to which their programs achieve intended objectives; include a summary of the findings of program evaluations completed in their Performance and Accountability Reports with a notation if no evaluations were completed; and present a schedule for future program evaluations in strategic plans. This plan employs a five-step program evaluation process in alignment with the objectives of *GPRA*.

The five-step research program evaluation process is similar to the four-step RD&T Strategic Plan evaluation process, but provides more detail, as shown in Figure 3 below:

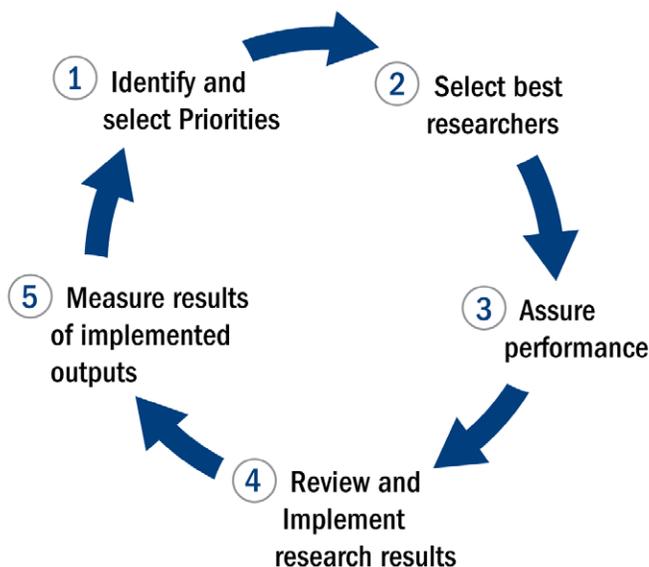


Figure 3. Research Evaluation Process

1. Identify and Select Priorities

The operating administrations will develop research programs and projects within their programs, based on the DOT RD&T Strategic Plan, operating administration RD&T strategic plans and research roadmaps, as well as interactions with national and international stakeholders. The intent is to achieve the strategic outcomes listed in the DOT RD&T Strategic Plan.

2. Select Best Researchers

The selection of researchers to execute specified research projects is expected to follow best practices of the scientific research community, including open competition and peer review. It is essential that qualified, capable, and responsible researchers or research teams are selected to perform DOT-funded research projects.

The UTC program is an excellent example of the DOT utilizing these best practices. The grants awarded for FY 2013 and 2014 funds were based on a competitive process (designed within RITA), utilizing subject matter experts, both within and external to the DOT, to review proposals from university consortia and make recommendations to the DOT Administrators on which centers to fund.

3. Assure Performance

Monitoring of researchers by qualified program managers is required to guarantee research results in a timely manner. It will also ensure an efficient use of DOT funds. This monitoring will include periodic in-depth reviews of research progress, including presentations by the researchers when needed.

4. Review and Implement Research Results

The results of completed research projects must be reviewed not only by program managers and DOT experts, but also by research peers and end users. These reviews are essential to maintain research quality and integrity and to introduce any new technologies or processes developed to those implementing the research results.

It is important to note that not all research produces a positive result when a new technology or process is developed. There are times when research results are negative and the decision is made that the technology or process is not feasible or does not work. This information is still very important, even though there is no implementation, and must be disseminated to eliminate any future research effort that would unnecessarily duplicate previous efforts.

The implementation of new technologies and processes will require a major commitment from the DOT in both policy and funding. In cooperation with infrastructure owners and operators, the DOT will develop approaches to streamline approval procedures and to identify sources of funding to address the initial higher costs of implementing new technologies or processes.

5. Measure Results of Implemented Outputs

The success of implemented outputs will be measured using the performance measures listed in the tables in each of the five Focus Areas. Based on the results, strategic outcomes or RD&T priority areas may be changed within the RD&T Strategic Plan as part of

the annual review. As these measurements are incorporated into the setting of priorities, this will close the program evaluation process feedback loop (illustrated on the previous page) and initiate a new cycle.

The RD&T Strategic Plan is reviewed each year, but many research outcomes, or the end impacts from the research products, will not take effect for years. This means there will be little data with which to adjust priorities in the first two or three years, but more data in later years that can be used to make major adjustments in strategic outcomes and RD&T priorities. This does not mean the RD&T Strategic Plan should not be reviewed early in its life cycle. The DOT must conduct annual reviews, starting with the first year, to maintain the validity and usefulness of the RD&T Strategic Plan. ●

Appendix A: Stakeholder Involvement in Plan Development

Stakeholders both inside and outside the Federal Government bring a unique perspective to research needs and strategies. Stakeholders include staff members at other Federal agencies, the private sector, industry associations, academic institutions and academic researchers, nonprofit advocacy organizations, State and local governments, and the general public.

RITA used the following approaches to obtain input for the RD&T Strategic Plan from stakeholders:

- Meeting with stakeholder groups to announce the development of the RD&T Strategic Plan;
- Opening a *Federal Register* docket to collect comments from stakeholders prior to developing the RD&T Strategic Plan;
- Using an expert panel to review and analyze stakeholder comments and ensure comments were addressed in subsequent drafts of the RD&T Strategic Plan;
- Requesting comments from RD&T planning team members, their staff, and colleagues; and,
- Obtaining comments and guidance through a Letter Report from the Committee for Review of the U.S. DOT RD&T Strategic Plan (April 30, 2013). This committee was chartered in accordance with 23 USC §508(c), “National Research Council Review.” A copy of the Letter Report is included as Appendix B.

Appendix B: National Research Council Review Letter

April 30, 2013

The Honorable Ray LaHood

Secretary

U.S. Department of Transportation

1200 New Jersey Avenue, SE

Washington, DC 20590

Dear Secretary LaHood:

Section 508 of the 2012 surface transportation authorization statute, *Moving Ahead for Progress in the 21st Century (MAP 21)*, calls for the U.S. Department of Transportation (U.S. DOT) to develop a 5-year strategic plan for federal transportation research, development, and technology (RD&T). The law requires the plan to describe the primary purposes, topics, expected outcomes, and anticipated funding of RD&T. It also calls for the plan to integrate the RD&T programs of all U.S. DOT modal administrations, to reflect input from a wide range of stakeholders, and to consider research conducted outside the U.S. DOT to avoid duplication of efforts. Finally, the law calls for the National Research Council (NRC) to review the plan.

On February 19 and 20, 2013, NRC, under the auspices of the Transportation Research Board (TRB), convened the Committee on the Review of the U.S. DOT Strategic Plan for Research, Development, and Technology, a 13-member committee of experts in transportation engineering, economics, system operations and administration, and research management. Senior officials from the Research and Innovative Technology Administration (RITA) provided a draft of the plan, entitled the *RD&T Strategic Plan for 2013–2018*, and briefed the committee on its development. Research managers from the department's modal administrations participated in these briefings and provided additional information about strategic plans within each administration. The committee then met in closed session to establish its findings and begin preparing this review, which was completed through correspondence. The roster of committee members and a list of presentations made by the individuals who briefed the committee are included as attachments to this letter report.

On behalf of NRC and the committee, I wish to thank the many U.S. DOT officials who participated in the briefings; they provided the committee members with valuable insights. Kevin Womack, Associate Administrator, Office of Research, Development and Technology, RITA, asked the committee for its assessment and provided an overview of the strategic planning process. He was extremely forthcoming in his discussions, and the committee appreciated his candor and receptiveness to committee comments. I would also like to thank the department for the opportunity to review a draft of the plan; the committee appreciates the chance to make substantive comments that can positively influence the shape of the final plan and believes that both the U.S. DOT and the committee benefited from reviewing the plan at an early stage. This letter report presents the results of the committee's review and is offered with the intention of aiding current and future strategic planning for RD&T by the U.S. DOT. The

committee would like to emphasize that it did not evaluate the topical focus of the modal administration strategic plans or research programs; rather, it focused on reviewing the U.S. DOT strategic plan along with the strategic planning process and performance measurement. References to topical coverage of the research plan are made only in the context of testing the plan against some of the important research topics that are currently being investigated or are anticipated on the basis of evolving demographics, technology, culture, economic conditions, and other factors.

Summary

The criticality of transportation to the economy, the environment, personal mobility and opportunity, public health and safety, and other aspects of quality of life requires continuing efforts to ensure that the benefits of mobility are realized and that its negative impacts are minimized. Effective RD&T allows transportation systems to keep evolving and improving to meet the changing needs of their users. As described below, the U.S. DOT faces the challenge of coordinating efforts between its administrations and with other entities to provide a robust and strategic transportation RD&T program in support of the department's strategic goals. Coordination across the modal administrations will not come easily, given the many institutional and financial constraints that the U.S. DOT faces. However, moving toward a strategic, coordinated research effort can improve the contributions of current and future RD&T to the achievement of national goals.

The committee has made both short- and long-term recommendations; the former apply to the current plan and the latter to future strategic plans. Highlights of the committee's recommendations to the U.S. DOT are listed below and are explained in greater detail in the sections that follow.

SHORT-TERM RECOMMENDATIONS

1. The plan should explain the research context of the U.S. DOT, including priorities and levels of resources as well as the roles and authorities of the different modal administrations.
2. Some of the modal administrations have put a great deal of effort into the development of their own strategic RD&T plans, and the U.S. DOT should leverage the strength of these modal plans when developing its overall strategic RD&T plan.
3. The plan's performance measures should be specific to a strategic research plan and should measure mode-specific research objectives and outputs as they relate to the department's strategic objectives.
4. The U.S. DOT should use the plan to describe past successes of and future opportunities for RD&T in order to provide a compelling case for the importance and value of funding transportation RD&T.

LONG-TERM RECOMMENDATIONS

1. RITA should develop longer-range RD&T strategic plans for the department, and the U.S. DOT might consider partnering with university transportation centers (UTCs) to develop long-term research plans that take advantage of resources outside the department.
2. The U.S. DOT should partner with universities for cross-modal research as well as both basic and advanced research, none of which are department strengths.
3. The department should stay attuned to investment in transportation-related RD&T by other federal agencies, national organizations, and international research organizations, both to draw on and to contribute to these efforts.
4. A substantial share of transportation-related research is conducted by federal agencies such as the National Aeronautics and Space Administration, the National Science Foundation, and the U.S. Departments of

Energy and Defense. The U.S. DOT should develop substantive interactions with other federal agencies and White House offices, and its plan should describe these efforts.

5. The U.S. DOT strategic research plan should be informed by and coordinated with numerous private sector stakeholders, including those entities involved in vehicle and facility development and services for automobiles, trucks, airlines, pipelines, the maritime sector, and rail. Future research agendas should be built around the major issues the U.S. DOT faces now and is likely to face in the future. The agendas should be driven by a deep and systematic strategic planning process.

Critical RD&T Issues and Opportunities

Both the U.S. economy and the world economy depend on an efficient, safe, and reliable transportation system to move people and goods. Transportation systems serve both rural and populated areas and link regions and the world, creating the potential for long-term economic growth and prosperity and contributing globally to the quality of life. In the United States, the population is increasing at the same time that it is becoming older and more diverse; these demographic changes mean that the transportation system must be able to respond to changing demand and conditions over the coming decades. A strong transportation RD&T program is needed to support sustained economic growth and help meet the needs of a growing and changing population as well as achieve the U.S. DOT's stated goals of safety, state of good repair, economic competitiveness, livable communities, and environmental sustainability.

Changes in technology are occurring rapidly as technological innovations move quickly from the prototype stage to being an integral part of society. These changes will undoubtedly affect the transportation systems of the future. These effects will include vehicle and infrastructure interaction along with real-time information for transit, air, and rail systems. In addition, technology is likely to transform the transportation system as computers begin to exert an increasing amount of control over vehicles and infrastructure. The department needs a forward-looking RD&T strategic plan to understand future directions and prepare for both expected and unexpected challenges. This environment of change, coupled with the pervasive role of transportation in society and the complexity of the interrelationships between government, industry, and the public, creates a challenging environment for developing a strategic research plan.

For example, the rise in communications technologies has the potential to shape future transportation demand in ways that cannot yet be fully anticipated. With cell phones, video conferencing, online shopping, and the many other innovations that have become commonplace over the past decade, communications technology has the potential to substitute for many transportation choices while increasing the demand for others. Online shopping may be reducing individual trips to stores, but it is increasing freight on highways and community streets. Similarly, video phone calls may result in fewer in-person business meetings but lead to more personal trips as individuals choose to stay closely connected with far-flung friends and family. The U.S. DOT's strategic plan needs to anticipate and plan to investigate the changes that evolving information and communications technologies will have on future patterns of travel demand to help states, local governments and agencies, and private carriers provide a high-functioning transportation system able to meet this demand.

Along with communication changes, advances in vehicle automation are likely to bring about regulatory and safety challenges for the U.S. DOT. The aviation system has been dealing with the complexities of human systems integration for some time as functions have become automated. Similar and even more complex challenges will emerge with the growth of automation in personal vehicles operated by drivers, most of whom have less training and skill than commercial pilots. The research on and pilot testing of autonomous vehicles

by Google and the U.S. DOT's connected vehicle initiative provide broad hints of what might be possible. Even without autonomous operations, every type of vehicle has safety and convenience features that rely increasingly on automated electronic control systems. Although these systems promise improved safety, they also raise questions about liability, privacy, and security that can be addressed through research. The department may well be faced with many regulatory and safety concerns related to these electronic control systems and will need to be able to provide evidence-based answers to support good decision making.¹

Safety for passengers, vehicles, and infrastructure will perpetually be a critical issue for society. According to the current and former Secretaries of Transportation, safety is the department's major cross-cutting priority and will continue to be a major focus of each modal administration. Indeed, certain modal administrations, including the Federal Railroad Administration and the Federal Motor Carrier Safety Administration, are almost exclusively tasked with a safety regulatory role. Secretary LaHood has emphasized safety throughout his term and Congress has recently responded to a Departmental request to task the Federal Transit Administration with a stronger safety mission.

Recent statistics indicate that after a period in which the safety records of every transportation mode were improving, highway deaths increased in 2012. Neither the causes of the sharp decrease in highway deaths and injuries before 2012 nor those of the subsequent spike in fatalities are well understood. The RD&T plan needs to include research across transportation modes to improve safety and lessen environmental impact. The role of the modal administrations as safety regulators demands that the department stay ahead of the risks, benefits, and costs of evolving systems and rapidly changing technologies. The department's difficulty in coping with new automotive technologies, as in the unintended acceleration case, or with aviation technologies, as in the case of the Boeing 787 batteries, shows the need for increased research to deepen staff skills and technical insights. The growing challenge of drivers using smart phones and texting while driving also requires further research, as the use of devices continues despite well-publicized warnings and legal prohibitions.

The issues listed above merely illustrate some of the major challenges that RD&T can help transportation providers address. Additional examples in areas such as materials, finance, human factors, climate change, and modal competition could be given. A good strategic plan will identify such issues and the research needed to prepare for them.

Context of the Strategic Plan and Letter Report

Creating and managing a unified RD&T plan for all modal administrations of the U.S. DOT is a significant challenge that is limited by a set of well-recognized institutional constraints. For example, the missions, stakeholders, authorizing and appropriating committees, and constituencies of each administration are mode specific, and this specificity represents the way U.S. transportation policy has been implemented for decades. As a result, most of the research programs funded within the department are mode specific and have little flexibility to pursue multi- and cross-modal opportunities. The RD&T maturity levels of the modal administrations also vary widely, especially with regard to strategic planning.

The varied roles of the U.S. DOT's modal administrations also have a strong influence on the research portfolios of both the individual administrations and the agency as a whole. The administrations for railroads, pipelines, motor carriers, and automobiles serve largely as safety regulators. However, the research programs of the

¹ Special Report 308: *The Safety Promise and Challenge of Automotive Electronics: Insights from Unintended Acceleration* (Transportation Research Board of the National Academies, Washington, D.C., 2012).

administrations devoted to highways, transit, and aviation focus on providing resources and expertise on system connectivity, operations, and maintenance. These research programs support the work of the Federal Aviation Administration's air traffic control service and of state, county, and local departments of transportation, transit agencies, and airports responsible for transportation infrastructure. This disparate set of missions, coupled with mode-specific funding mechanisms, makes the creation of a unified RD&T plan a significant challenge. The resulting lack of a rational, coherent approach to the U.S. transportation system is a serious handicap that is worsening with time, and the importance of this handicap cannot be understated.

In addition, the department's long-term strategic planning has been constrained in recent years by a continued series of short-term funding authorizations. The previous aviation authorization legislation was subject to dozens of short-term extensions. Authorization of the highway and transit programs was delayed and extended multiple times over a 2-year period. *MAP-21* is only a 2-year bill that expires in 18 months. An environment of continued uncertainty regarding both short- and long-term funding is not one in which long-term strategic planning and supportive research activities can thrive.

Despite these and other challenges facing the department, strategic planning for transportation RD&T is vitally important. Without a well-articulated plan, there is less assurance that the department's well-intentioned efforts will serve the goals it is striving to achieve.

Current Draft of the Strategic Plan

The February 2013 draft of the strategic plan is divided into five chapters that correspond to each of the department's five strategic goals: safety, state of good repair, economic competitiveness, livable communities, and environmental sustainability. Each chapter begins by listing relevant strategic system outcomes. This introduction is followed by sections that describe research for each of the modes and a section on cross-cutting research. At the end of each chapter is a list of proposed performance measures that relate back to the strategic outcomes.

The committee commends the general readability of the current draft and the department's attempt to overcome modal constraints by organizing the document according to well-defined departmental goals instead of modes. The inclusion of performance measures is useful, although the particular measures included generally describe transportation system performance instead of the impact of RD&T. Some required details were also missing from the plan; these included information about the share of departmental resources allocated to research in each goal area, examples of important contributions of previous and current RD&T efforts, and information about how performers of the research are chosen.

PREVIOUS GUIDANCE

The current review of the U.S. DOT's RD&T strategic plan is the second required by authorization legislation for surface transportation. In 2005, the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)* required the department to develop a strategic plan and charged the NRC with an independent review. The NRC's 2006 review recognized the short time the department was provided in which to prepare a plan and described what a strategic plan "could and should do" given the constraints described above.² The current committee's assessment of the 2013 draft is given in the sections that follow; the headings used are taken from the 2006 report, a copy of which is attached.

² Committee on the Review of the U.S. DOT Strategic Plan for Research and Development Letter Report: August 2006 (Transportation Research Board of the National Academies, Washington, D.C., 2006), <http://www.trb.org/Main/Public/Blurbs/157676.aspx>.

Articulate the Role and Value of U.S. DOT's RD&T

The draft plan does not make a sufficiently strong case for the role and value of the RD&T undertaken by the U.S. DOT, whether for the department as a whole or at the administration level. Although there is a section entitled “The Role of Federal Transportation RD&T,” the overview it gives of the valuable role that the department’s research plays is very general. The draft plan does point out that, “[b]ecause the Federal Government owns and operates only limited portions of the Nation’s transportation system, RD&T investment represents one of the most effective ways in which the Federal Government can contribute to the improvement of our transportation system” (p. 8). The plan then describes some of the responsibilities facing the U.S. DOT in the most general of terms, with no mention of any measure of the value of the department’s research programs or how they support departmental priorities. A plan that explained how research supports the department’s congressionally mandated regulatory role and its workforce development role, as well as how research helps ensure cost-effective investment of federal resources, would make a much stronger case about the value of departmental research.

Highlight and Promote Ways to Overcome Constraints to Strategic RD&T Investment

The draft plan does not highlight the reduction in constraints that has occurred since the passage of *SAFETEA-LU* in 2005. Most notable are the lack of research earmarks in *MAP-21* and the reduction in the number of narrowly designated research topics that Congress expects the department to address. As a result, the Federal Highway Administration and the Federal Transit Administration are now facing the welcome but difficult challenge of identifying and prioritizing their research funding. The lack of earmarks has been particularly notable in the UTC program, as it has allowed RITA to award all funding for the program competitively, thereby enhancing the potential for more effective returns on the research investment, even with additional costs to manage the new program. Many of the administrative and institutional hurdles to strategic planning remain, and the strategic plan could identify and promote ways for the administrations to collaborate and overcome these constraints.

Describe the RD&T Program in Various Dimensions to Inform Decisions

As pointed out in the NRC’s 2006 letter report, a strategic plan can inform decisions about priority topics that research should address and about the nature of the research that is needed to address these topics.³ As illustrated above in the section on critical RD&T issues and opportunities, transportation is facing many large-scale, overarching issues that a good strategic plan ought to address. The draft RD&T plan identifies the priority areas that will serve the department’s strategic goals, but it would benefit from providing advice to policy makers about the kinds of research needed to achieve the goals. Almost all of the department’s RD&T is highly applied research designed to make incremental improvements in addressing current problems. The dominance of applied research has long proven beneficial and is appropriate given the regulatory roles of most of the modal administrations. Some research topics, however, require the development of new knowledge and understanding derived from basic or advanced research.⁴ For example, solving problems of human systems integration with increased vehicle automation would seem to benefit from longer-term basic research as well as near-term applied research.

The current draft of the strategic plan states that “DOT operating administrations will use the DOT RD&T Strategic Plan internally to refine their RD&T strategic plans” (p. 5). The content of the presentations to the committee during its February 2013 meeting suggests that exactly the opposite has occurred within the

³ Committee on the Review of the U.S. DOT Strategic Plan for Research and Development Letter Report: August 2006, <http://www.trb.org/Main/Public/Blurbs/157676.aspx>.

⁴ Research and Technology Coordinating Committee Letter Report: December 2005 (Transportation Research Board of the National Academies, Washington, D.C, 2005). http://onlinepubs.trb.org/onlinepubs/reports/rtcc_december_2005.pdf

department in the past. Individual operating administrations have created their own strategic plans that are based on the administration's scope and priorities. Some of these individual strategic plans, including those of the Federal Railroad Administration and the Pipeline and Hazardous Materials Safety Administration, appear to be strong and well conceived, but they do not appear to be informed by a department-wide RD&T strategic planning process. The renewed emphasis on strategic planning required by *MAP-21* may help provide more departmental direction to these modal plans.

Identify Gaps in Cross-Modal Policy and Systems Research

Because the department's research is primarily mode specific, little opportunity exists for policy or systems research affecting all modes. Under *SAFETEA-LU*, for example, the department had scarcely any resources for examining national policy issues at a multi- or cross modal level. Better insight into how the various modes, both collectively and individually, serve national goals would be helpful to national policy makers, as would information on the areas in which modal policy changes might improve safety, economic competitiveness, or the environment. Collaboration between the U.S. DOT and other research organizations that perform related policy and systems research may have increased since the 2006 strategic plan, but the current draft plan does not provide substantive details. Identification of gaps in research, by topic and type, would inform policy makers about important areas that are being neglected for want of resources.

Promote Efficient and Effective Research Processes

The current plan provides little information about the development of research processes that would improve the performance of the department's many research programs. Instead, it focuses primarily on the department's stated priorities under the five strategic goals listed above. Little information is provided about stakeholder input into either the research programs of the various modal administrations or the department's strategic plan. A short and limited appendix describes plans to request comments on the strategic plan through a notice in the *Federal Register*, which seems to be a bureaucratic and ineffective approach to obtaining substantive input. The plan does not develop or explain methods for ensuring relevance, quality, and performance or for creating performance-based metrics to measure research outputs. The plan also does not include financial information that is required by *MAP-21* and that can provide a sense of priorities among goals and modalities. The committee would have appreciated an outcome-based assessment of the 2006 strategic plan that described how well the U.S. DOT had performed against its many goals. Such an after-the-fact analysis is a necessary part of any efficient and effective process for developing a strategic plan.

To understand the value of its many and varied research programs, the U.S. DOT needs to rely on evidence-based decision making, peer reviews to ensure the production of objective research, and evaluations of program results. Research developed to support a particular advocacy position is becoming increasingly common in transportation as well as other areas; thus, federal processes to ensure objectivity are becoming increasingly important. Research program evaluation is a relatively new but growing area that other federal departments have begun implementing to provide policy makers with quantitative rather than qualitative measures of the returns on investment in research and development.⁵ The U.S. DOT has some internal resources in research program analysis and evaluation; for example, the department employs at least one individual who has won awards for his expertise in these areas. The modal administrations within the department apparently evaluate their programs with varying levels of rigor; those administrations with strong evaluation programs and skilled

⁵ NRC, *Measuring the Impacts of Federal Investments in Research: A Workshop Summary* (National Academies Press, Washington, D.C., 2011).

employees are well positioned to provide guidance for all the departmental administrations, and this capability is an asset the strategic plan could promote.

Potential alternatives to the five-year research strategy that the Department currently pursues are roadmaps or gate systems. A roadmap system would be event-based instead of calendar-based; this type of system may be more meaningful as it is based on actual research efforts instead of fluctuating budgetary levels and an artificial timeline created by legislation. Alternatively, a gate system allows progress from one technological stage to another based on relevant factors. For example, these factors may include technical readiness levels and the Critical Decision process as currently used at the Departments of Energy and Defense and the National Nuclear Security Administration.

Finally, the opportunities to implement the contents of this strategic plan are greater than was the case with previous plans because of the increased discretion in funding given to the modal administrations, as described above. To ensure that the department invests these discretionary resources in the most effective manner, the plan would need to address how departmental research programs solicit stakeholder input, implement merit review of competitively solicited research proposals, provide peer review of completed research, and monitor and evaluate research programs.

Recommendations

The committee is providing both short- and long-term recommendations. The short-term recommendations can be implemented in the final version of the draft RD&T plan and do not require significant changes in departmental strategy. The long-term recommendations should be considered over next few years and addressed in future updates of the research strategic plan.

SHORT-TERM RECOMMENDATIONS

The following four recommendations can and should be implemented in the final draft of the strategic plan to be published later this year:

1. Explain the research context in terms of variations in available resources and in modal roles, authorities, and priorities.
2. Leverage the strength of the modal RD&T plans.
3. Get the performance measures right.
4. Create a more compelling strategic plan that will be useful for policy makers.

These recommendations, which are discussed in the following sections, may require rewriting of portions of the report, but all of them take into account knowledge and information that the department already has available.

Explain the Research Context

The strategic plan should provide more information about the resources available for carrying out the plan, whether those resources are outlined by modal administration, by strategic goal, or by some other means. Strategic plans that are otherwise excellent but that lack information about funding sources also lack strength and significance. Section 508 of MAP-21 specifically requires a description of “the anticipated annual funding levels for the period covered by the strategic plan.” The committee acknowledges that because future funding sources are uncertain and modal administrations are not allowed to indicate resource allocation outside of

the normal budgeting process, this requirement presents a challenge. The U.S. DOT should, however, provide information about allocation of past and current RD&T funding toward the goals outlined in the plan. Providing funding levels allows both the U.S. DOT and other readers of the plan to understand where the department's overall priorities lie.

The strategic plan also needs to better explain the context of the research goals it outlines. Stakeholders, particularly Congress, need to be reminded about the differences between the modal administrations in terms of mission, funding, and priorities. Greater clarity about the strategic goals and the ability of each administration to work toward attainment of those goals would be helpful, as some of the department's five primary goals (such as safety) seem to be more important to the current administration than do others.

Leverage the Strength of the Modal RD&T Plans

Some of the modal administrations have done a great deal of work in developing their own strategic research plans. The quality of these plans varies, and the U.S. DOT would be well served to build on the strongest of the plans. Some administrations are already doing thoughtful strategic planning that suits their needs and resources and that reflects serious stakeholder involvement and customer interfaces. The overall plan should take the modal efforts into account and make clear that a great deal of effort has gone into the planning process.

Get the Performance Measures Right

The performance measures need to be appropriate for a strategic research plan rather than for a general departmental strategic plan. The measures should be specific to research objectives and outputs rather than to system performance and should also be specific to modes as well as to the overall system. Breaking the measures down by modal administration also creates accountability for the administrations. Clearly defined research objectives produce verifiable results and help policy makers and research managers avoid focusing on unproductive effort.⁶ Although all of the performance measures should be considered carefully, the committee particularly recommends strengthening the measures associated with livability. As currently written, the goal is aimed almost entirely at transit and affords little opportunity for any other modal research to affect livability. Getting the performance measures right is an important first step toward research program evaluation, which the plan should also address. The strategic plan should be responsive to both the administrations' goals and the goals outlined in *MAP-21* and should have performance metrics that reflect the full range of administration and congressional priorities and account for estimates of economic benefit.

Create a More Compelling Strategic Plan

Although the RD&T strategic plan is required by congressional mandate, the U.S. DOT should use the plan as an opportunity to describe its past research successes and future prospects to Congress and the public. The U.S. DOT has had many successes in RD&T that have led to significant transportation improvements for the public and its own administrations. Too often, however, the department has not made these successes clear to its many stakeholders. Success stories should be displayed prominently throughout the document, highlighting the value that a strong RD&T plan brings to both the U.S. DOT and the nation. Incorporation of graphics and sidebars would improve the readability of the strategic plan and provide a compelling case for the importance

⁶NRC, *Measuring the Impacts of Federal Investments in Research: A Workshop Summary*.

and value of funding transportation RD&T. The strategic plan should also describe the processes being used to ensure relevance, quality, and leadership and should identify gaps in research by topic area and type.

LONG-TERM RECOMMENDATIONS

In the long term, the U.S. DOT has the opportunity to rethink its strategic plan and address more of the structural issues that the department's RD&T plan faces. The long-term recommendations are as follows:

1. Develop a longer-range strategic plan within the U.S. DOT.
2. Partner with universities and transportation infrastructure owners to promote research and workforce development.
3. Stay attuned to national and worldwide transportation research.
4. Increase involvement with other federal departments and entities.
5. Determine important areas of future research.

These recommendations are discussed in the following sections.

Develop a Longer-Range Strategic Plan within the U.S. DOT

Recent transportation RD&T strategic plans have looked at a 5-year time frame because of the language and authorization periods in past surface transportation legislation. Some applied research will yield measurable results within this period, but 5 years is insufficient for advanced or basic research designed to address major anticipated challenges. As the primary research arm of the department, RITA should develop longer-range strategic plans that reflect the time required for the development of new knowledge and its transfer into practice. In addition, the department might consider working with UTCs to develop long-term research plans that take into account human and intellectual capital outside of the U.S. DOT. Finally, the department, and RITA in particular, should consider incorporating a systems engineering activity at the department level to define and assess the RD&T that would best address the challenges.

Partner with Universities and Transportation Infrastructure Owners to Promote Research and Workforce Development

The U.S. DOT provides funds to universities to carry out transportation research. Multiple programs with varying objectives fund the university systems; these programs include Centers of Excellence, which focus on Federal Aviation Administration programs, and UTCs, which focus on multimodal research. Universities are valuable assets for carrying out research but have been historically underutilized by the U.S. DOT. They are a good venue for doing multimodal work that does not fit neatly into the department's existing modal research framework and for carrying out basic and advanced research. This multimodal research should support the broad spectrum of transportation research and be reflective of short and long-term goals for our transportation system. The newly competitive research environment should improve the quality of university research. Universities are also an ideal resource for promoting workforce development, particularly that which results from investments in RD&T. In addition, the U.S. DOT should partner with state DOTs and other public agencies responsible for transportation infrastructure to implement the results of these research efforts. U.S. DOT and UTC collaboration will result in only limited RD&T outcome implementation unless the owners of infrastructure are party to it as stakeholders.

Stay Attuned to National and Worldwide Transportation Research

Transportation-related research in the United States is conducted by many agencies other than the U.S. DOT; indeed, the federal RD&T investment outside the U.S. DOT exceeds that inside the department. U.S. DOT research focuses largely on infrastructure, performance, demand, safety, and, to a lesser extent, strategies and policies for mitigating transportation's adverse impacts on the environment,⁷ yet transportation includes vehicles, fuels, emissions, and other forms of environmental impact. The U.S. Department of Defense, for example, has alternative fuels programs, and the largest federal research program on reducing transportation energy consumption is through the U.S. Department of Energy. The U.S. Environmental Protection Agency funds research on controlling motor vehicle emissions and the land use consequences of transportation policies investment.

For the United States to remain a world leader in transportation research, the U.S. DOT needs to stay in close connection with research centers around the world. Because of constrained and uncertain funding, the U.S. DOT may become less involved with international efforts, particularly as travel is curtailed, but international cooperation should remain a focus of the department. The RD&T strategic plan, for example, should highlight how RITA can stay informed about research programs and results around the world through international scans of technologies and development and coordination with other national RD&T programs.

Increase Involvement with Other Federal Departments and Entities

Just as many of the issues confronting the modal administrations cut across many of the administrations, many of the issues the U.S. DOT faces are also being faced by other agencies, research institutions, and regulatory bodies. The department needs to deepen its relationships with other federal agencies, including the U.S. Departments of Energy and Defense and also the U.S. Environmental Protection Agency, to include research. The draft plan contains some generalities about this type of interaction but does not provide many specifics. The department should consider becoming more involved with the Office of Science and Technology Policy and the National Science and Technology Council. If the U.S. DOT develops better connections with these organizations, it may have a better opportunity to provide input and shape the transportation and transportation-related research funding within the department and across the federal government in the future.

Determine Important Areas of Future Research

As part of its strategic planning process, the U.S. DOT should consider and explore areas that will be of concern in future years, such as technological and other issues discussed earlier in this report. A research agenda on policy should also consider competition within and across modes and the potential for influencing modal preferences to serve social, economic, and environmental goals. An emphasis on needed research topics may also help alleviate the losses in funding for research programs, including the National Cooperative Freight Research Program and the Hazardous Materials Cooperative Research Program, which were abolished by MAP-21.

⁷ Special Report 295: *The Federal Investment in Highway Research 2006–2009: Strengths and Weaknesses* (Transportation Research Board of the National Academies, Washington, D.C., 2008).

Concluding Remarks

In closing, the committee is pleased that the U.S. DOT is engaged in strategic RD&T planning and has welcomed the opportunity to comment on the draft strategic plan at a point at which it could influence the final document. The 2006 review occurred late in the report development cycle and had little impact on the previous RD&T strategic plan. The committee has striven to be candid and constructive in its review and trusts that its advice will be received in this spirit. I welcome the opportunity to discuss this review and look forward to progress in this important area.

Sincerely,

Mortimer Downey, Chair

Committee on the Review of the U.S. DOT Strategic Plan for Research, Development, and Technology

Attachment 1: Committee on the Review of the U.S. DOT Strategic Plan for Research, Development, and Technology

Attachment 2: Meeting Presentations

Attachment 3: 2006 Review of USDOT RD&T Strategic Plan⁵²

Attachment 1:

Committee on the Review of the U.S. DOT Strategic Plan for Research, Development, and Technology

Mortimer Downey, Senior Advisor, Parsons Brinckerhoff, Washington, D.C., *Chair*

Irwin Feller, Professor Emeritus of Economics, Pennsylvania State University, University Park

Angela Gittens, Director General, Airports Council International, Montreal, Quebec, Canada

John Halikowski, Director, Arizona Department of Transportation, Phoenix, Arizona

Lester Hoel, Professor Emeritus, University of Virginia, Charlottesville

Cliff Johnson, President, Pipeline Research Council International, Falls Church, Virginia

Victor Lebacqz, Founder and Principal, VICC Associates, Aptos, California

Rebecca McDaniel, Technical Director, North Central Superpave Center, Purdue University, West Lafayette, Indiana

Steven Polzin, Director, Mobility Policy Research, Center for Urban Transportation Research, University of South Florida, Tampa

Thomas Sheridan, Professor Emeritus, Massachusetts Institute of Technology, Cambridge

Constance Sorrell, Chief of Systems Operations (retired), Virginia Department of Transportation, Richmond

Gerhard Thelen, Vice President of Operations Planning and Support, Norfolk Southern Corporation, Norfolk, Virginia

Linda Watson, President and Chief Executive Officer, Capital Metropolitan Transit Authority, Austin, Texas

The names of those who attended the meeting in person are shown in bold. John Halikowski and Lester Hoel participated by conference call, and all committee members assisted in the writing of the report.

Attachment 2

MEETING PRESENTATIONS

FAA AST Research and Development Strategy

Ken Davidian, Director of Research, Office of Commercial Space Transportation, Federal Aviation Administration; and John Wiley, Acting Director, William J. Hughes Technical Center, Federal Aviation Administration, U.S. Department of Transportation

NHTSA Research: Relationship to RD&T Plan

Tim Johnson, Director of Crash Avoidance and Electronic Controls Research, National Highway Traffic Safety Administration, U.S. Department of Transportation

Maritime Administration Research and Development Activities and Demonstration Projects

Carolyn Junemann, Environmental Protection Specialist, Maritime Administration, U.S. Department of Transportation

Pipeline Safety Research, Development, and Technology

Robert Smith, Pipeline Safety R&D Manager; and James Simmons, Acting Chief, Research and Development, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation

Federal Motor Carrier Safety Administration Research and Technology Program Overview

Steven Smith, Director of the Office of Analysis, Research & Technology, Federal Motor Carrier Safety Administration, U.S. Department of Transportation

FTA RD&T Strategic Plan

Jarrett Stoltzfus, Transportation Program Specialist, Office of Research, Demonstration and Innovation, Federal Transit Administration, U.S. Department of Transportation

FHWA RD&T Strategic Plan

Michael Trentacoste, Associate Administrator, Office of Research, Development, and Technology, Federal Highway Administration, U.S. Department of Transportation

Federal Railroad Administration R&D Strategic Planning

John Tunna, Director, Office of Research and Development, Federal Railroad Administration, U.S. Department of Transportation

National Research Council Review of U.S. DOT RD&T Strategic Plan FY 2013–2018

Kevin Womack, Associate Administrator, Office of Research, Development and Technology, Research and Innovative Technology Administration, U.S. Department of Transportation

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²DOT, *Strategic Plan FY 2012-2016*; available at <http://www.dot.gov/dot-strategic-plan>.

³*Transportation for Tomorrow: Report of the National Surface Transportation Policy and Revenue Study Commission* (August 2007); p. 31; http://transportationfortomorrow.com/final_report/index.htm.

⁴*Norman Y. Mineta Research and Special Programs Improvement Act* (P.L. 108-426, Nov. 30, 2004, the “Mineta Act”) created the RITA (RITA) and assigned it these responsibilities.

⁵(August 2006); available at <http://www.gao.gov/new.items/d06917.pdf>.

⁶*The Stevenson-Wydler Technology Innovation Act* of 1980 directed large Federal laboratories to establish Offices of Research and Technology Applications (ORTA) to support technology transfer activities. RITA’s Technology Transfer Program intends to fulfill the requirements of the ORTA.

⁷Center of Excellence, Commercial Space Transportation; available at: www.coe-cst.org.

⁸Centers for Disease Control and Prevention, “10 Leading Causes of Injury Deaths by Age Group—2010,” http://www.cdc.gov/injury/wisqars/pdf/10LCID_Unintentional_Deaths_2010-a.pdf.

⁹DOT, NHTSA, *Vehicle Safety-Fuel Economy Rulemaking*; available at www.nhtsa.gov/staticfiles/rulemaking/pdf/2011-2013_Vehicle_Safety-Fuel_Economy_Rulemaking-Research_Priority_Plan.pdf.

¹⁰DOT, PHMSA, *Research & Development: Systematic Evaluation Process*; available at <https://primis.phmsa.dot.gov/rd/evaluation.htm>.

¹¹Elaboration on all of PHMSA pipeline safety program measures for program objectives are found publicly at <https://primis.phmsa.dot.gov/rd/performance.htm>.

¹²Available at <http://www.dot.gov/dot-strategic-plan>.

¹³Centers for Disease Control and Prevention, “10 Leading Causes of Injury Deaths by Age Group—2010,” http://www.cdc.gov/injury/wisqars/pdf/10LCID_Unintentional_Deaths_2010-a.pdf.

¹⁴DOT, NHTSA, Fatality Analysis Reporting System, *DOT Strategic Plan FY 2012–2016*, available at <http://www.dot.gov/dot-strategic-plan>.

¹⁵DOT, NHTSA, National Center for Statistics and Analysis, *TRAFFIC SAFETY FACTS 2011 Data* (April 2013), available at <http://www-nrd.nhtsa.dot.gov/Pubs/811753.pdf>.

¹⁶DOT, FMCSA, *Large Truck Crash Overview 2010*, available at <http://www.fmcsa.dot.gov/facts-research/research-technology/report/LargeTruckCrashOverview2010.pdf>, as of May 2013.

¹⁷DOT, RITA, BTS, *National Transportation Statistics*, May 2013, Table 2-34.

¹⁸DOT, RITA, BTS, *National Transportation Statistics*, May 2013, Table 2-14.

¹⁹DOT, FAA, the National Aviation Research Plan describes the R&D targets and the method of validation in order to achieve these milestones. Available at: http://www.faa.gov/about/plans_reports/media/2012_NARP-WEB.pdf.

²⁰DOT, RITA, BTS, *National Transportation Statistics*, April 2012, Table 1-35.

²¹DOT, FRA, Office of Safety Analysis, 1.01 Accident/Incident Overview, <http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/statsSas.aspx>.

²²DOT, RITA, BTS, *National Transportation Statistics*, July 2012, Table 2-50.

²³Available at: <http://www.dot.gov/dot-strategic-plan>.

²⁴For example, FHWA's Office of Asset Management also provides technical assistance to State DOTs on best practices, asset inventory development and data management support, decision support tool use and development (e.g., HERS-ST), and workshops, conferences, and networking.

²⁵Please see the FHWA's HERS-ST (Highway Economic Requirements System—State Version) for additional information. HERS-ST is an engineering/economic analysis (EEA) tool that uses engineering standards to identify highway deficiencies, and then applies economic criteria to select the most cost-effective mix of improvements for system-wide implementation.

²⁶Additional information on the "Every Day Counts" initiative is available at <http://www.fhwa.dot.gov/everydaycounts>.

²⁷Additional information on the Airport Cooperative Research Program is available at <http://www.trb.org/ACRP/ACRP.aspx>.

²⁸Available at: <http://www.dot.gov/dot-strategic-plan>.

²⁹U.S. Census Bureau, Foreign Trade, Historical Series, available at <http://www.census.gov/foreign-trade/statistics/historical>.

³⁰DOT, FHWA, *Conditions and Performance Report*, Chapter 2 available at <http://www.fhwa.dot.gov/policy/2010cpr/chap2.htm#3>.

³¹DOT, RITA, BTS, *Airline On-Time Statistics and Delay Causes*, available at http://www.transtats.bts.gov/ot_delay/ot_delaycause1.asp?display=data&pn=1.

³²Air Transport Association, *Cost of Delays*, available at <http://airlines.org/Pages/Annual-U.S.-Impact-of-Flight-Delays.aspx>.

³³DOT, RITA, BTS, *National Transportation Statistics*, Table 1-73: *Amtrak On-Time Performance Trends and Hours of Delay by Cause* (January 2011), available at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_73.html.

³⁴DOT, FHWA, *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level*, Chapter 1, April 2005, available at <http://www.fhwa.dot.gov/environment/freightaq/chapter1.htm>.

³⁵Jones, Crystal, "Perspective on Freight Congestion," *Public Roads* (July/August 2007, Vol. 71, No. 1), available at <http://www.tfrc.gov/pubrds/07july/06.htm>.

³⁶Additional information on ITS JPO Connected Vehicle Research is available at http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm.

³⁷Available at <http://www.dot.gov/dot-strategic-plan>.

³⁸American Medical Association, *Physician's Guide to Assessing and Counseling Older Drivers*, 2nd edition (June 2010), available at http://www.nhtsa.gov/staticfiles/nti/older_drivers/pdf/811298.pdf.

³⁹Additional information on the Nonmotorized Transportation Pilot Program is available at <http://www.fhwa.dot.gov/environment/bikeped/ntpp.htm>.

⁴⁰Available at: <http://www.dot.gov/dot-strategic-plan>.

⁴¹EPA, *Inventory of U.S. Greenhouse Emissions and Sinks: 1990-2011* (April 2013), available at <http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html> as of May 2013.

⁴²EPA, *1970-2012 Average annual emissions, all criteria pollutants* (June 2012), available at <http://www.epa.gov/ttn/chief/trends/> as of May 2013.

⁴³DOE, Energy Information Administration, *U.S. Primary Energy Flow by Source and Sector, 2011*, available at http://www.eia.gov/totalenergy/data/annual/pecss_diagram.cfm, as of May 2013.

⁴⁴DOE, Energy Information Administration, *U.S. Primary Energy Flow by Source and Sector, 2011*, "Figure 5.13a Petroleum Consumption Estimates by Sector," available at http://www.eia.gov/totalenergy/data/annual/pecss_diagram.cfm as of May 2013.

⁴⁵Environmental Protection Agency, *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*, available at <http://www.epa.gov/ttnchie1/trends>.

⁴⁶RITA, BTS, *National Transportation Statistics*, “Table 1-40: Passenger Miles Traveled.” Available at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_40.html.

⁴⁷EPA, Office of Transportation and Air Quality, Frequent Questions. Available at <http://www.epa.gov/otaq/about/faq.htm>.

⁴⁸Additional information about the DOT Center for Climate Change and Environmental Forecasting is available at <http://climate.dot.gov>.

⁴⁹For example, FAA is conducting a study to identify and assess metrics for carbon dioxide (CO₂) emissions from aircraft that may potentially be used to set standards for the certification of new aircraft and to monitor the operational performance of the commercial aircraft fleet. The results of the study will be provided within the work program of the International Civil Aviation Organization’s (ICAO) Committee on Aviation Environmental Protection for considering development of the aircraft CO₂ standard by the end of 2012.

⁵⁰CAAFI is a forum for the worldwide commercial aviation community to engage the emerging alternative fuels industry and to work together, share and collect needed data, and direct research on aviation alternative fuels.

⁵¹Additional information about the Voluntary Airport Low Emission Program is available at <http://www.faa.gov/airports/environmental/vale>.

⁵²For the TRB, “Committee on the Review of the U.S. DOT Strategic Plan for Research and Development Report: August 2006,” see http://onlinepubs.trb.org/onlinepubs/reports/letterreport_usdotrd&tplan.pdf.



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