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16. Abstract

This report is the top-level planning document for research and development in the U.S. Department of Transportation focuses on the internal planning and coordination procedures, key DOT programs, partnership initiatives, enabling research concepts, education and training support, state DOT activity, and measures of performance and programs. The principle objective of the plan is to enable higher returns from modal R&D investments by emphasizing areas of collective concern on a Department-wide basis. This report also places a high level of concern on safety specifically on understanding the roles of human factors in safe passage, the need to make transportation accessible to all citizens, and making infrastructure secure against all threats.

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PREFACE

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LIST OF ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ABS	Antilock Brakes
ACAS	Air Carrier Access Act
ACS	Adaptive Control Systems
AIS	Automatic Identification System
ALERT	Advanced Law Enforcement and Response Technology
ALPS	Advanced Locomotive Propulsion System
APEL	AASHTO Product Evaluation List
APTA	American Public Transit Association
ASR	Alkali Silica Reaction
ATM	Automated Traffic Management
ATS	American Travel Survey
AVP	Advanced Vehicle Program
BTS	Bureau of Transportation Statistics
BRT	Bus Rapid Transit
CAI	Civil Aeromedical Institute
CAASD	Center for Advanced Aviation System Development
CBU	Core Business Unit
CDS	Crashworthiness Data System
CFS	Commodity Flow Survey
CIREN	Crash Injury Research and Engineering Network
CMM	Capability Maturity Modeling
CMS	Corporate Management Strategies
CVS	Commercial Vehicle Operations
CVSN	Commercial Vehicle Information Systems Network
DARPA	Defense Advanced Research Projects Agency
DGPS	Differential Global Positioning System
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOJ	Department of Justice
DOT	Department of Transportation
DSRC	Dedicated Short Range Communication
DTA	Dynamic Traffic Assignment
DTA	Damage Tolerance Analysis
EID	Emerging Infectious Diseases

EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FARS	Fatality Analysis Reporting System
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FRP	Federal Radionavigation Plan
FRP	Fiber Reinforced Polymer
FTA	Federal Transit Administration
GA	General Aviation
GAO	General Accounting Office
GES	General Estimating System
GIS	Geographical Information System
GPRA	Government Performance and Results Act
GPS	Global Positioning System
HBCU	Historically Black Colleges and Universities
HERMES	High Speed Electromagnetic Mapping and Evaluation System
HPC	High Performance Concrete
HPMS	Highway Performance Monitoring System
HPS	High Performance Steel
IBC	International Border Clearance
IBCSS	International Border Crossing Safety System
IBRC	Innovative Bridge Research and Construction
IDEA	Innovations Deserving Exploratory Analysis
ISTEA	Intermodal Surface Transportation Efficiency Act
IT	Information Technology
ITS	Intelligent Transportation System
ITS JPO	Intelligent Transportation System Joint Program Office
ITWS	Integrated Terminal Weather System
IVI	Intelligent Vehicle Initiative
LTPP	Long Term Pavement Performance
MARAD	Maritime Administration
MEMS	Microelectromechanical Systems
MTMC	Military Traffic Management Command
MCR&T	Motor Carrier Research and Technology
MPO	Metropolitan Planning Organization
MTS	Marine Transportation System
MAGLEV	Magnetic Levitation

NADS	National Advanced Driving Simulator
NAS	National Airspace System
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NASS	National Automotive Sampling System
NCHRP	National Cooperative Highway Research Program
NDE	Non-Destructive Evaluation
NDGPS	Nationwide Differential Global Positioning System
NHTSA	National Highway Traffic Safety Administration
NIST	National Institute of Standards and Technology
NITI	National Intelligent Transportation Infrastructure
NOAA	National Oceanic and Atmospheric Administration
NPTS	Nationwide Personal Transportation Survey
NSF	National Science Foundation
NSTC	National Science and Technology Council
NTI	National Transit Institute
NTL	National Transportation Library
NTPEP	National Transportation Product Evaluation Program
NUMAC	New Ultrasonic and Magnetic Analyzer for Cracks
NWS	National Weather Service
OHM	Office of Hazardous Materials
OMB	Office of Management and Budget
OPS	Office of Pipeline Safety
OST	Office of the Secretary of Transportation
OSTP	Office of Science and Technology Policy
PAIR	Partnership for the Advancement of Infrastructure and its Renewal
PCC	Portland Cement Concrete
PCCIP	President's Commission of Critical Infrastructure Protection
PDD	Presidential Decision Directive
PEC	Program Evaluation Council
PERES	Precision Electromagnetic Roadway Evaluation System
PNGV	Partnership for a New Generation of Vehicles
PTC	Positive Train Control
R&D	Research and Development
R&T	Research and Technology
RABA	Realigned Budget Authority
RADIUS	Research and Development in the United States
RALES	Research and Locomotive Evaluator/Simulator
RD&T	Research, Development and Technology
RDT&E	Research, Development, Test & Evaluation
RE&D	Research, Engineering, and Development
RRF	Ready Reserve Force
RSPA	Research and Special Programs Administration

RTAP	Rural Transportation Assistance Program
RTCC	Research and Technology Coordinating Committee
S&T	Strategy National Transportation Science and Technology Strategy
SAFER	Safety and Fitness Electronic Records
SACP	Safety Assurance and Compliance Program
SATMS	Space and Air Traffic Management System
SBIR	Small Business Innovative Research
SBU	Service Business Units
SCADA	Supervisory Control and Data Acquisition
SESCB	Subway Evaluation Simulation Chemical and Biological Model
SHRP	Strategic Highway Research Program
SP&R	State Planning and Research
STECRP	Surface Transportation Environment Research Program
STR	Surface Transportation Research
STURAA	Surface Transportation and Uniform Relocation Assistance Act of 1987
TCQSP	Transit Capacity Quality of Service Principles
TCRP	Transit Research Cooperative Program
TDC	Transit Development Corporation
TDIPP	Technology Deployment Initiative and Partnership Programs
TDSS	Traveler Decision Support System
TDWR	Terminal Doppler Weather Radar
TEA-21	Transportation Equity Act for the 21st Century
TERM	Transit Economic Requirements Model
TFHRC	Turner Fairbanks Highway Research Center
TMC	Traffic Management Centers
TPMS	Transit Performance Monitoring System
TRANSIM	Transportation Analysis and Simulation
TRB	Transportation Research Board
TTC	Transportation Technology Center
UCRD	Urban Chemical Release Detector
UMR	University Marine Research
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
UTC	University Transportation Center
VMT	Vehicle Miles Traveled
VNTSC	Volpe National Transportation Systems Center
VRTC	Vehicle Research and Test Center
VTS	Vessel Traffic Services
WARP	Weather and Radar Processor
WJHTC	William J. Hughes Technical Center

Chapter I
DOT Research and Development Context and Strategy

Introduction

Transportation is a complex, technology-intensive and highly decentralized function in modern society. Ongoing research and development (R&D) will increasingly be a critical element in assuring that the U.S. and global transportation system continues to meet the needs of all users and responds effectively to new challenges. A key role of the Department of Transportation (DOT) is the performance and application of appropriate transportation-related R&D, as well as the stimulation and guidance of similar activities throughout the transportation community — governments, the private sector and academia.

The Department plans its research and technology development activities around five core strategic goals, and carries them out via several complementary corporate management strategies. A principal objective of this *DOT R&D Plan* is to enable higher returns from modal R&D investments by emphasizing areas of collective concern on a Department-wide basis. Such high-level concerns include understanding the role of human factors in safe passage, the need to make transportation accessible to all citizens, and making the infrastructure secure against all threats. This *Plan* thus serves as a way to transcend individual R&D projects.

Modal R&D programs are conducted through a combination of in-house activities, stand-alone contracts, interagency partnerships, and private-public partnership initiatives. This diversity of activity is necessary because transportation concerns extend beyond the programmatic boundaries of the Department and are intrinsic to the missions of other Federal agencies as well as numerous non-Federal interests.

This *DOT R&D Plan* encompasses internal planning and coordination procedures, key DOT programs, partnership initiatives, enabling research concepts, education and training support, state DOT activity, and measures of performance and programs. Appendices include a detailed inventory of the Department's FY 2001 R&D programs, as well as proposed FY 2001 modal budgets for research and technology development programs. This chapter presents an overview and summary of the strategic framework for the Department's R&D.

Strategic Framework

Transportation is intrinsically linked to the economic health and security of the Nation. Economic growth and security are dependent on a well-functioning, interconnected transportation system. As both an employer and a consumer of goods and services, transportation contributes significantly to the economy, and it is a key element in the production of every other product and service. It contributes about 11 percent to the U.S.

Gross Domestic Product. It employs as many as one in eight full-time employees in the United States—nearly 16.5 million men and women, providing various transportation services or manufacturing transportation-related equipment. Transportation also provides strategic mobility for the military and national defense.

In 1997 the DOT published its *Strategic Plan FY1997-2002* (DOT 1997a), a document that provides a comprehensive vision for advancing the Nation's complex and vital transportation system into the 21st century. The plan sets forth the overall direction, vision, and mission of the Department, establishes broad goals, delineates intended outcomes, and identifies key challenges.

As a companion piece to the *Strategic Plan,* the Department annually prepares a *Performance Plan* (DOT 2000), which accompanies each DOT budget request. The *Performance Plan* defines those performance indicators and goals that will be used to measure progress toward achievement of the strategic goals found in the *Strategic Plan.* By linking these goals to the budget, it describes one fiscal year's effort within DOT and shows how this effort fits into the long-range plan for the Department and the U.S. transportation system.

Based on the legislation that established the Department, the *Strategic Plan* describes the purpose of the Department as follows:

> *"The national objectives of general welfare, economic growth and stability, and security of the United States require the development of transportation policies and programs that contribute to providing fast, safe, efficient, and convenient transportation at the lowest cost consistent with those and other national objectives, including the efficient use and conservation of the resources of the United States."*

The Secretary of Transportation has articulated the vision of how the Department will carry out its purpose, as contained in the Strategic Plan. The Strategic Plan also provides a mission statement to describe the underlying purpose for every activity and initiative of the Department.

VISION STATEMENT

A visionary and vigilant Department of Transportation leading the way to transportation excellence in the 21st Century.

MISSION STATEMENT

Serve America by ensuring a safe, fast, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people. today and into the future.

DOT Strategic Goals

The Plan identifies five National Strategic Goals for transportation that capture the most important outcomes influenced by the Department's programs:

- **Safety** - Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.

- **Mobility** - Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of choices.

- **Economic Growth and Trade** - Advance America's economic growth and competitiveness, domestically and internationally, through efficient and flexible transportation.

- **Human and Natural Environment** - Protect and enhance communities and the natural environment affected by transportation.

- **National Security** - Advance the Nation's vital security interests in support of national strategies such as the National Security Strategy and National Drug Control Strategy by ensuring that the transportation system is secure and available for defense mobility and that our borders are safe from illegal intrusion.

The National Transportation Science and Technology Strategy

President Clinton established the National Science and Technology Council (NSTC) by Executive Order in November 23, 1993. This council is the principal means for the President to coordinate science, space, and technology policies across the Federal government. Through the NSTC, Federal agencies work cooperatively to ensure that Federal science and technology investments support national goals. The Technology Committee of the NSTC developed the *National Transportation Science and Technology Strategy* (EOP NSTC 1999a) to help Congress and the Administration establish national transportation research and technology priorities and coordinated research activities. Based upon numerous outreach events, environmental scans, and an analysis of the transportation system's current and future strengths, weaknesses, opportunities, and threats, it also incorporates the role to be played by the larger transportation enterprise.

The institutionalization of an ongoing process for transportation strategic planning and system assessment enables policy makers and implementers at all levels to adjust the allocation of scarce resources to meet changing transportation requirements. As shown in Figure I-1, this process, which involves the establishment of a broad consensus among and outreach to the different levels of government, industry, academia, and the public, will:

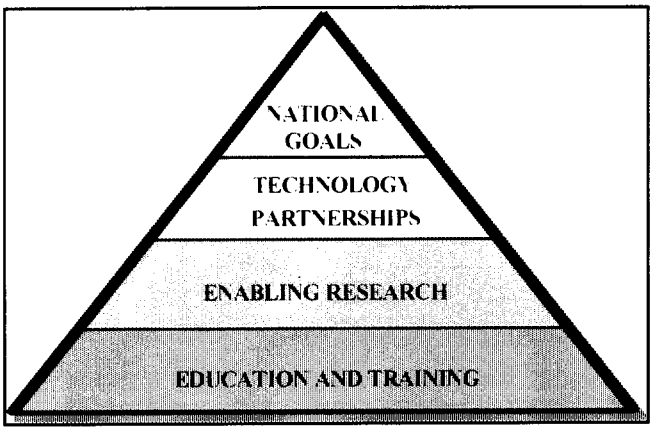

Figure I-1. NSTC Strategic Planning Framework

- Establish and assess strategic national goals and associated R&D priorities in a changing external environment, including international trends and market opportunities, ensuring that transportation R&D is defined from a long-term system perspective.

- Identify private–public technology partnerships that support the strategic transportation goals[1].

- Define and foster a long-term enabling research agenda that supports future national goals and fosters the transportation breakthroughs of the next century[2].

- Develop education and training initiatives that ensure a capable and well-trained 21st century transportation work force.

The *Strategy* thus provides a direction and framework for transportation R&D in America and describes a planning process, private–public partnerships, enabling research, and education and training that will advance our transportation system and our Nation.

DOT's R&D Strategic Planning Process

In addition to supporting the Department's strategic goals and missions, the DOT research and development program presented in this plan serves the broader purpose of meeting the goals and objectives of the Department and the NSTC. R&D is the starting point for innovation, and innovation will be essential in achieving the Nation's near- and long-term transportation goals. The capacity to transform new technologies, concepts, and ideas rapidly into new products, processes and services, i.e. the process of innovation, is a top priority in both the private and public sectors. Innovation inherently begins with the research findings that provide the foundation for innovation and enable practical implementation of new ideas and concepts. The science and technology framework established by NSTC thus provides the overall context and guidance for the Department's R&D program.

That program is also shaped by the DOT operating administrations who, for the most part, actually define and conduct specific departmental research, based on their close interaction with the transportation community and their understanding of transportation system technologies, operations, challenges and opportunities. Their understanding of R&D needs is combined and integrated with DOT and national goals, and is formalized in their modal strategic plans and the performance agreements concluded between the modal Administrators and the Secretary.

DOT actively supports and initiates partnerships and other collaborations among its operating administrations and with other Federal agencies, businesses and universities to leverage resources and broaden the range of knowledge and expertise brought to bear on

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[1] Examples of multi-agency initiatives include the Intelligent Vehicle Initiative, Transportation and Sustainable Communities, and Next Generation Transportation Vehicles. These and other NSTC initiatives are summarized in the *National Transportation Technology Plan* (EOP NSTC 2000a).

[2] Federal transportation-related enabling research is described in the *National Transportation Strategic Research Plan* (EOP NSTC 1999b).

transportation-related topics. In this way, the Department develops a dynamic R&D program specifically intended to support national and DOT goals by stimulating and sustaining an innovation environment. The overall strategic planning process incorporates extensive outreach to the transportation and technology communities (see Figure I-2).

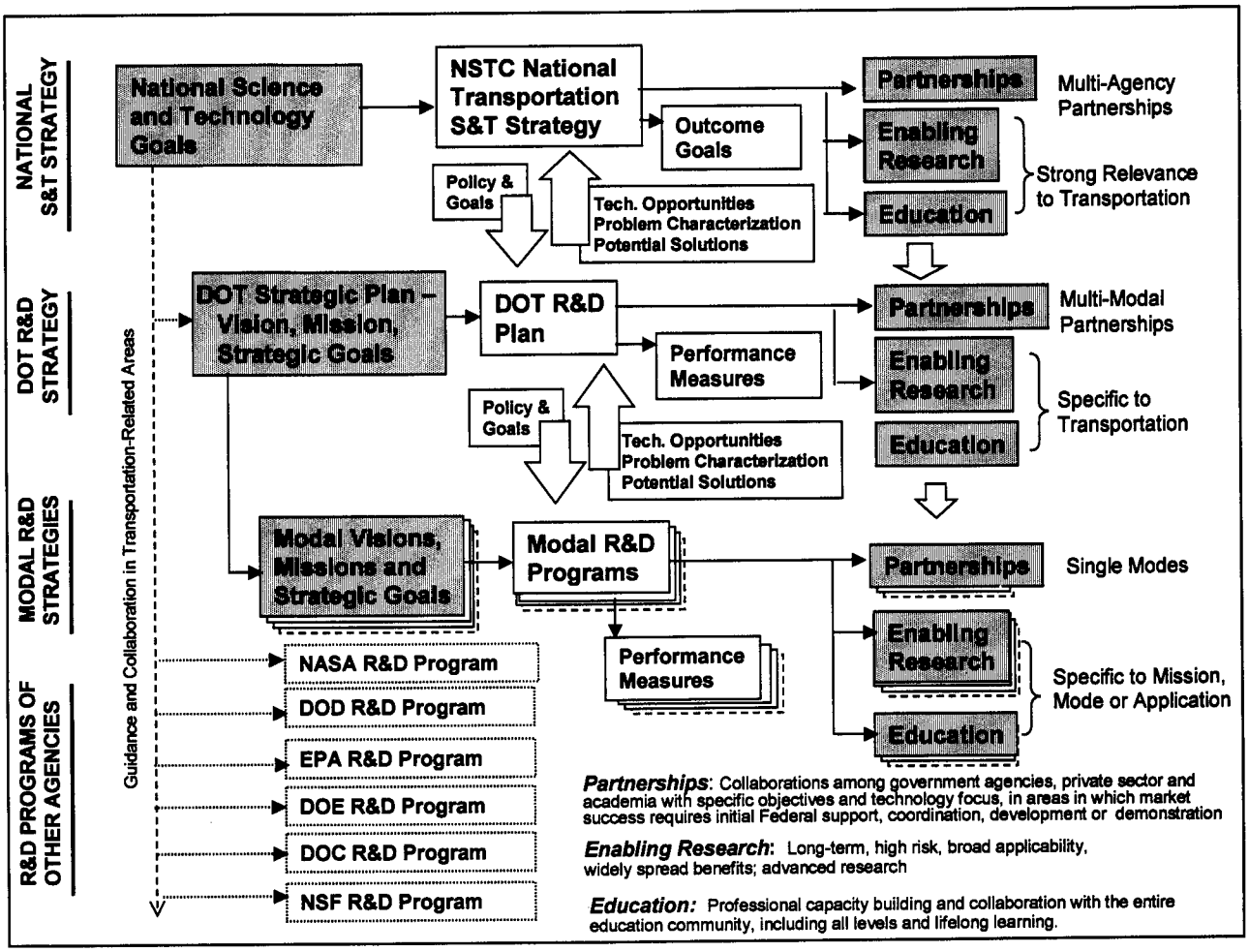

Figure I-2. DOT R&D Strategic Planning Process

DOT R&D Corporate Management Strategy

In addition to establishing goals and associated strategies, the DOT Strategic Plan also identifies over-arching management strategies designed to build an environment in DOT conducive to accomplishing the strategic agenda. These strategies cut across all organizational boundaries. Of particular relevance to the DOT R&D Plan is the Research and Technology (R&T) Management Strategy. Patterned after the NSTC structure, it includes (1) participation in the NSTC public-private partnership initiatives, (2) support for enabling research, and (3) educational initiatives to provide the needed 21st century workforce.

At the core of the R&T strategy is the intent that the Department's R&D programs sustain an innovation environment that accelerates the absorption of new concepts, technologies, and services into the transportation system. Specific management activities associated with the R&T Management Strategy are:

- **Strategic Planning**. The annual DOT Transportation R&D Plan will provide the strategic framework for aligning DOT R&D activities with the DOT Strategic Plan and annual Performance Plan and Report, the NSTC Transportation Science and Technology Strategy and implementation plans, and requirements outlined in TEA-21 and FAA authorizations.

- **World-Class Transportation R&D Capability**. To ensure that in-house R&D organizations are technical centers of excellence, the Department will assess their performance relative to the FY 2000 baseline, using Malcolm Baldrige or President's Quality Award Criteria, ISO 9000, or the Software Engineering Institute's Capability Maturity Model certification.

- **R&D Tracking**. To ensure decision makers have complete, accurate and timely information on the Department's R&D activities, the Department is developing a comprehensive DOT R&D tracking system.

- **Peer Review**. The Department aims to ensure that its R&D portfolio is balanced and addresses the critical long-term needs of the Department and the Nation. To this end, the National Research Council through the Transportation Research Board, Committee for Review of the National Transportation Science and Technology Strategy, now conducts an annual assessment of the Department's R&D plans and programs, and how they contribute to achievement of Departmental goals articulated in the *DOT Strategic Plan* and the *DOT Annual Performance Plan* and *Report*. In March 2000 the group completed a review of these elements, with a focused analysis directed towards the DOT's top-priority goal of improving safety. This review articulated some concerns that had arisen in its reviews of government-wide planning and strategy documents, so the present report already is responsive to several of the concerns raised. Other Committee concerns will be addressed in the next update of this document.

R&D Focus of DOT Offices and Operating Administrations

The operating administrations and other elements of the Department each conduct a broad range of research and technology programs appropriate to their specific mission and responsibilities. The dominant emphasis of their R&D and related activities is summarized below.

Bureau of Transportation Statistics (BTS). BTS funding is authorized in the research section of the Transportation Equity Act for the 21st Century. BTS provides the critical knowledge and understanding of our transportation system that is needed in the assessment of research needs and opportunities, and in the formulation of policy.

Federal Aviation Administration (FAA). FAA's research is directed towards improving the security, safety, and efficiency of operations in the National Airspace System. Components of this program include research in security technology, aviation weather products, continued airworthiness of existing aircraft and airworthiness of new aircraft technologies, advanced air traffic management technologies and procedures, the role of human performance in safe operation, maintenance, and renewal of both air traffic control systems and aircraft, advanced airport pavement design methodologies, aircraft crash rescue and firefighting technologies, airport runway and taxiway lighting, marking and signage systems and wildlife hazard mitigation and management techniques for airports.

Another FAA strategic research area involves the rapidly growing commercial space transportation sector. Partnerships with NASA, DOD, states and industry assure low-cost access to space through improved technology and operations. The partnerships also address the safe integration of new spaceports and routine launch operations of reusable vehicles into the National Airspace System.

Federal Highway Administration (FHWA). FHWA has a program to assure the development and widespread application of advanced technology and innovative approaches in ongoing operation, maintenance and renewal of the Nation's highway systems, as well as safety and environmental enhancement.

Federal Motor Carrier Safety Administration (FMCSA). Formerly an office within FHWA, FMCSA became a separate DOT operating administration on January 1, 2000. It is responsible for the issuance, administration, and enforcement of Federal laws and regulations addressing motor carrier and driver safety, hazardous materials, and drug and alcohol testing requirements.

Intelligent Transportation Systems Joint Program Office (ITS JPO). The DOT Intelligent Transportation System (ITS) Program, managed by the ITS Joint Program Office and housed in FHWA, is fostering and supporting application of advanced information technologies to improve surface transportation mobility, capacity, safety and environmental compatibility. Major program elements include developing an intelligent vehicle and supporting deployment of information infrastructure for rural and urban highway applications, commercial vehicle operations, and public transit systems.

Federal Railroad Administration (FRA). FRA conducts a railroad safety R&D program that addresses human factors, rolling stock and components, track and structures, track-train interaction, train control, highway-railroad grade crossings, hazardous materials, train occupant protection, railroad system safety, and R&D facilities and equipment. FRA also sponsors technology development and demonstration projects to facilitate introduction of high-speed passenger rail services.

Federal Transit Administration (FTA). FTA research is aimed at stimulating application of technological innovation in transit system operations, including programs such as development and testing of hybrid-electric buses and fuel cell and battery-powered propulsion systems.

Maritime Administration (MARAD). MARAD participates actively in several important cooperative programs to advance innovation in shipbuilding and marine operations.

National Highway Traffic Safety Administration (NHTSA). NHTSA R&D: 1) conducts research to improve vehicle crash avoidance and crashworthiness; 2) collects and analyzes crash data regarding the vehicle crashes through the National Center for Statistics and Analysis; 3) in conjunction with FHWA, conducts the intelligent vehicle initiative research; 4) develops national guidelines for crash injury mechanisms through the National Transportation Biomechanics Research Center; and 5) with FHWA, is building the National Advanced Driving Simulator.

Research and Special Programs Administration (RSPA). The RSPA agenda emphasizes transportation strategic planning and system assessment in support of DOT and NSTC. In addition, RSPA conducts continuing R&D in support of its responsibilities in pipeline safety and transport of hazardous materials.

US Coast Guard (USCG). Coast Guard research is focused on technologies, materials and human factors research directly related to improvement of mission performance. USCG is partnering with the Navy, DOC, and other DOT modes to design, develop and test a standard fuel cell propulsion system for marine and other heavy-duty vehicular applications.

Intermodal Cooperation on Cross-Cutting Research. The Department conducts a variety of activities, typically coordinated by the Office of the Secretary or the Research and Technology Coordinating Council, that address cross-modal R&D and related issues such as human factors and climate change.

Transportation-Related and Enabling R&D Conducted by Other Federal Agencies

The DOT has the most direct and explicit Federal responsibility related to transportation. As described above, nearly all DOT operating administrations carry out important transportation research directed toward improved performance of their agency missions and strengthening the national transportation system. Further, as part of their respective missions, other Federal agencies also conduct a substantial amount of research that is highly relevant to transportation and likely to play an important role in transportation systems in the future. The primary agencies of this type are identified below with an indication of the major thrust of their transportation-related R&D activities.

Department of Commerce (DOC). Much of the transportation related R&D conducted under the DOC is performed by the National Institute for Standards and Technology (NIST), which has as its primary mission promotion of U.S. economic growth by working with industry to develop and apply technology, measurements, and standards. This research is particularly visible in its construction material research, much of which is relevant to transportation. The Office of the Under Secretary of Commerce for Technology manages the Partnership for a New Generation of Vehicles (PNGV) program. Research conducted by the National Weather Service (NWS) is also important to the entire transportation enterprise.

Department of Defense (DOD). The Department of Defense accounts for nearly half of all Federal R&D. As a large contributor to R&D for the Federal government, and with a mission inherently requiring mobility and transportation, DOD achieves much transportation-related advancement through R&D efforts. These include participation in the Commerce-led PNGV research and other surface vehicle technologies, aviation/aeronautical and space transportation technology, ship design and propulsion, satellite positioning and communications, design tools, and information technologies.

Many defense programs include significant consideration of human performance in operation of aircraft. The Defense Advanced Research Projects Agency (DARPA) has provided substantial funding in areas including electric vehicles and maritime technologies. DOD also does considerable basic and applied research in areas directly applicable to transportation, such as human factors, materials, electronics, an system integration.

Department of Energy (DOE). The Department of Energy is primarily concerned with energy conservation and reduction of petroleum dependence, so it is naturally involved with transportation. The transportation energy program R&D budget request for FY 1998 is $306 million, a substantial amount of which is associated with PNGV. It is responsible for the major part of Federal PNGV funding. Overall, the transportation energy program emphasizes alternative fuels and electric propulsion. DOE has 20 major laboratories and similar facilities. Many have strong capabilities in materials, energy conversion and storage, electronics, instrumentation, and system and data analysis.

Environmental Protection Agency (EPA). The Environmental Protection Agency's transportation research primarily involves abatement, control and compliance, and specific programs on air and water quality.

National Aeronautics and Space Administration (NASA). NASA has a long and distinguished history of aeronautical and space transportation R&D. While topics such as propulsion, aerodynamics and control systems have predominated, NASA is also now emphasizing aviation safety and air traffic management technology. NASA is also exploring a new generation of environmentally compatible and economically feasible subsonic and high-sped civil transport aircraft. NASA's work on remote

sensing may have significant implications for the way transportation systems are planned and managed in the future.

National Science Foundation (NSF). The National Science Foundation is an independent Federal agency responsible for promoting science and engineering through programs that invest over $3.3 billion per year in almost 20,000 research and education projects. Its mission includes initiation and support of scientific and engineering research and programs to strengthen scientific and engineering research potential.

Chapter II
DOT R&D Planning and Coordination Procedures

As described in the previous chapter, transportation activities in this country contribute to achieving five broad societal goals: safety, mobility, economic growth, environment, and security. These goals are the linchpins of the DOT's *Strategic Plan* 1997-2002 (DOT 1997a), and are fully consistent with the goals established by the President's National Science and Technology Council for transportation research programs.

The various elements of an effective federally funded transportation research program must ultimately support these goals. This requires a translation of the five broad top-level goals into specific transportation research activities and opportunities, which, when completed, have a high likelihood of advancing the goals they are conceived to support. These candidate activities provide the basis for budget and program development to conduct the research, deploy the technologies that result, and contribute to achievement to the top-level goals.

Within the DOT, the *DOT R&D Plan* is designed to directly support the *DOT Strategic Plan* and the annual *Performance Plans* which focus implementation of its five-year directions on an annual basis. The *DOT R&D Plan* therefore becomes a key resource supporting the Department's budget and program development process, establishing priorities and linking research and technology development occurring throughout the Department to the specific goals it is intended to achieve. This type of presentation highlights the relationship of disparate modal research programs throughout DOT, illuminating areas of convergence and synergy, while at the same time helping to avoid possible duplication of effort. Chapter III of this report formalizes the connections between these strategic goals and the Department's research and technology development activities.

Government-Wide Coordination and Prioritization

The OSTP Guidance

Over the last several years the directors of the President's Office of Science and Technology Policy (OSTP) and Office of Management and Budget (OMB) have issued a guidance memorandum intended to establish priorities and emphasis areas for R&D in the budgeting process, as seen from a top-level interagency perspective. The most recent of these guidance memoranda was issued in April 1999 for FY-2001 programs. It establishes eleven priority areas critical to the national interest, and requires coordinated interagency investment to successfully address them:

1. Information Technology R&D
2. Global Change Research

3. Climate Change Technology (including the Partnership for a New Generation of Vehicles and use of biological materials as substitutes for fossil-fuel)
4. Emerging Infectious Diseases (EID)
5. Protecting Against 21st Century Threats (to our Nation's critical infrastructures)
6. Aviation Safety, Security, Efficiency, and Environmental Technologies
7. Plant Genome
8. Food Safety
9. Integrated Science for Ecosystems Challenges
10. Educational Research
11. Nanotechnology

Some of these priorities are specific to transportation, some impact transportation, and some are peripheral to it. Overall, the guidance has tended to emphasize longer term science and technology issues, and as such particularly tends to impact program formulation for basic or enabling research. In any case, this memorandum provides Federal agencies, including DOT, with explicit areas upon which to focus their research scrutiny.

NSTC National Transportation Science and Technology Strategy

The *NSTC Transportation S&T Strategy* (EOP NSTC 1999a) provides more specific guidance on the development of Federal transportation R&D programs. It is a high-level document intended to help Congress, the White House, and Federal agency heads to establish national R&D priorities and coordinated research activities in transportation. The text is developed through the Subcommittee on Transportation R&D reporting to the NSTC Committee on Technology.

The first version of this document, issued in 1997, focused exclusively on coordinating and setting priorities for Federal agency programs. The second (and most recent) version of the document was published in 1999, and built upon the base established in the first edition. It incorporated an even greater role for state, local, and tribal agencies; academic institutions; industry; and the larger transportation enterprise. Transportation R&D at the state and local level is also discussed in Chapter VII of this report. The *NSTC Strategy* also added a number of research and partnership priority areas highlighted since the release of the first document.

The *NSTC Strategy* provides a rationale and framework for guiding Federal partnership initiatives, long-term strategic research, and education and training to make the transportation system more productive and more efficient. As an overarching strategy, it identifies specific topics and emphasis areas for transportation R&D across the Federal government, within the DOT, and in partnerships, training and similar initiatives at state and local levels, academia, and industry. It outlines a four-tiered approach, with particular detail on the lower tiers:

1. Strategic Planning and Assessment - These activities help evaluate needs and opportunities for new transportation technologies, and establish "stretch goals" for achieving the broader national strategic transportation goals.

2. Private-Public Technology Partnerships (13 key topics) - These elements address national priorities, and typically involve technologies that are mature enough to allow development of implementation partnerships among elements of the public and private sectors. Since most transportation systems and services are provided by state and local governments and industry, the appropriate Federal (and DOT) role to bring them into service is to establish partnerships with appropriate organizations. This enables the participants to focus their collective resources and capabilities on addressing the long-term needs of the transportation system with the new technology options. These areas are highlighted in the *NSTC Strategy*:

   - Aviation Safety Research Alliance
   - Next Generation Global Air Transportation
   - Next Generation Transportation Vehicles
   - National Intelligent Transportation Infrastructure
   - Intelligent Vehicle Initiative
   - Transportation and Sustainable Communities
   - Transportation Infrastructure Assurance
   - Enhanced Goods and Freight Movement at Domestic and International Gateways
   - Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure
   - Maritime Safety Research Alliance
   - Space Transportation Technologies
   - Accessibility for Aging and Transportation Disadvantaged Populations
   - Enhanced Transportation Weather Services

   The *NSTC National Transportation Technology Plan* (EOP NSTC 2000a) elaborates on the partnerships set forth in the *NSTC Strategy*, describing the problems they are intended to address, goals, objectives, requirements, an investment strategy, and implementation challenges. Chapter IV discusses the 13 partnership initiatives in terms of DOT R&D activities.

3. Enabling Research (7 key topics) - The Federal government spends some $5 billion per year on longer-term transportation issues, mostly in agencies outside DOT. The challenge for the Department is to leverage this activity, and help focus it on the areas most likely to improve transportation services. Cooperative research on these NSTC topics then will provide the technical basis for development of more mature transportation technologies to address specific problems or opportunities:

   - Human Performance and Behavior
   - Advanced Materials
   - Computer, Information, and Communication Systems

- Energy, Propulsion, and Environmental Engineering
- Sensing and Measurement
- Tools for Transportation Modeling, Design and Construction
- Social and Economic Policy Issues

As with the partnerships, a more detailed *Transportation Strategic Research Plan* (EOP NSTC 1999b) provides additional information about promising technologies or areas for enabling research activities. Specifically, its aim is to find ways to stimulate innovation and research investment by state and local governments, industry and universities in the research areas defined in the *NSTC Strategy*. Chapter V of this report addresses DOT R&D activities in terms of these enabling research areas.

4. Education and Training (4 key topics) - Recognizing the critical need for talented transportation researchers and an educated transportation workforce, the *NSTC Strategy* highlights four key areas for educational program development:

    - Introduction of Transportation Concepts: Elementary and Secondary Education
    - Vocational and Technical Training
    - Transportation Degree Programs: International and Multidisciplinary
    - Mid-Career Transportation training

One of the most important components of the Department's R&D management strategy is to assure a continual investment in the skills and abilities of the professionals responsible for designing, constructing, operating and maintaining our Nation's transportation system. The DOT will soon publish its first ever *Transportation Research and Education Plan* (EOP NSTC 2000b), providing additional detail about the initiatives envisioned on these topics from a DOT perspective. The Plan will also include a compilation of current, Federal-based research and education activities in the field of transportation. The relationship between that *Plan* and the Department's R&D activities is the topic of chapter VI of this report.

The future transportation workforce pipeline will also benefit as a result of the opportunities provided by FHWA's Dwight David Eisenhower Transportation Fellowship Program, designed to attract bright minds to the field of transportation. In addition, the Garrett A. Morgan Technology and Transportation Futures Program addresses the workforce pipeline at the pre-college level (see Chapter III).

Features of the DOT R&D Planning Process

The Department's R&D planning process has become increasingly sophisticated over time, both in response to internal drives to achieve common programmatic and strategic purpose under the ONE DOT concept, and external drivers that shape both the direction and conduct of transportation science and technology. Among external drivers, the

NSTC strategies and the associated NRC review and recommendations (see Box II-1) have particularly important impacts on DOT R&D, and R&D planning processes within the Department is now configured to address these recommendations. The DOT R&D planning process now includes integration of NSTC and DOT priorities to promote innovation, explicit links between research planning and performance measurement, and the establishment of DOT research emphasis areas.

Integration of NSTC and DOT Priorities to Promote Innovation

Research and technology program development within the DOT is an integration process, drawing together inputs from a variety of sources inside and outside the Department. These sources include high level planning documents, established strategic goals, external market forces and needs, and R&D concepts and partnerships germinated throughout the greater transportation community. It also reflects an integration process between the transportation sector and the Federal R&D that supports it. This process — typically referred to as the innovation process — is a top priority. It represents the capacity within the public and private sectors to transform technologies, concepts, and ideas rapidly into products, processes, or services.

This process has also been a major emphasis in DOT program development in recent years, and was the focus of "The Spirit of Innovation in Transportation" conference held in June 1999. That session brought together leaders from the technology and transportation communities to consider integrated strategies to stimulate continuing technological innovation in transportation. The conference addressed issues critical to achieving innovation, such as ensuring a highly skilled workforce capable of meeting or exceeding our national transportation goals. It also provided an independent validation of many of the NSTC research and partnership topics.

As such, the NSTC process provides a key set of consistent, system-level, and validated areas to consider in formulating each fiscal year's R&D budget proposals. However, the "success" of the program development process is judged ultimately by how well the programs undertaken support each operating administration's mission, and the overall DOT goals to which they contributed. As such, when the DOT operating administrations develop their annual budget submissions, the management process which has evolved in the post-Government Performance and Results Act era requires that they explicitly connect their existing and proposed research and technology development programs to both the DOT strategic goals (as expressed in the *DOT Strategic Plan* and implementing *Performance Plans*) and the NSTC priorities (as expressed in the *NSTC Strategy*). The process within DOT is transportation-driven; the NSTC process is science, technology, and innovation-driven.

Because of the consistency between the NSTC and DOT top-level goals, the process has worked very well over the past several years. The Corporate Management Strategy in the *DOT Strategic Plan* was specifically conceived to enhance this goal-driven program formulation, both within individual modes and across the department. The *Performance Agreements* of the individual modal administrators with the Secretary of Transportation

Box II-1. Recommendations of the National Research Council, Transportation Research Board, Committee for Review of the National Transportation Science and Technology Strategy

Alignment of R&T with Strategic Plan	R&T priorities and activities should be tied more explicitly to the Department's strategic and performance goals, and their relationship to these goals should be articulated more clearly.
Resources	The R&D Plan should include the funding budgeted for specific R&T activities and performance goals, since budgets are a tangible reflection of the real priorities of an agency.
Criteria and Methodologies for Program Development	DOT should employ rational criteria and methodologies in prioritizing and budgeting for its R&T programs and should include these criteria and methods in the R&D Plan.
Types of R&T Activities Undertaken	The documents should clearly explain DOT's role in transportation R&T by identifying where its R&T activities are most appropriately focused and demonstrating that its investments are, in fact, in areas not likely to be covered by other agencies or the private sector.
Public-Sector Organizational Roles and Coordination	The roles of various public-sector participants (other than federal agencies, DOT operating administrations, state and local governments) and the mechanisms for coordinating their participation should be described in the R&D Plan. The R&T activities DOT has chosen to pursue should reflect these coordination efforts.
Outreach	The R&D Plan should be developed with input from the public, private, and academic sectors. The methods of obtaining this input and results of the outreach should be documented in the plan itself.
Performance Measurement	Performance measurement of DOT's R&T activities should extend beyond theoretical discussion. Specific measures, methods of applying them and analyzing the results, and the actions to be taken in response should be specified in the R&D Plan.

Source: (Sussman 2000)

are formulated as key implementation elements of the departmental strategic planning process. Each includes specific R&D elements that contribute directly to accomplishing the goals of the Department level *Performance Plan,* or supports broader, operational commitments made in the document. Some transportation systemic goals are multimodal, and require the cooperative efforts of several modes for their achievement. As such, the overall transportation-related goals set forth in the *DOT Performance Plans* are achieved through the efforts of the individual operating administration programs.

As the leader in the Federal government for transportation, the *NSTC Strategy* and related planning documents – technology, strategic research, and research and education – provide the mechanism for the Department to guide collective Federal investment to address national goals. This focus, combined with the emphasis on science and technology throughout the NSTC process, results in "R&D push." This energizes the *DOT R&D Plan* with internally generated innovations, directives, and concepts (see Figure II-1). Simultaneously, the Department responds to external market conditions in the transportation sector – "R&D pull" – that suggests areas for innovation and technology development necessitated by a rapidly changing transportation environment.

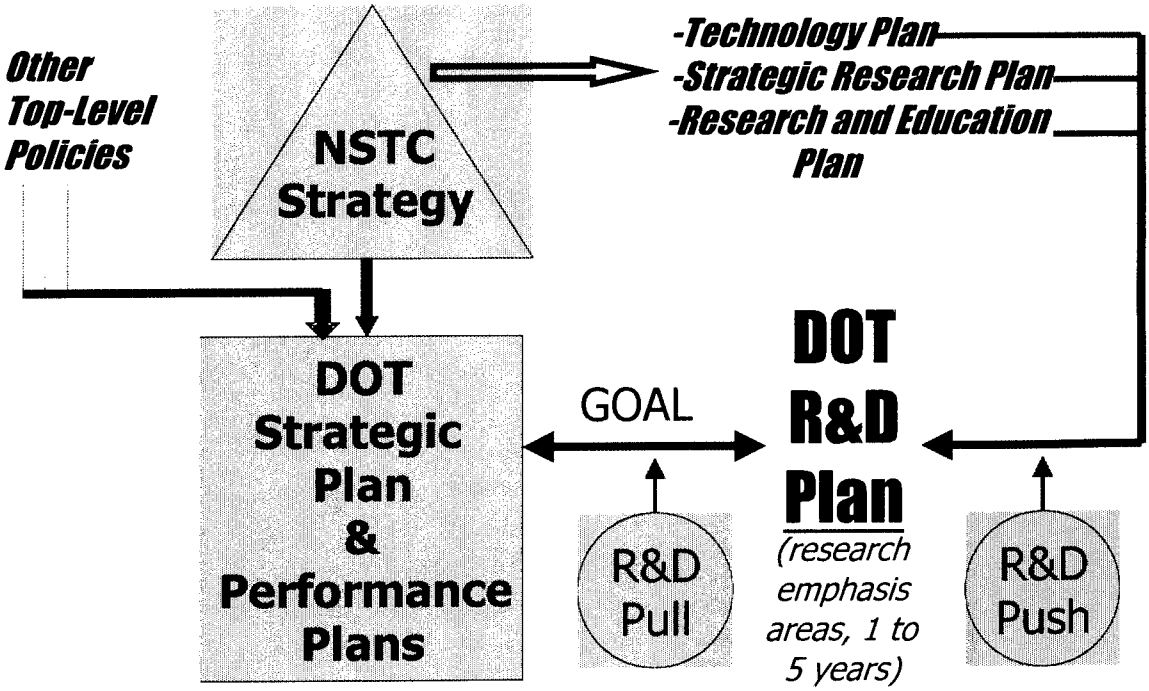

Figure II-1. DOT R&D Planning Process

It should be noted that the DOT Strategic Plan and DOT R&D Plan both have a limited focus, emphasizing programs and options in the 1-5 years following their publication. This means that neither document currently puts heavy emphasis on identifying long-term "stretch goals" or research needs. In most cases, programs to address such goals will take decades to have an impact on transportation system performance.

Explicit Links between Research Planning and Performance Measurement

The *DOT Performance Plan* defines those performance indicators and goals used to measure progress toward achieving strategic goals. By linking these goals to the budget, it describes what a fiscal year's effort within DOT is intended to accomplish, and shows how this effort fits into the long-range plan for the Department and the U.S. transportation system. Each *DOT Performance Report* will provide a public accounting of performance against the goals in earlier Performance Plans.

The annual *Performance Agreements* between the operating administrators and the Secretary, as well as the overall *DOT Performance Plan* and *Strategic Plan*, contribute to the formulation of the *R&D Plan* through their contribution to the goal-setting process. Sets of outcome measures specify the parameters intended to document the resolution of a problem (e.g. levels of reduction in transportation fatalities or congestion). Performance measures and indicators then become a means by which to quantify and statistically evaluate how well goals are achieved within a predetermined time frame. This information can then be used to assess the effectiveness of R&D in contributing to resolution of high-priority problems, and thereby to channel scarce R&D resources in order to address fundamental concerns. For longer-term and enabling research, these research activities will provide downstream benefits measurable through baseline indicators and performance goals. Chapter VIII of this report presents a discussion of how the Department measures the success of its research and technology development programs.

Establishment of Research Emphasis Areas

A pivotal aspect of the *DOT R&D Plan* is its focus on identifying a limited number of emphasis areas. These emphasis areas have been defined collaboratively by all elements of the Department over the last year and are not technology-focused They do represent the consensus of DOT senior management on priority areas with a high potential for near-term payoff. They developed a priority program agenda for DOT— not as a totally new set of activities, but in a context established by the DOT *Strategic Plan*, *Performance Plans*, and other existing planning documents. The purpose for developing this multi-year agenda is to target DOT efforts during the budgeting process; it includes lists of key activities in support of each of the five DOT strategic goals and Corporate Management Strategies. Each emphasis area is supported by a specific action plan.

The *emphasis areas* are not a substitute for the *Strategic Plans* or *Performance Plans*, but they are central to shaping the overall strategy of the Department in carrying out R&D over the next two to five years. Most are intermodal, and many focus on research

initiatives. Three broad criteria determine priorities for these areas with respect to DOT goals:

- Key deliverable in the next two to five years, tied to performance goals
- Outcome(s) highly visible
- Failure to achieve outcome(s) will reflect negatively on the Department

These research emphasis areas are generally not the day-to-day activities in support of the mission or management of the Department. Rather, they are activities by which the public will evaluate programmatic success by the Department in the near term. These areas establish our most compelling goals and chart the Department's course.

Selection of Performance Goals and Performance Measures

DOT focuses on achievement of a limited number of outcomes in general, because these have a higher probability of delivering value to the American public. Outcomes are the reason for the existence of the Department. Program performance goals may contribute to outcomes, but may not assure those outcomes by themselves. For example, departmental program goals to promote seat belt use and reduce grade crossing crashes both contribute to the ultimate outcomes of reduced automotive fatality and injury rates — a higher level DOT performance goals. Related activities contribute to fatality rate reduction in other modes — aviation and motor carriers, for example. Similarly, the goals established to promote ITS integration and formalized through DOT's Operation Timesaver contribute to improvements in highway congestion, mobile source emissions, energy efficiency, and safety (fatalities and injuries). These are included in the *DOT Performance Plan* because together they describe aims and accomplishments

Performance measures address activities in each area of DOT work (see Chapter VIII). When considered along with external factors and information revealed in program evaluations, these measures provide valuable insight into the performance of DOT programs. When supported by accurate and current data (indicators), they are a proxy for the success of individual projects and for the cumulative effectiveness of transportation R&D.

Research managers can use systemic performance measures to determine if intended outcomes are occurring as a result of investments in R&D. They are also helpful in assessing R&D investment's involvement in stimulating broader trends. Program evaluators can use a variety of analytic techniques to assess and/or isolate the extent to which R&D programs are contributing to overall outcomes and trends. The GPRA requires agencies to develop a schedule of program evaluations to include in their strategic plans. An initial DOT schedule was included in the first *Strategic Plan*, and extended considerably in the FY 2000 *Performance Plan.*

Most R&D projects are multi-year. Hence, their contribution to the achievement of a particular performance goal will not be realized until the projects implementing new

technologies are either operational or supporting ongoing service provision. This is especially true for R&D that supports promulgation of new Federal regulations, which often take a few years to take effect. Consequently, not all R&D activities identified in the FY 2001 budget submission will have measurable outcomes in that particular year. DOT agencies continually assess their goals and performance measures to accurately accomplish their respective missions. They also establish contributions to the overall mission of the Department, and assure the synergy of the modal DOT science and technology programs.

Chapter III
Key R&D Programs of the Department of Transportation

This chapter describes the major research and technology development programs of the Department of Transportation in terms of strategic goals and corporate management strategy. Strategic planning and investments in innovative research and technology development are a principal means by which the Department of Transportation achieves desired outcomes. They also help it to maintain its leadership role in U.S. transportation policy, operations, investment, and research. Technology partnerships and programs in transportation education and training also fortify the R&D activities of the Department.[1]

Although many transportation R&D activities reside entirely within the Federal government, a substantial number involve partnering with state and local authorities and with the transportation industry. These are the broad areas of action that the DOT, state, and local governments commonly use to bring about desired results.

This R&D Plan focuses on DOT's five strategic goals, and the technology partnerships, enabling research, education and training, and the DOT Corporate Management Strategies (CMS) that will achieve those goals. The CMS provide the over-arching organizational and decision-making environment conducive to accomplishing the strategic agenda. Of particular relevance to this plan is the *Research and Development Management Strategy*, a blueprint for advancing transportation research and technology through strategic planning, exchange of information, education, and partnerships. Another CMS of particular importance is the ONE DOT Management Strategy, which emphasizes the day-to-day management of programs and actions and will yield a Department that can act as an integrated, purposeful leader to optimize transportation efficiency and effectiveness.

The Department has identified 23 specific areas of programmatic emphasis to support achievement of the strategic goals and implementation of the management strategies. Many have a strong R&D focus, or very substantial research elements. Even those primarily addressing non-research activities can be expected to have some R&D component or benefit from research in related areas. Four areas are elements of the Research and Development CMS. All of the emphasis areas are listed in Table III-1, grouped in terms of the strategic goal primarily affected. The remainder of this chapter provides a concise description of R&D activities associated with each area. In addition, the chapter concludes with a detailed list, by mode, of the Department's FY 2001 research and technology development programs and projects expressed in terms of the strategic goals (see Table III-3 at the end of this chapter).

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[1] Other DOT actions, such as direct operations, infrastructure investment, capital investments, financial tools, rulemakings, and enforcement strategies also support the strategic goals, but these are not the focus of this report.

Table III-1. DOT Emphasis Areas

Safety	
	Seat Belt Use and Occupant Protection
	Advanced Transit Technology Safety Assessment
	Human Centered Systems Research Program
	Safer Skies
	Safety Technology Sharing/Transfer
Mobility	
	High Speed Rail
	Accelerated Deployment of Intelligent Transportation Systems (ITS)
	ITS for Urban Rail Technologies
	Global Positioning System (GPS) Applications
	Marine Transportation System (MTS)
	Intermodal Connectors
	Aging America
	Accessible Transportation
Economic Growth and Trade	
	Marine Transportation System (MTS)
	Multi-modal Integration
	Intermodal connectors
	Corridors and Borders
	Garrett A. Morgan Program
Human and Natural Environment	
	Advanced Vehicle Technology Program
	Sustainability (Center for Climate Change)
	New Technologies for Quieter Aircraft
National Security	
	Critical Infrastructure Protection (Transportation Infrastructure Assurance R&D)
	Implement White House Commission on Aviation Safety/Security Recommendations
Corporate Management Strategies	
	R&D Strategic Planning
	World-Class R&D Capability
	National R&T Partnership Initiatives
	Railroad Research and Technology

R&D Supporting the Safety Goal

Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.

Safety is our most important strategic goal. Transportation enables the movement of people and goods, fueling our economy and improving our quality of life. However, transportation exposes people, property and freight to the risk of harm. We strive to improve the benefits of transportation while constantly reducing the risk to health and well being. The FY 2001 budget request proposes $4 billion for direct safety programs to meet this challenge—a 13 percent increase over 2000.

The DOT will act to promote public-private partnerships to demonstrate cost-effective safety technologies, such as intelligent vehicles, air traffic management, and enhanced weather services. It will develop, deploy, and promote cost-effective information technology (IT). In addition, the Department will seek to advance transportation research that explores the causes of, and countermeasures for, transportation incidents in all modes of transportation.

Strategic outcomes that the Department wants to achieve include:

- Reduce the number of transportation-related deaths
- Reduce the number and severity of transportation-related injuries
- Reduce the rate of transportation-related fatalities per passenger mile traveled and per ton-mile of total freight shipped (or vehicle miles traveled)
- Reduce the rate and severity of transportation-related injuries per passenger mile traveled and per ton-mile of total freight shipped (or vehicle miles traveled)
- Reduce the dollar loss of high-consequence, reportable transportation incidents
- Reduce the number of reportable transportation incidents and their related economic costs

Safety-Related Emphasis Areas

Seat Belt Use and Occupant Protection (NHTSA)

As vehicle travel increases, so does the exposure of people to potential crashes. Beginning in 1991 and increasingly every year thereafter, DOT and its partners have succeeded in convincing the majority of the population to buckle up. However, the behavior of part-time seat belt users and non-users is becoming more difficult to change. NHTSA, the lead DOT agency in this area, remains committed to the national seat belt use goals of 86 percent by 2001.

Seat belt use and occupant protection programs are central to achieving DOT's goals for highway fatality and injury rates. In FY 2001, DOT will continue to work with the states and communities to develop and demonstrate innovative programs to inform and educate people about the benefits of buckling up. NHTSA will conduct public information and education

research to continue to improve the understanding of high-risk populations. NHTSA will initiate research on advanced restraint systems and the development of advanced injury criteria and evaluation of enhanced dummy injury measures. It will also continue outreach efforts to address the over-representation of youth, elder, minority, and rural populations in fatal crashes and injuries.

The *Buckle Up America* program will focus on expanding activities in: public information and education; outreach targeted to high-risk audiences; and evaluation, training, and program development to enhance the safety messages. Partnerships, promotions, and educational materials for diverse audiences will increase.

The Department will also address this area through efforts that emphasize research in injury biomechanics, human performance and behavior, and lifetime driver learning. This will help to maximize safety opportunities and investments in crashworthiness, crash prevention, and crash avoidance areas.

The Department's *Aging America* program addresses the safety and mobility problems faced by older drivers. It is described below in the section on Mobility, but will also have significant safety benefits.

Advanced Transit Technology Safety Assessment (FTA)

The FTA will assure that safety-critical issues are addressed during the design and new technology development phases of transit operations. In FY 2001, DOT will reduce transit-related fatalities and improve safe, reliable service using the most cost-effective technology available, such as Communication-Based Train Control.

Public transit provides a flexible alternative to automobile and highway travel, offering a higher degree of safety as well. However, public expectations for safety are higher for transit than they are for highway travel. As the population grows, the use of public transit will likely increase. Increased ridership of public transit would lead to an increase in the absolute number of fatalities and injuries even if the rate per 100 million passenger miles traveled does not change.

DOT provides grants to improve the condition of transit infrastructure, and it works with states, local transit authorities, and the transit industry to develop technology, provide training, and supply technical assistance that advances safety. DOT also conducts research and collects data in order to provide valuable information on safety and standards.

- Through Formula Grants, Capital Investment Grants, and the Job Access and Reverse Commute Programs, FTA invests in the public transit infrastructure.
- The Safety and Security Program funded with transit National Research and Technology funds will develop technology and system designs that will improve the security of the riding public. Activities will include using information technology to improve highway-rail interactions, training programs on topics such as system security, bus and rail accident investigation, and fatigue awareness, and technical assistance to states and local

agencies to improve the safety and security of public transit. Activities will include joint use of safety certifications, guidance on emergency management, including natural disasters and terrorist attacks, oversight of drug and alcohol testing programs, evaluation of state safety oversight programs

Human Centered Systems Research Program (DOT-wide)

This DOT-wide program will develop technology, methods, and systems to mitigate human error and improve operator performance of commercial and non-commercial vehicles, equipment, and systems. Its goal will be to reduce by at least one-third transportation crashes, incidents or mishaps that result in fatalities and injuries within 20 years. For FY 2001, this program will focus on research to: (1) detect operator fatigue and enhance alertness, and (2) upgrade operator knowledge, skills and attitudes.

NHTSA will focus on preventing crashes through behavioral programs, on lessening the severity of crashes by improving vehicles, and on emergency response capabilities – the human, vehicle and environmental factors that influence the crash event. Special emphasis will be placed on efforts to reduce injuries to children. NHTSA will also focus research on high-risk groups, such as older drivers, youths, and others who appear disproportionately in transportation safety statistics.

FHWA will conduct research to address run-off-the road and pedestrian and bicycle safety. It will take the lead in identifying effective safety technologies and work to facilitate their development and use.

The Human Factors Research Program of RSPA is critically important for safety. Human error continues to be the most common cause of transportation crashes, accidents, and incidents in most modes. This program also seeks to address the issues of operator fatigue and other performance-impairing conditions, through use of information technology for training operators and monitoring their performance real-time.

To counter the growing number of incidents involving human factors, FRA led in the research and development of fatigue countermeasures. In cooperation with the industry and the National Aeronautics and Space Administration, FRA developed a training course on fatigue countermeasures. FRA also conducted Safety Assurance and Compliance Program (SACP) compliance/assistance audits for drug and alcohol use on four railroads and published a Safety Advisory on the safe use of prescription and over-the-counter drugs.

Safer Skies (FAA, OST)

In 1997, the White House Commission on Aviation Safety and Security established a goal of reducing the fatal accident rate by 80 percent by 2007. The FAA has accepted that challenge. Research that makes an impact and provides solutions to aviation problems in the short term is crucial to the FAA's mission and an integral part of its commitment to aviation. Equally important is long-term research that is designed to advance aviation technology and meet the future needs of the aviation community. The FAA will continue its support for an NSTC partnership, the Aviation Safety Research Alliance. A range of research activities is planned,

including nondestructive inspection testing methods, propulsions and fuel systems safety, and crashworthiness.

This area focuses on the most critical safety problems in commercial and general aviation, including loss of control, pilot decision making, runway incursions, passenger seat belt use, uncontained engine failures and survivability. The area will develop a data driven set of safety initiatives.

Safety Technology Sharing/Transfer (multimodal)

The DOT operating administrations will work to identify highly effective safety technologies and facilitate their development and intermodal uses. The focus of this activity is on product development through intermodal cooperation. Mature, developed and emerging technologies in one mode may be applicable to safety challenges faced by other modes. For example, anti-lock braking technology developed for aircraft is now widely used on vehicles traveling our Nation's highways. The deployment of safety technology across modes presents opportunities for high payoff initiatives. The transfer of a mature technology to another mode may provide a near term product while multi modal initiatives to develop and deploy emerging technology are likely to take longer. Funding will be used selectively to accomplish three things: transfer technology between modes; support multi modal technology development and deployment; and transfer technology to customers.

Other Key Safety Research

The FTA Safety and Security R&D program directly addresses the safety goal. In addition, a number of multidisciplinary R&D, technology, and R&D support programs of FTA are linked to all the strategic goals, including safety. These include Research and Technology Program Support; Performance and Review/Evaluation; Human Resources, Transit Cooperative Research Program (TCRP), National Transit Institute, and University Transportation Research.

Three R&D programs of the U.S. Coast Guard — Waterways Safety Management and Aids to Navigation, Marine Safety Research, and Improved Search and Rescue Capability — address the strategic goal of safety for the commercial waterborne and recreational boating modes. Among the program activities of the Waterways Safety Management and Aids to Navigation program are the development and demonstration of advanced electronic navigation aids and collision warning systems. The activities of the Marine Safety Research program include studying operator fatigue and alertness issues, which are critical to safety. The Improved Search and Rescue Capability seeks to develop better search tools, equipment, and procedures.

The Pipeline Safety R&D program of the Research and Special Programs Administration (RSPA) addresses the safety of the pipeline system. Pipeline safety concerns may appear relatively minor as measured by fatalities, injuries, and damage on a national scale. However, individual pipeline incidents, such as the Houston shipping channel fire of October 1994, and the San Juan, Puerto Rico explosion of November 1996, can have a disastrous impact locally. The Pipeline Safety R&D program advances pipeline safety through a national pipeline mapping system that tracks the location of all pipelines accurately (to

minimize outside force damage incidents), and through development of internal inspection tools to detect faults in pipelines before catastrophic failure occurs.

The Research and Technology Program of RSPA is linked to all DOT strategic goals, including safety. This program involves strategic planning, coordination, and definition of goals for Department wide R&D. The hazardous materials R&D programs of RSPA address safety of all modes, since truck, rail, waterways, and pipelines transport hazardous materials. These programs also address the strategic goal of Human and Natural Environment. The Research and Analysis program provides analytical support to the regulatory and standard-setting functions of the RSPA office of Hazardous Materials, while the Research and Development program advances technical knowledge to assist response to hazardous materials emergencies, and to assist enforcement of regulations.

R&D Supporting the Mobility Goal

Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of choices.

Mobility as much as any other factor defines us as a nation. It *connects* people with work, school, community services, markets, and other people. The U.S. transportation system carries over 4 trillion passenger miles of travel and 3.7 trillion ton miles of freight every year – generated by more than 260 million people and 6 million businesses. For efficiency and equity of access, our transportation system frequently relies on common public infrastructure that is maintained on limited national resources – our land, waterways, and airspace.

Mobility Emphasis Areas

High Speed Rail

Intercity rail passenger service helps to reduce highway and aviation congestion in many areas of the U.S. It can help decrease the need for more highway and aviation infrastructure, reduce air pollution, and decrease our use of energy resources. The Administration has proposed increased funding to expand intercity passenger rail service and lay the foundation for high-speed rail. These investments will support increased ridership, and DOT's ultimate goal on improving the overall financial health of AMTRAK. DOT's strategies include quarterly assessments of ridership and revenue performance relative to targets.

Accelerated Deployment of Intelligent Transportation Systems (ITS)

Congestion is one of the largest causes of frustration and unhappiness by users of the highway system. Delay on the Nation's highway systems is a major cost to motorists, amounting to $51 billion annually in lost wages and wasted fuel. It has consequences that are even more serious on national productivity. Congestion adds to the cost of production, drives prices up, and reduces funds available for investment in product development or firm expansion. Reducing delay will improve the mobility and productivity of all system users, increase national productivity and better position American firms in the world economy

Highway congestion is a persistent problem, and opportunities to build new roads or expand existing roads have declined substantially. Intelligent Transportation Systems (ITS) use electronic information and communications technology to extend the capacity of our existing infrastructure system – examples are freeway management, traffic signal control, electronic toll collection, transit management, and regional multimodal traveler information. While deployment of ITS is beneficial, piecemeal purchase and installation of technology create artificial system boundaries. The challenge to Federal, state, and local transportation officials is to integrate these systems so that the Nation can realize all the potential benefits associated with ITS.

Current strategies are to invest in the long-term goal of deploying the ITS infrastructure; completing key on-going initiatives and investing in tools for increasing the capacity of the existing system; and funding alternative travel modes. In FY 2001, the FHWA will provide funding through the ITS program to deploy an integrated electronic and communication infrastructure to enable or enhance operations. It will also develop tools that can be used by system managers to improve the operation of the existing system and to measure the success of selected strategies.

Other R&D in this emphasis area includes the development and test of a winter maintenance decision support system for system managers and road weather information systems for travelers. Elsewhere, the DOT will develop a best practices guidelines for systematic, integrated surface transportation operations including arterial and freeway management systems, travel demand management systems, and operational aspects of value pricing.

The DOT, in cooperation with the Environmental Protection Agency and the Department of Housing and Urban Development, is also investigating ways that changing urban development patterns affect highway congestion.

ITS for Urban Rail Technologies

FTA will test, demonstrate, and promote deployment of ITS rail technologies that encourage rail transit use, more effectively manage intermodal connectivity, and improve safe operations. In FY 2001 and beyond, the focus is on research and demonstration of technologies at selected deployment sites that involve intermodal connectivity, such as rail-to-bus, rail-to-airport or rail grade crossings.

DOT implements a wide range of strategies to address congestion and improve operations on the highway transportation system. Historically, the Department has improved national mobility and productivity by increasing, rebuilding, or otherwise enhancing the physical highway infrastructure. The focus has now shifted to improving the operations and efficiency of our surface transportation system. Key strategies include continuing to invest in the long term goal of deploying the ITS infrastructure; completing key on-going initiatives and investing in tools for increasing the capacity of the existing system; and funding alternative travel modes, such as rail and transit.

Global Positioning System (GPS) Applications

The DOT is the lead agency within the U.S. Government for all Federal civil GPS matters. Within the DOT, the U.S. Coast Guard and Federal Aviation Administration operate radionavigation programs providing a variety of services to all modes, including aviation, maritime, and land.

To make the GPS suitable for civilian transportation applications, the DOT is sponsoring GPS augmentations and two new civilian signals to be added to future satellites in the L2 and L5 frequency bands. A properly protected, GPS-based transportation infrastructure will improve the measured safety and efficiency of all modes of transportation. American productivity and the global economy will benefit when national infrastructures, such as the transportation system, are improved through using the GPS to better satisfy timing and positioning needs.

The value of the GPS and augmentations is recognized by a wide array of national applications. For many non-transportation applications, such as agriculture, private DGPS services are currently available that provide the necessary accuracy. In contrast, many transportation applications have safety concerns that require more than just accuracy. Transportation applications in the different modes require the combination of accuracy, reliability, availability, propagation characteristics, and radiocommunications protection that the DOT-sponsored systems are designed to satisfy.

Marine Transportation System (MTS)

Over two billion tons of domestic and foreign commerce are transported through U.S. ports and waterways every year. As larger volumes of maritime and recreational vessel traffic squeeze U.S. port capacities, navigation accidents involving commercial vessels can greatly affect cargo throughput, and may even force closure of major waterways. These accidents also may cause serious damage to ships and navigation channels, putting people and other ships at risk.

The goal of the MTS is to ensure that America's Marine Transportation System is the world's most technologically advanced, safe, secure, efficient, effective, accessible, globally competitive, dynamic and environmentally responsible system for moving goods and people.

In support of this objective, the Department intends to explore several research areas: vessel clearance information exchange; landside access to ports; hydrographic and weather information; and waterways traffic management information.

The USCG will examine new approaches to improving the timeliness of waterway navigation information to mariners, increase overall distribution capacity and quality, and conform to the operation of modern navigation systems. It will test the effectiveness of an Automatic Identification System (AIS) in cooperation with the private sector and state/local government agencies as one promising technology that can be used in support of the DOT effort to introduce the maritime community to the "Intelligent Transportation Society" concept.

Intermodal Connectors

The goal is to identify five important departmental intermodal projects or initiatives of national or international significance. Strategic outcomes are as follows: to improve the structural integrity of the transportation system; to balance new physical capacity with the operational efficiency of the Nation's transportation infrastructure; to increase intermodal physical, information, and service connectivity; to increase access to the transportation system for the movement of all people and freight; and to provide preventive measures and expeditious response to natural and man made disasters in partnership with other agencies to ensure that we provide for the rapid recovery of the transportation system.

Aging America

Under its *Aging America* program, the Department has emphasized the safety and mobility problems faced by older drivers. There will be a 50 percent growth in older adult users between now and 2020, requiring a transportation system that is safe, accessible, integrated, efficient, and offers flexibility of choices. The *Aging America* research plan has 10 distinct components, several of which point to research or educational/training needs to provide continued safe mobility for older adults. In FY 2001, we will conduct operational tests and demonstrations focusing on recommended technologies and techniques, such as smart cards, recognition technology tied to reservation systems, and software to handle demand responsive transit to meet the needs of the elderly.

Accessible Transportation for the Transportation Disadvantaged

Transportation can be vital in maintaining independence for people with disabilities. However, despite important progress toward accessibility, transportation remains a major obstacle to employment and participation in the community for many people with disabilities. The Americans with Disabilities Act (ADA) requires that public transportation services must be accessible to individuals with disabilities, and DOT has set a goal which is more ambitious than the statutory requirements of ADA. The Department seeks to develop initiatives that address the needs of disabled Americans.

Transportation Services for Welfare Recipients and Low-Income Persons

DOT provides grants to state and local governments, and non-profit organizations representing the disabled, Native Americans, migrant workers, welfare recipients, and low-income individuals to create new and expanded transit services. The services are intended to move people from their homes to employment sites and other employment-related services, such as child-care and job training. Grants also support services that provide access to suburban employment sites.

FTA's Job Access and Reverse Commute program provides grants to state and local governments and non-profit organizations representing the disabled, Native Americans, migrant workers, welfare recipients and other low income individuals to create and expanded transit services. The services are intended to move people from their homes to employment sites and other employment-related services such as child-care and job training. Grants also

support services that provide access to suburban employment sites. Under the Job Access Support Program of the National Research and Technology Program, FTA will provide technical assistance to transportation planners, document the best practices of transportation planning, and demonstrate innovations in transportation services for welfare recipients and other low-income individuals.

Other Key Mobility Research

The FTA Fleet Operations program and Equipment and Infrastructure program advance the goal of mobility by using ITS concepts to make transit system operations more efficient and reliable. The FTA Specialized Customer Services program and Rural Transit Assistance Program address the mobility needs of underserved populations (the elderly and persons with disabilities) and underserved regions (rural regions) respectively. The Metropolitan/Rural Policy Development program enhances the local transit planning process through developing a better understanding of relationships between transit and land use planning, a better quantification of transit benefits, and more effective financing mechanisms for the expedited execution of planned transit system construction or expansion. This leads to enhanced mobility for transit users and potential transit users.

The FTA's Bus Rapid Transit (BRT) demonstration program is moving forward with the selection of ten demonstration sites and 17 program participants overall. The BRT will focus on technical assistance, and workshops on such topical issues as Intelligent Transportation Systems applications, vehicles and vehicle procurement, traffic engineering and infrastructure, land use and development and innovative financing. More emphasis and resources will be placed on data collection and evaluation of actual operating projects during FY 2001 and FY 2002. Technology transfer of lessons learned and professional development will dominate in the out years.

As in the case of the safety goal above, a number of multidisciplinary R&D support programs of FTA are linked to all the strategic goals, including mobility. These programs are Research and Technology Program Support; Performance and Review/Evaluation; Human Resources; Transit Cooperative Research Program (TCRP); National Transit Institute; and University Transportation Research.

The improved navigational aids developed through the USCG Waterways Safety Management and Aids to Navigation program promote greater mobility by enabling greater use of waterways.

R&D Supporting the Economic Growth and Trade Goal

Advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation.

Economic growth and trade reflects some of the most basic purposes of our transportation system. Beyond access and mobility, transportation is an enabler – a factor of production. One has only to look back at the historic role of canals, railroads, and the creation of the National Highway System to see the tremendous leveraging effects. On the other side of the

ledger, there are costs. These may be in terms of delay, fairness and equity, regulatory cost, or even the shocks to our economy associated with disruptions. The FY 2001 budget proposes $1.2 billion in direct programs to meet these challenges – about 19 percent more than 2000.

Economic Growth and Trade Emphasis Areas

Marine Transportation System (MTS)

The Marine Transportation System area is discussed under the Mobility goal.

Multi-modal Integration

The strategic goal is to advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation. The DOT seeks to enhance the movement of both goods and people as they use the Nation's transportation systems through the coordinated development and deployment of interoperable automated information systems and other technologies.

Intermodal connectors

The Intermodal Connectors area is discussed under the Mobility goal.

Corridors and Borders (FHWA)

The use of improved highway infrastructure initiatives and the deployment of Intelligent Transportation Systems (ITS) technology at international border crossings will contribute significantly to an efficient, effective transportation system and increase the global competitiveness of the United States. The Department and FHWA are working cooperatively with the appropriate Federal, state and local agencies involved in border-crossing processes to maximize the efficiency and effectiveness of infrastructure improvements and the deployment of ITS technologies. TEA-21 provides funding for priority corridors and border crossings that will be used for the development of increased vehicle inspection capacity and freight capacity projects such as improved rail and highway grade crossings and grade separations.

The International Border Clearance (IBC) Program will deploy Dedicated Short-Range Communication Technology (DSRC) including the International Border Crossing Safety System (IBCSS) at select border crossing sites in cooperation with the Treasury and Customs Service. This program works cooperatively with other Federal agencies to deploy ITS technology at international border crossings, and supports related initiatives of the states, insuring that the technology deployed is in full compliance with the ITS National Architecture.

Garrett A. Morgan Technology and Transportation Futures Program (DOT-wide)

The U.S. needs an educated, innovative, and highly skilled transportation workforce in the 21st century if it is to compete effectively in the global economy, and provide its people with

a safe, efficient transportation system. This future outcome can be achieved only by investing now in the people who will make up our future workforce, and in research programs that will develop the tools and techniques that the future transportation system will require.

DOT is working with the private sector, labor, and educational institutions, and is encouraging University Transportation Centers (UTCs), funded by DOT grants, to develop and implement focused transportation degree programs, and with schools at all levels to expand the information available to students about the potential for careers in transportation.

RSPA is managing 33 UTCs and helping to create a new University Marine Research (UMR) program for maritime research. The Centers will provide educational grants to students pursuing careers in transportation, will perform basic and applied research, will conduct outreach efforts for pre-college students and practitioners, and will report on performance indicators for the 1999-2000 academic year. The Garrett A. Morgan Technology and Transportation Futures Program also partners with the education, business, labor and non-profit communities to interest students of all ages in transportation careers and ensure they have the knowledge and skills for those careers.

Other Key Economic Growth and Trade Research

Working with partners in transportation-related industries and other branches of government, the Department aims to facilitate technology development, and support and harmonize international standards. This actively fosters the establishment of intelligent transportation standards and practices through partnerships with industry and other Federal, state, and international entities. Additional R&D areas include application of advanced industrial design, and environmentally friendly technology and manufacturing techniques in transportation-related industries in order to cut costs and improve product marketability.

The FTA Fleet Operations programs and Equipment and Infrastructure programs advance the goal of Economic Growth and Trade by improving the operational efficiency (and hence reducing the costs) of transit systems. The FTA Metropolitan/Rural Policy Development program supports the Economic Growth and Trade goal by strengthening the economic basis for transit infrastructure development and service expansion. The International Mass transportation program researches foreign technologies and operating procedures for application to the U.S. transit vehicle manufacturing, infrastructure construction, and system operation industries, to increase their international competitiveness. This program also explores opportunities for foreign contracts for U.S. transit business. In addition, the six multidisciplinary R&D and related support programs referred to earlier are linked to the Economic Growth and Trade goal as well.

The USCG Waterways Safety Management and Aids to Navigation program enhances Economic Growth and Trade through programs that make the use of waterways more efficient.

R&D Supporting the Human & Natural Environment Goal

Protect and enhance communities and the natural environment affected by transportation.

Transportation makes our communities more livable, enhancing the quality of our lives and our society. However, transportation generates undesired consequences too, such as pollution, noise, and the use of valuable land and fisheries. No matter how much is done to improve the capacity and efficiency of our transportation system, we can not consider our programs to be successful unless we also manage the effects on our environment, and ultimately our own health.

Human and Natural Environment Emphasis Areas

Advanced Vehicle Technology Program

Moving people and goods requires more than one-quarter of the total energy used in the U.S., and two-thirds of U.S. petroleum consumption. DOT is working to reduce transportation petroleum consumption by encouraging the use of fuel-efficient transportation. One aspect of this effort is supporting the development of fuel-efficient vehicles, as well as alternatives to petroleum fueled vehicles. RSPA is leading a public/private partnership to develop, demonstrate, and deploy advanced transportation technologies for medium- and heavy-duty vehicles through the Advanced Vehicle program. This program includes as partners other Federal agencies (e.g., Department of Defense, Department of Energy), private companies, research institutions, and state and local governments. The AVP focuses on all vehicles except passenger cars and light trucks, and thus complements the activities of the Partnership for a New Generation of Vehicles (PNGV). Other DOT administrations, principally FTA, are also involved, as well as seven regional consortia of state and local governments.

Sustainability (Center for Climate Change and Environmental Forecasting)

Transportation operations currently account for about one third of the carbon dioxide (CO_2) emissions, or 27% of greenhouse gas emissions, from human activity in the U.S. In response, DOT is organized a Center for Climate Change and Environmental Forecasting. The center will provide a standing analytical support capability for climate-related issues and other evolving cross-departmental environmental considerations. It will marshal the expertise resident in all the Department's modal administrations and be managed by an intermodal steering committee of high-level program managers, led by the Office of the Secretary. It will provide the base for coordinating and sharing research, evaluating strategies, developing policy, and fostering and demonstrating multi-modal approaches that will reduce greenhouse gases from the transportation sector.

New Technologies for Quieter Aircraft (FAA)

Public concern and sensitivity to aircraft noise around airports is high. In recent years, noise complaints have increased even while quieter aircraft technology has been introduced. This

aircraft noise is an undesired by-product of our mobility, and the government acts to reduce the public's exposure to unreasonable noise levels.

DOT is pursuing a program of aircraft noise control in cooperation with the aviation community through noise reduction at the source (development and adoption of quieter aircraft), soundproofing and buyouts of buildings near airports, operational flight control measures, and land use planning strategies. The FAA is continuing to develop noise research and assessment technologies, implement operational flight control measures to help reduce neighborhood exposure to aircraft noise, examine and validate methodologies used to assess aircraft noise exposure. In addition, FAA is engaged with NASA in joint noise reduction technology research. The research objective is to identify technological concepts to reduce community noise impact of future subsonic jet airplanes by half (7 to 10 decibels), relative to 1992 technology, by the year 2001.

Other Key Human and Natural Environment Research

The FTA Equipment and Infrastructure program includes a strong component of R&D on fuel-efficient, low-emissions transit vehicle technologies, thus advancing the Human and Natural Environment goal. The Metropolitan/Rural Policy Development and Planning program and the Project Development program address the Human and Natural Environment goal through better land use planning, better planning for meeting metropolitan air quality goals, and so on.

The USCG Marine Environmental Protection program addresses the strategic goal of Human and Natural Environment through its focus on preventing, and minimizing the impact of, spills of petroleum products and other hazardous materials in waterways.

The RSPA Office of Pipeline Safety (OPS) R&D program has clear environmental implications as well, because of the hazardous nature of most goods transported by pipeline. Similarly, the RSPA Office of Hazardous Materials (OHM) R&D programs on hazmat safety are clearly linked to the Human and Natural Environment goal.

R&D Supporting the National Security Goal

Advance the Nation's vital security interests in support of national strategies such as the National Security Strategy and National Drug Control Strategy by ensuring that the transportation system is secure and available for defense mobility and that our borders are safe from illegal intrusion.

Transportation provides the vital, strategic mobility of materials and forces in times of national emergency, contributing the Nation's security. The Department of Transportation provides unique resources in the Coast Guard for national defense. The transportation system, however, is also vulnerable to intentional harm, and our borders our vulnerable to intrusion through smuggling of contraband and illegal migrants. The DOT's objective is to advance the benefits of transportation to our national security while minimizing the vulnerability of our Nation to disruption, damage, or exploitation through the transportation system.

There is a wide range of potential targets as well. These range from people (operators and/or customers) to physical assets (bridges, terminals, control centers, rail track, radar sites, etc.), vehicles (aircraft, cars, trucks, rail cars, ships, etc.) and support infrastructures (electrical power, communications, information systems, etc.). The frequency, magnitude, and specific consequences of such events are highly variable and usually extremely difficult to predict with any certainty in either the medium or long term.

The owners and operators of transportation services have had a great deal of experience with preparing for, and dealing with, the consequences of natural disasters and human accidents. Rapid responses by the transportation sector to such events as Hurricane Andrew, the 1993 Midwest floods, the Northbridge earthquake, and most recently Hurricane Floyd demonstrate the flexibility required of the system.

In regard to deliberate human incidents, a recent analysis of the vulnerability of the U.S. surface transportation system (highway, rail, transit, maritime, and pipelines)[2] determined that the security and anti-terrorism profile of these modes was relatively low, especially when compared to the historical experience of commercial aviation. The substantial majority of major security and terrorist incidents in recent years have occurred in aviation. Therefore, the day-to-day security posture of aviation operations is substantially higher than for these other modes. This situation, however, leaves surface modes more vulnerable to potential attack than is the case in aviation. This vulnerability is further reinforced by the relatively open nature of the surface transportation environments due to their high volume of traffic and their physical extent.

Information and communications systems are essential to transportation, symbolizing strength but also increasing dependence and risk. Few surface transportation modes are as critically dependent on information and communications systems as the FAA's National Airspace System (NAS). Similarly, major pipelines rely on automated Supervisory Control and Data Acquisition (SCADA) systems to monitor pressure and temperature and regulate operations by remotely controlling valves and pumps. This situation will change in the future, however, as information technologies become increasingly embedded into transportation operations and management. For example, the implementation of Vessel Traffic Systems (VTS) in increasing numbers of major U.S. ports help to route merchant ships in harbor and dock areas. In its more advanced designs, the Intelligent Transportation System (ITS) concept for highways and transit relies on the extensive use of communications and information systems linking traffic counters, closed-circuit televisions, transit vehicles, emergency vehicle dispatching and variable message signs to Traffic Management Centers (TMCs). Thus, within five to ten years, the relative level of surface transportation 'cyber' vulnerabilities will rise substantially to approach the level of aviation.

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[2] U.S. Department of Transportation, Research and Special Programs Administration and Office of Intelligence and Security. *Surface Transportation Vulnerability Assessment.* Draft Final Report, April 1998.

In addition to this general cyber outlook, the recent report of the President's Commission on Critical Infrastructure Protection (PCCIP 1997) identified two specific information and communications vulnerabilities that represented serious potential vulnerabilities. These are: first, the proposed reliance on the Global Positioning System (GPS) as the single source of radio-navigation for aircraft landing guidance by 2010; and second, the proposed architecture for the FAA's modernized National Airspace System (NAS). In both cases, the Commission recommended extensive further study and analysis of the vulnerabilities identified in these proposals before they are implemented as planned.

The highway network is the most significant single surface mode, in terms of both volume and extent. The most vulnerable segments appear to be bridges and tunnels, due to their concentration of several routes at one point and the time and expense needed to replace or repair them. Fortunately, the extensiveness of this mode, with its four million miles of roads and hundreds of thousands of bridges, also creates a very resilient situation in which high-priority shipments can be more easily re-routed than would be possible in rail, maritime, or pipeline modes.

Since transit operations are focused in regions and isolated from each other, the impact of an incident would be limited geographically. In some cities, such as Chicago or New York City, such an incident may also disrupt passengers transiting from one connection or mode to another. In addition, the economic impacts of a sustained disruption of transit services in such a region could become significant.

National Security Emphasis Areas

Critical Infrastructure Protection (Transportation Infrastructure Assurance R&D)

The private sector or state and local agencies own and operate the majority of the Nation's transportation infrastructure. Achievement of this goal relies on increased coordination and cooperative partnerships with private industry and law enforcement, and the willingness of industry to adjust security procedures based on threat information provided by DOT. OST, USCG and RSPA will expand research on high priority critical infrastructure vulnerability areas, and further develop contingency plans. FAA will continue conducting security vulnerability and risk assessments of the air traffic control facilities, and implementing a National Airspace System Risk Management Program to determine the most cost effective way to protect its employees and critical infrastructure. FAA will also further develop information security plans to prevent penetration of information systems and corruption of air traffic and operational data. OST will continue development of the Infrastructure Assurance Training and Awareness Program; provide full-time liaison with the intelligence community; and upgrade and reconfigure its secure communications system.

Implement White House Commission on Aviation Safety/Security Recommendations

The U.S. and its citizens are often the targets for terrorist groups seeking to challenge power, or to influence international relations. Although the number of terrorist incidents or threats against aviation has been low, the potential losses associated with any such incident are unacceptable. Because terrorists seek to destroy public confidence in the safety of air travel,

the continued growth of commercial air transportation depends on the effectiveness of aviation security.

In addition to many operational and regulatory programs, FAA is expanding research and development to improve human factors and technology for detecting explosive devices and weapons and to decrease the vulnerability of airports and aircraft to security threats.

Other Key National Security Research

In other parts of the Department, the USCG Comprehensive Law Enforcement R&D program enhances national security through development of advanced technologies. These include items such as ultrasonic imaging sensors to non-invasively detect the presence of illegal drugs and other contraband, and acoustic detection systems to track suspect vessels.

Corporate Management Strategies

Six overarching Corporate Management Strategies (CMS) are the means whereby the Department of Transportation achieves the five strategic goals that comprise the *DOT Strategic Plan 1997-2002* (DOT 1997a). Of these, the CMS for *R&D Management* has the most profound effect on the achievement of strategic goals. The One-DOT CMS, by virtue of its enveloping approach, has both direct and indirect effects. To varying degrees, other CMS affect the conception, planning, and conduct of research and technology development activities, thus emphasizing the crosscutting nature of R&D and the breadth of organizational commitment needed to do the job well (see Table III-2). Since their inception, the DOT has enjoyed substantial success in the deployment of CMS in support of R&D.

Research and Development Management

The aim of this CMS is to advance transportation research and technology to shape a safe, fast, efficient, accessible and convenient transportation system for the 21st century through strategic planning, world class research, better exchange of information on useful technological innovations, partnerships, and research education and training.

Innovation is essential in achieving the Nation's near- and long-term transportation goals. The capacity to rapidly transform new technologies, concepts, and ideas into new products, processes and services is a top priority in both the private and public sectors. The public and private sectors recognize that sustaining an innovation climate into the 21st century requires:

- An educated and motivated workforce
- Investments in long-term enabling research
- Government-university-industry partnerships
- A supportive legal and regulatory framework
- A flexible manufacturing capacity
- Access to investment and venture capital
- An entrepreneurial culture
- Vital markets

Table III-2. Relationships between Corporate Management Strategies, Strategic Goals and R&D

Corporate Management Strategies	Strategic Goals				
	Safety	**Mobility**	**Economic Growth**	**Environ-ment**	**Security**
One DOT, Working Together	Direct and Indirect Effects	Direct and Indirect Effects	Direct and Indirect Effects	Direct and Indirect Effects	Direct and Indirect Effects
Human Resource Management	Indirect	Indirect	Indirect	Indirect	Indirect
Customer Service Management	Indirect	Indirect	Indirect	Indirect	Indirect
R&D Management	Direct	Direct	Direct	Direct	Direct
Information Technology Management	Indirect	Indirect	Indirect	Indirect	Indirect
Resource and Business Process Management	Indirect	Indirect	Indirect	Indirect	Indirect

More specific description of these elements are documented in the National Science and Technology Council (NSTC) *Transportation Science and Technology Strategy* (EOP NSTC 1999b) and related implementation plans, and the NSTC report *Public/Private Partnerships: Implications for Innovation in Transportation* (EOP NSTC 1998). The Department and the NSTC are applying these elements to transportation R&D through a peer-reviewed, government-wide strategic planning and management process. The process steers and guides government, industry and academic science and technology investments to address the Nation's transportation goals and create an innovation environment that accelerates new technologies, concepts and ideas into the transportation system. The preliminary elements of the process are in place and are enacted into law in TEA-21.

The Department's Research and Technology Coordinating Council in conjunction with the operating administrations and Secretarial offices have the responsibility for improving R&D management within the Department. Key 2001 milestones include:

- Update the DOT R&D Plan to ensure the Department's R&D activities support DOT strategic goals, foster innovation by encouraging world-class enabling research and workforce development, and address provisions of TEA-21 and FAA authorization.

- Provide decision makers with complete, accurate and timely information on the Department's R&D activities by deploying an initial operating capability for the DOT R&T tracking system.

Conduct an annual National Research Council peer review of the Department's R&D program to ensure a balanced portfolio that addresses the critical long-term needs of the Department and the Nation.

World-Class R&D Capability

The Department will ensure that in-house R&D organizations (see Box III-1) have world-class transportation R&D capability. Key 2001 milestones include an assessment of R&D organization performance relative to the FY 2000 baseline, using Malcolm Baldrige Quality Award Criteria, ISO 9000, or the Software Engineering Institute's Capability Maturity Model certification.

National R&T Partnership Initiative

The Department will develop and extend public-private partnerships to enable greater information diffusion, quicker product development, and faster rates of learning. The partnerships in the *Strategy* encourage companies, universities, and Federal, state, and local agencies to pool resources in pursuit of shared transportation goals and, hence, accelerate innovative solutions to the Nation's transportation needs.

Plans are underway to develop an action plan as part of the annual NSTC report, *Public/Private Partnerships: Implications for Innovation in Transportation.* This will identify ways to eliminate regulatory and legal barriers to innovation, and recommend "best practices" to accelerate the innovation process. The focus will be on the implementation of the *Partnership for the Advancement of Infrastructure and Its Renewal* – transportation that is identifying ways to bring innovation to the transportation construction industry.

Enabling Research

The DOT will advance the areas of enabling research identified in the NSTC National Transportation Strategic Research Plan, February 2000. Key 2001 milestones include:

- Leverage and focus ongoing long-term research activities in the Department and across the Federal government by bringing together the research and transportation communities to identify areas for collaboration. The Department has identified four top priorities for enabling research, which are crosscutting and require long-term efforts: Human Performance and Behavior, Advanced Materials, Nanotechnology, Energy Conversion and Storage, and Computer, Information, and Communication Systems.

- DOT will build on the work of the University Transportation Centers and other education and training activities to implement a departmental Transportation Research and Education Plan that will help develop a skilled and educated workforce necessary to plan, implement and operate the transportation systems of the 21st century (EOP NSTC 2000b). Key 2001 milestones are implementation of the DOT University Research and Education Plan, and serving as a resource for the Garrett A. Morgan Technology and Transportation Futures Program.

Box III-1. The DOT R&D Centers

Much of the Department's R&D takes place in its own research and technical facilities, thus it is important that these institutions reflect the highest standards of competence and ability. To achieve this goal, these institutions will be exploring a number of well-recognized quality programs to establish standards of excellence for themselves. Among these are: ISO 9000 certification, Malcolm Baldrige Award and President's Quality Award criteria, Capability Maturity Modeling (CMM), and benchmarking. The USDOT maintains seven in-house research centers. These are:

William J. Hughes Technical Center (WJHTC)
Atlantic City, NJ (FAA) The Technical Center is the national scientific test base for FAA research, development and acquisition programs. Center activities involve test and evaluation in air traffic control, communications, navigation, airports, aircraft and security. The Center consists of laboratories, test facilities, support facilities, and test aircraft.

Civil Aeromedical Institute (CAMI)
Oklahoma City, OK (FAA) The CAI provides research on the human factors of aviation safety. Scientists study aircraft crashes and perform forensic toxicology studies to identify causes and to develop ways to prevent accidents or make them more survivable. CAMI psychologists develop tests to assure the validity of air traffic controller selection and training methods. Researchers test the effects of medical conditions, medications, fatigue, age, work, and rest schedules on performance in air traffic and aircraft environments. CAMI specific research in accident mitigation includes occupant restraints and seats including child safety eats and in emergency cabin lighting and evacuation systems.

Transportation Technology Center, Inc. (TTC)
Pueblo, CO (FRA) TTC is a world-class railroad research and test center that offers a wide-range of capabilities including computers for simulations, laboratories, and test tracks. The center is owned by the Federal Railroad Administration and is operated for it under a care, custody and control contract by Transportation Technology Center, Inc., a wholly-owned subsidiary of the Association of American Railroads (AAR). The United States, Canadian, and Japanese governments and freight, intercity passenger, and commuter railroads and their suppliers use the facility to evaluate, under controlled conditions, the operation of conventional and advanced systems.

Turner Fairbanks Highway Research Center (TFHRC)
McLean, VA (FHWA) The TFHRC houses the FHWA's Research, Development, and Technology Service Business Unit. TFHRC provides advanced R&D related to new highway technologies. The research focuses on providing solutions to complex technical problems through the development of more economical, environmentally sensitive designs, more efficient, quality controlled constructions practices, and more durable materials. TFHRC has more than 40 laboratories conducting research in safety, intelligent systems, pavements, structures, and human factors.

U.S. Coast Guard Research and Development Center
Groton, CT (USCG) The R&D Center is the Coast Guard's sole facility performing research, development, test and evaluation (RDT&E) in support of the Coast Guard's major missions of Maritime Law Enforcement, Maritime Safety, Marine Environmental Protection and National Security. These efforts are broad and varied, and manifest themselves by supporting the acquisition and regulatory processes, and improving the efficiency and effectiveness of Coast Guard operations and resources.

Vehicle Research and Test Center (VRTC)
East Liberty, OH (NHTSA) The VRTC conducts research and vehicle testing in support of the agency's mission to save lives, prevent injuries, and reduce traffic-related health care and other economic costs. VRTC performs research in Crash Avoidance, Crash Worthiness, and Biomechanics. These R&D activities produce safer vehicles through improved vehicle performance, improved occupant protection systems, improved structural integrity of vehicles, increased understanding of driver behavior, and the use of intelligent systems to enhance drivers' ability to avoid crashes and travel safely.

Volpe National Transportation Systems Center (Volpe Center)
Cambridge, MA (RSPA) In support of DOT policy objectives, the Volpe Center anticipates future national, state, local, and international transportation and logistics issues and requirements, and responds to current needs and priorities in accordance with its role as the national center of transportation and logistics expertise. Its mission is to provide support for national transportation-related initiatives and acquisitions; anticipate and create awareness of national and international transportation trends and issues; serve as a bridge to industry, academia, and other Federal agencies; and enhance the Nation's capabilities to meet future transportation requirements.

Table III-3. Relationship of DOT Research Programs and Projects to DOT Strategic Goals, FY 2001						
Mode/Program/Project Title	**Relationship with DOT Strategic Goals**					
	Safety	**Mobility**	**Economic Growth & Trade**	**Human & Natural Environ-ment**	**National Security**	**CMS* (FHWA projects only)**
FHWA						
Structures						
Bridge inspection		S	S			
High performance materials		S	S			
Engineering applications		S	S			
Pavements						
Asphalt concrete pavements		S				
Portland cement concrete (PCC) pavements		S				
Long term pavement performance (LTPP)		S				
Pavement technology tools		S				
Recycled materials		S				
Asset Management						
Systems integration		S	S			
Management systems		S	S			
Network preservation		S	S			
Operations						
Operations-MUTCD, work zone ops., weather	W	S				
Freight management operations		S	S			
Surveillance equipment					S	
Policy						
Investment performance		S				
Value pricing		S				
Improving economic productivity			S			
Highway cost allocation			S			
Research cooperation with international			S			
Highway Performance Monitoring System						S
Travel and mobility						S
Fuels and finance						S
Federal Lands						
Advance materials/pavements		S				
High performance materials/bridge		S				
Reduce user delays	W	W	S	S		
Integration of AWIPS weather data	W				S	
Integration of road closure information	W				S	
Highway Safety						
Run-off road safety	S					
Pedestrian and bicycle safety	S					
Human centered technical support	S					
Safety management	S					
Speed management	S					
Work zones	S					
Designated problems-study adv. trauma plan	S					
Planning and Environment						
STECRP advisory board				S		
Real estate services				S		
Environment-air quality/climate, global change				S		
Planning-transportation and land use				S		
Agency-wide Initiatives						
R&T technical support -- TRB coop, report ctr., SBIR						S
International outreach						S
Advanced research – diagnostic methods						S
Resource centers						S
MIHE reserve						S

Table III-3. Relationship of DOT Research Programs and Projects to DOT Strategic Goals, FY 2001

Mode/Program/Project Title	Relationship with DOT Strategic Goals					
	Safety	Mobility	Economic Growth & Trade	Human & Natural Environ-ment	National Security	CMS* (FHWA projects only)
R&T strategic planning						S
RD&T computer support						S
Innovative financing						S
Knowledge management						S
Civil rights						S
ITS JPO						
ITS Research and Development						
Traffic management and control		S	S	S		
Intelligent vehicle research	S	W	W			
Rural research	S	S	S			
Advanced transit management		S				
Commercial vehicle operations	S		S			
Enabling research	S	S	S			
Intermodal freight research		W	S			
ITS Deployment Incentives	S	S	S			
ITS Deployment Incentives-metro/rural		S	S	S		
Commercial vehicle operations-deployment	S		S			
Hazardous materials monitoring systems	S			S		
Texas Transportation Institute	S	S				
FMCSA						
Crash causation and profiling	S					
Regulations and enforcement	S					
Driver related research and technology	S					
Hazmat safety & cargo tank integrity	S			S		
Commercial driver training and performance	S					
Physical qualifications	S					
Car-truck proximity	S					
R&T mgt., media and special projects	S					
FAA						
Air Traffic Services						
WJHTC technical labs	S	S	S			
Center for Advanced Aviation System Development	S	S	S			
Aviation weather analysis and forecasting	S	S	S			
Information systems security					S	
Advanced technology development and prototyping	S	S	S			
Airports						
Airport technology	S	S	S			
Aircraft safety						
Fire resistant materials/aircraft fire safety research	S					
Structural safety & advanced materials/structures	S					
Propulsion and fuel systems	S					
Flight safety/atmospheric hazards research	S					
Aging aircraft	S					
Aircraft catastrophic failure prevention research	S					
Aircraft safety risk analysis	S					
Security						
Explosive and weapons detection					S	
Security of civil aviation airports and air carriers					S	
Human systems integration					S	
Explosive/advanced threat vulnerability					S	

Table III-3. Relationship of DOT Research Programs and Projects to DOT Strategic Goals, FY 2001						
Mode/Program/Project Title	**Relationship with DOT Strategic Goals**					
	Safety	**Mobility**	**Economic Growth & Trade**	**Human & Natural Environ-ment**	**National Security**	**CMS* (FHWA projects only)**
Human Factors and Aviation Medicine						
Flightdeck/maintenance/system integration human	S					
Air traffic services human factors	S	S	S			
Aeromedical research	S					
Environment and Energy						
Environment and energy				S		
NHTSA						
Data analysis program	S					
Driver/vehicle performance	S					
National Automotive Sampling System (NASS)	S					
National Transportation Biomechanics Research	S					
Special Crash Investigations (SCI)	S					
Vehicle Research and Test Center	S					
Technology transfer	S					
Safety systems (crashworthiness)	S					
Fatality Analysis Reporting System (FARS)	S					
State data program	S					
Highway safety research	S					
Heavy vehicles	S					
Seat belt use and occupant protection (flagship)	S					
Partnership for a new generation of vehicles (PNGV) (flagship)	S			S		
FRA						
Locomotive safety	S					
Passenger car safety performance	S					
On-board monitoring systems	S					
Wayside monitoring systems	S					
Material and design improvements	S					
Train operations	S	W				
Yard and terminal	S					
Hazmat transportation safety	S			S		
Tank car structural integrity (Hazmat)	S					
Damage assessment, damage tolerance analysis & inspection (Hazmat)	S			W		
Grade crossings - human factors issues	S	W				
Material and rail inspection	S					
Track strength	S					
Vertical track support	S					
Bridge safety	S	W				
Track geometry	S					
Wheel/rail interaction	S					
Special trackwork	S					
Electrification safety	S					
Heavy axle load safety	S					
Vehicle/track interaction safety standards	S			W		
Advanced train control	S	W				
Grade crossing safety (infrastructure)	S	W				
Signal systems safety	S					
Grade crossing safety (equipment & operations)	S					
Performance-based regulations	S					
Accident avoidance (HSGT)	S	W				

Table III-3. Relationship of DOT Research Programs and Projects to DOT Strategic Goals, FY 2001

Mode/Program/Project Title	Relationship with DOT Strategic Goals					
	Safety	Mobility	Economic Growth & Trade	Human & Natural Environ-ment	National Security	CMS* (FHWA projects only)
Accident survivability (HSGT)	S	W				
Infrastructure (HSGT)	S	W				
Test support equipment for transportation technology center	S					
High-speed rail safety support	S	W	W			
Environmental impact analysis	S			S		
Track inspection research vehicle	S					
Transportation Technology Center	S					
USCG						
Waterways safety management and aids to	S	S	S	W	W	
Comprehensive law enforcement	W	W	W	W	S	
Marine safety research	S	W		S	W	
Marine environmental protection				S		
Improved search and rescue capability	S			W		
Technology investment	S	S	S	S	S	
FTA						
Safety and security	S				S	
Fleet operations		S	S			
Specialized customer services		S	W			
Research and technology program support	S	S	S	S	S	
Performance and review/evaluation	S	S	S	S	S	
International mass transportation			S			
Transit Cooperative Research Program (TCRP)	S	S	S	S	S	
National Transit Institute	S	S	S	S	S	
University transportation research	S	S	S	S	S	
Equipment and infrastructure		S	S	S		
Metropolitan/rural policy development		S	S	S		
Planning and project development		W	W	S		
Human resources	S	S	S	S	S	
Rural Transportation Assistance Program (RTAP)		S	W	W		
RSPA						
Pipeline Safety R&D						
Information systems	S	W	W	S		
Risk assessment	S	W	W	S		
Mapping	S	W	W	S		
Nondestructive evaluation	S	W	W	S		
Pipe location and monitoring technology	S	W	W	S		
Research and Technology						
R&D planning and management						
Advanced vehicle technologies (flagship)			S	S	W	
Human factors research program (flagship)	S			W	W	
Transportation Infrastructure Assurance R&D		W	W		S	
Response Management Support	S	S	S	S	W	
Hazardous Materials Safety						
Information systems	S		W	S		
Research and analysis	S	W	S	S	W	
Regulation compliance	S		W	S	W	
OST						
Services for persons with disabilities	S	S	S	S		

Table III-3. Relationship of DOT Research Programs and Projects to DOT Strategic Goals, FY 2001

Mode/Program/Project Title	Relationship with DOT Strategic Goals					
	Safety	Mobility	Economic Growth & Trade	Human & Natural Environ-ment	National Security	CMS* (FHWA projects only)
Safety and travel pattern analysis of U.S. motor carrier operations	S	S	S	W	W	
Mitigating environmental impacts	W	W	S	S	W	
Economic & international trade trends: implications for freight	S	S	S		S	
Improving ground access to airports	S	S	S	W	W	
DOT's transportation livability initiative	W	S	S	S		
Radionavigation and Positioning						
Preparation of the Federal Radionavigation Plan	S	S	S	S	S	
Technical support of GPS modernization	S	S	S	S	S	
GPS vulnerability study follow-on requirements	S	S	S	S	S	
Technical support of GPS spectrum protection &	S	S	S	S	S	
Aviation and International Policy	S	S	S		S	
Intermodalism Studies	S	S	S			
MARAD	Does not do R&D					
BTS	Does not do R&D					

Notes: S denotes a strong relationship, W denotes a weak relationship.

* The FHWA classifies some of its projects using CMS as a strategic goal. CMS refers to six strategies to achieve the other five goals. These strategies are: one-DOT; human resources; customer service; research and technology; information technology; and resource management.

Chapter IV
NSTC Partnership Initiatives

Partnerships are way for the Department of Transportation and other agencies to achieve strategic goals while avoiding possible duplication of their R&D efforts. They also economize on resources, speed up the innovation process, and establish a culture of cooperation that can have long-lasting benefits to the agencies and to society. Partnerships of both public and private sector participants are instruments that help ensure that higher-risk, higher-payoff projects are properly cultivated in the planning and budgeting process.

This chapter discusses the 13 partnership initiatives (see Table IV-1) described in the *Transportation Science and Technology Strategy* (EOP NSTC 1999a). Together with the Enabling Research areas presented later in this document, they comprise the R&D core of the *Strategy*. Several of the multidisciplinary R&D areas connect to multiple Strategic Partnership Initiatives, as discussed with reference to the strategic goals.

One of the tenets of the President's Committee of Advisors on Science and Technology is that the Nation can best profit from its investments in research through the exchange of people and ideas among Federal agencies, state and local governments, industry, academic institutions, private citizens, and other stakeholders. The NSTC's *National Transportation Science and Technology Strategy* identifies 13 technology partnerships that meet the criteria identified by the President's Committee: (1) they address recognized national needs; (2) they have a technology focus; (3) they could rely on the private sector for implementation; and (4) they require some Federal involvement.

Rather than formal research programs, the technology partnerships represent broad-based collaborative efforts in key technology areas. Samples of modal programs related to the 13 NSTC partnership initiatives are represented in Table IV-2. These partnerships vary in terms of their maturity, with some representing well-established R&D activities and others requiring further definition and interagency coordination. Yet, all of the partnerships focus on the innovation process: getting technology into the marketplace cheaper, faster, safer, and in an environmentally friendly way. The Department's role in these efforts includes strategic planning; reducing barriers; promoting national technical standards; fostering private sector investments; and stimulating creative financing for technology deployment.

This chapter concludes with a detailed list, by mode, of the Department's FY 2001 R&D programs expressed in terms of the partnerships (see Table IV-3 at the end of this chapter).

Table IV-1. Summary of the 13 NSTC Technology Partnerships

Title	Vision	Goals	Near-term Outcomes	Summary	Participants
1. Aviation Safety Research Alliance	An even safer aviation system that accommodates continued growth in air traffic while experiencing fewer aircraft accidents and related fatalities.	Identify methods that, when implemented, would reduce the fatal aviation accident rate by 80 percent by 2007, as compared to the 1990-1996 baseline.	Reduce the fatal aviation accident rate for commercial air carriers from a 1994-1996 baseline of 0.037 fatal accidents per 100,000 flight hours to 0.032 per 100,000 flight hours in 2001 and .0074 by 2007. Reduce the general aviation fatal accident rate from a 1994-1996 average of 1.67 fatal accidents per 100,000 flight hours. By 2001, reduce the 1997 baseline of 318 runway incursions to 241 incursions.	This effort addresses the need to reduce the aviation accident rate as air traffic doubles over the next decade, as called for by the White House Commission on Aviation Safety and Security. Together with other partners, the FAA, NASA, and DOD will accomplish this through a coordinated program to (1) further define the safety goal; (2) identify focus areas; (3) agree on intervention strategies; and (4) commit to mutual action plans.	Federal: FAA, NASA, DOD (lead agencies); DOE; NIST; NSF; NWS; U.S. Bureau of Mines. Other: United Nations/International Civil Aviation Organization, aircraft and avionics manufacturers, airlines, aviation organizations, universities.
2. Next Generation Global Air Transportation	A safer, more efficient, environmentally compatible, and sustainable airspace system that meets future needs for global air transportation.	Achieve a global air transportation system that supports "free flight" and similar concepts and that (1) assures the most effective use of present and future air system capacity and (2) assures system capacity is devoted to meeting the highest priority needs for it.	Reduce the rate of air travel delays from a 1994-1998 baseline of 181 delays per 100,000 activities to 161 per 100,000 activities in 2001. Increase the number of flight segments that aircraft are able to fly off ATC-preferred routes from 75 percent in 1996 to 80 percent in 2001. By 2001, reduce the 1997 baseline of 318 runway incursions to 241 incursions.	Anticipating the future growth in air traffic, this partnership addresses the near- and long-term modernization and evolution of the NAS to assure that it continues to meet users' needs. Including both the enabling technology and associated operational practices, modernization will (1) provide new systems to enhance capabilities and services and (2) make the critical infrastructure for ATC services far easier and more cost-effective to operate and maintain.	Federal: FAA, NASA (lead agencies); DOD; NSF; NWS; USCG. Other: Airlines, aircraft and avionics industries, airport authorities, academia, International Civil Aviation Organization.
3. Next Generation Transportation Vehicles	A far more sustainable transportation system with fewer harmful environmental impacts and reduced dependence on fossil fuels.	Develop internationally competitive, domestically produced transportation vehicles that achieve unprecedented gains in fuel efficiency and in both environmental and operational performance, including reduced greenhouse gas emissions.	By 2001, reduce on-road mobile source emissions to a target level of 61.4 million tons as compared to the 1996 baseline of 65.9 million tons. Reduce greenhouse gas emissions from transportation in the United States. Reduce the Nation's vulnerability to oil price shocks by reducing transportation energy consumption as a function of gross domestic product.	This partnership addresses the problems of petroleum dependence, global warming, and pollution through research leading to the development of highway vehicles, ships, locomotives, and aerospace vehicles that are better designed and more efficient. It has four thrusts: (1) continue the PNGV and Advanced Technology Transit Bus activities and supplement them by also focusing on medium and heavy-duty vehicles; (2) demonstrate and develop the marine application of fuel cells; (3) support the development, test, and demonstration of non-electric high-speed rail technology; and (4) develop and demonstrate the next generation of aerospace vehicles, including aircraft with more efficient and cleaner engines.	Federal: DOT (FAA, FHWA, FRA, FTA, MARAD, RSPA, USCG); DOD (Army, Navy, DARPA); DOC; DOE; and NASA (all lead agencies); also EPA and NSF. Other: Vehicle, engine, and fuel-cell manufacturers; aircraft manufacturers; fuel producers; component suppliers; developers of fuel cells and other new energy-conversion technologies; shipyards; state and local authorities; universities.

Table IV-1. Summary of the 13 NSTC Technology Partnerships

Title	Vision	Goals	Near-term Outcomes	Summary	Participants
4. National Intelligent Transportation Infrastructure	A truly seamless intermodal surface transportation system that accommodates private, public, and commercial vehicles; permits increasing communication and cooperation between infrastructure and vehicles; and utilizes relevant communication and information technologies to promote access and commerce.	Make the most effective use of the existing transportation system; reduce costs of operating and using the surface transportation system; reduce travel time for all system users; increase productivity and improve customer service for highway and transit users; provide accurate system information to enable more effective transportation planning, operating policies, and pricing/control strategies; reduce traffic crashes and fatalities; and permit experimentation with, and demonstration of, policy-sensitive traffic control strategies.	By 2001, reduce delays on Federal-aid highways to 8.9 hours of delay per 1,000 vehicle-miles traveled, from the 1996 level of 9.2 hours. Integrate intelligent transportation systems in 75 of the largest metropolitan areas by 2005. For 2001, the target is 56 areas compared to a 1997 baseline of 34 areas.	The NITI refers to the integrated electronics, communications, and hardware and software elements that can support intelligent transportation systems (ITS). A communication and information "backbone," the NITI will enable ITS products and services to work together to save time and lives. It will allow surface transportation to be managed as a seamless entity by integrating transportation and management information systems and will provide the data needed for more effective transportation planning. This effort is closely related to the Intelligent Vehicle Initiative (IVI), described below.	Federal: DOT (ITS Joint Program Office lead agency, FHWA, FRA, FTA, MARAD, USCG); DOD (USACE); DOJ (INS); Treasury (Customs); NSF; USDA. Other: state DOTs, MPOs, emergency response and law enforcement agencies, railroads, trucking companies, information systems vendors and manufacturers, ITS Service Centers.
5. Intelligent Vehicle Initiative	A roadway system where Americans operate in a significantly safer environment and enjoy greater mobility and efficiency, while enhancing and preserving the environment and character of the communities it serves.	Reduce the number of highway crashes and pedestrian casualties and the resulting injuries and fatalities; improve the effectiveness of intelligent systems to assure safe vehicle operation.	Reduce the rate of highway-related fatalities per 100 million vehicle-miles traveled from 1.7 in 1996 to 1.5 in 2001. Reduce the rate for injuries from 141 in 1996 to 113 per 100 million vehicle-miles traveled in 2001.	The IVI is a government-industry program to accelerate the development and commercialization of safety- and mobility-enhancing driver-assistance systems. Overall emphasis of the IVI is on four areas: (1) research and evaluation of the costs and benefits of IVI products; (2) development of industry-wide standards; (3) system prototyping; and (4) field test evaluations of the most promising products.	Federal: DOT (ITS Joint Program Office lead agency, FHWA, FTA, NHTSA, RSPA/ Volpe Center); DOD (TARDEC); NSF. Other: Motor vehicle and trucking industries, fleet operators, state and local transportation and law enforcement agencies, emergency response organizations, universities and other research organizations, professional societies.

Table IV-1. Summary of the 13 NSTC Technology Partnerships

Title	Vision	Goals	Near-term Outcomes	Summary	Participants
6. Transportation and Sustainable Communities	A transportation system that meets the needs for mobility and accessibility while balancing the current and long-term goals of economic growth, environmental quality, and social equity.	Integrate and coordinate existing research agendas to minimize duplication and research gaps while optimizing support for a sustainable transportation system; develop improved technical tools and models to analyze the impacts of transportation activities on both the natural and the social environment.	By 2001, reduce on-road mobile source emissions to a target level of 62.2 million tons as compared to the 1998 level of 63.7 million tons. Reduce carbon-equivalent emissions from transportation sources. By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent. Minimize the adverse impacts of transportation projects on wetlands and replace at least 1.5 acres of wetlands for every 1 acre affected where impacts are unavoidable.	This partnership explores how sustainable transportation and land use can help to achieve a balance among the often conflicting goals of economic growth, environmental quality, and sustainability. It furthers Federal agencies' efforts to work with each other and with other levels of government, the private sector, and the public to expand understanding of the consequences of transportation choices; develop better forecasting, planning, and assessment tools; conduct technology research; and develop sustainable community and transportation initiatives.	Federal: DOD (USACE); DOE; DOT (Office of the Secretary, BTS, FAA, FHWA, FRA, FTA, RSPA); EPA; HHS (CDC); HUD; Interior (National Parks Service); OMB all lead agencies. Other: state and local transportation and environmental agencies and organizations; public health agencies; MPOs; mayoral offices; environmental advocates; environmental technology manufacturers and vendors; transportation system design, engineering, and construction firms; materials manufacturers; vehicle and fuel manufacturers; universities.
7. Transportation Infrastructure Assurance	A transportation infrastructure that is secure from acts of terrorism and crime and that adapts rapidly to natural or intentional disruptions.	Develop a comprehensive approach to assessing threats to the security of transportation's physical and information infrastructure and to implementing integrated security technologies and procedures tailored to these threats.	Increase the detection of explosive devices and weapons that may be brought aboard aircraft. Get threat information to those who need to act within 24 hours, at least 90 percent of the time.	This partnership is developing and implementing measures to improve the security of transportation information systems, passenger and freight terminals, and other infrastructure, as well as of the people and cargo using or transiting them. At a minimum, it addresses (1) the physical security of transportation terminals; (2) the security of vital communication and information systems; and (3) the development and dissemination of information about security incidents and assessments of threats to transportation facilities and operations.	Federal: DOT (FAA, FHWA, FRA, FTA, ITS Joint Program Office, MARAD, RSPA, USCG); DOD; DOJ (FBI, INS, NIJ); NSF; Treasury (U.S. Customs) all lead agencies. Other: State and local law enforcement agencies; port and airport authorities; transportation service providers (airlines, bus lines, transit agencies, trucking companies, ship lines, railroads, parcel and freight companies).

Table IV-1. Summary of the 13 NSTC Technology Partnerships

Title	Vision	Goals	Near-term Outcomes	Summary	Participants
8. Enhanced Goods and Freight Movement at Domestic and International Gateways	A more productive national economy afforded by a more flexible, efficient, and seamless freight transportation system.	Improve freight mobility at the Nation's land borders and ports; ensure diffusion of existing freight information technologies and networks; expedite the global flow of goods.	Reduce the percentage of ports reporting landside impediments to the flow of commerce from 40 percent in 1999 to 37 percent in 2001.	Building on earlier investments in technology, port infrastructure, and freight terminals, this partnership facilitates intermodal freight applications of advanced information technologies. Major efforts focus on technology demonstrations and deployment of innovative logistics practices at our Nation's land border crossings, ports, and key freight corridors. Another element addresses the mitigation of community impacts resulting from rapid growth of freight movement in certain corridors and terminal locations.	Federal: DOT (ITS Joint Program Office and Secretary's Office of Intermodalism lead agencies, FAA, FHWA, FRA, MARAD, RSPA, USCG); DOC; DOD (MTMC); DOE; DOJ (INS); EPA; State; Treasury (U.S. Customs); USDA. Other: National governments and international societies; state and local agencies; port and airport authorities; industry (air cargo companies, trucking companies, ship operators, railroads, parcel and freight companies, equipment manufacturers, vehicle manufacturers).
9. Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure	A self-sustaining, environmentally compatible transportation infrastructure that is durable and efficient and that requires fewer human, economic, and environmental resources to produce, operate, and maintain.	Accelerate the comprehensive repair, renewal, and advancement of the Nation's aging transportation infrastructure using stronger, cheaper, and environmentally superior materials and more cost-effective program delivery and management systems; reduce waste, pollution, and emissions generated in the production of infrastructure materials.	Increase the percentage of miles on the National Highway System that meet pavement performance standards for acceptable ride quality from 91.8 percent in 1998 to 91.9 percent in 2001. Reduce the percentage of bridges on the National Highway System that are deficient from 22.7 percent[1] in 1999 to 22.3 percent in 2001. Maintain in good or fair condition at least 93 percent of runways at all commercial service airports and reliever airports, as well as selected general aviation airports.	This partnership represents the transportation component of the Partnership for the Advancement of Infrastructure and its Renewal (PAIR), an umbrella initiative for existing government, private sector, and university infrastructure, building, and construction programs. Called PAIR-T, it seeks to create an environment that fosters an unprecedented level of collaboration and synergy on transportation research and development, demonstration, testing, evaluation, and technology transfer to state and local institutions. A major focus is the reduction of non-technical barriers that impede the introduction of innovative products and processes into the marketplace. PAIR-T partners are collaborating on (1) identifying barriers to deploying innovative infrastructure renewal technologies; (2) removing these barriers; and (3) accelerating market acceptance of infrastructure products.	Federal: DOT (FHWA and RSPA lead agencies, FAA, FRA, FTA, MARAD, USCG); DOD (USACE); DOC (NIST); NSF. Other: CERF; AASHTO; CIRT; state DOTs and other state and local agencies; chemical, automotive, and material manufacturers; commercial freight, air transport, and insurance industries; infrastructure construction, planning, and management firms; communications, water, gas, and electric utilities; University Transportation Centers and other universities; Transportation Research Board; industry and trade associations.

Table IV-1. Summary of the 13 NSTC Technology Partnerships

Title	Vision	Goals	Near-term Outcomes	Summary	Participants
10. Maritime Safety Research Alliance	A maritime transportation system that is the world's safest and most cost-effective.	Reduce collisions; deaths and injuries from maritime casualties; and the risk of passenger vessel casualties with major loss of life.	Reduce the number of high-risk passenger vessel casualties to 52 per 1,000 vessels in 2001; the overall target is a 10 percent reduction over the period 1999–2003. Reduce the number of collisions, allisions, and groundings from 1,377[1] in 1999 to 1,199 in 2001. Reduce recreational boating fatalities from 773[3] fatalities in 1999 to 749 in 2001.	This partnership supports this vision through a broad safety research alliance among Federal agencies, state and local authorities, and private interests. It addresses three critical safety areas: human factors, vessel technology, and information systems. Efforts build on existing safety research partnerships, including DOT's MTS initiative, the Coast Guard's Prevention Through People Program, and the work of the United States Ship Structures Committee.	Federal: DOT (MARAD, USCG) and DOD (MTMC, Navy, USACE) all lead agencies. Other: Port authorities and other state and local authorities, the maritime industry, the intermodal industry, vessel manufacturers, shipyards and repair facilities, universities.
11. Next-Generation Space Transportation Technologies	Realization of the full potential for commerce, technology, and exploration in space.	Research, develop, verify, and transfer advanced aeronautics, space, and related technologies to support revolutionary space vehicles, launch systems, and operations.	Continue vehicle assembly of the X-33, a half-scale technology demonstrator of a full-scale, commercially developed reusable launch vehicle (RLV), in preparation for flight-testing. Complete vehicle assembly and begin flight-testing of the X-34, which will demonstrate technologies necessary for an RLV but will not be a commercially viable vehicle itself. Proceed with assembly and flight test plans for the X-37, the first-ever orbital experimental space transportation demonstrator, which will play a major role in developing systems for a second generation RLV.	Technologies that make space more accessible and cost-effective will strengthen existing aerospace companies and foster new space-based industries; improve our stewardship of the environment; and enhance our competitive position in the world marketplace. Involving NASA, the FAA, and industry, this partnership will develop and demonstrate technology that supports full-scale, highly competitive reusable space launchers and related spaceport infrastructure. These technologies will make possible new space transportation systems with orders of magnitude improvements in safety, cost, reliability, and environmental impacts.	Federal: FAA, NASA (lead agencies); DOD; NSF. Other: state authorities, U.S. commercial space launch providers, launch site operators, and satellite manufacturers and owners.

Table IV-1. Summary of the 13 NSTC Technology Partnerships

Title	Vision	Goals	Near-term Outcomes	Summary	Participants
12. Accessibility for Aging and Transportation Disadvantaged Populations	A transportation system that meets the mobility and accessibility needs of the elderly, the poor, persons with disabilities, and all other Americans without access to a private automobile.	Create model alternative transportation systems that serve the needs of the elderly and transportation-disadvantaged people while taking full advantage of existing services, resources, and development patterns; promote development of transit compatible communities that integrate transit and pedestrian services for all users; provide opportunities for employing welfare recipients by preserving communities and enhancing transit.	By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent. Increase the percentage of key rail stations that are in compliance with the Americans With Disabilities Act (ADA) from 49 percent in 1999 to 58 percent in 2001. Increase the percentage of bus fleets that are ADA-compliant from 77 percent in 1999 to 83 percent in 2001. Increase the number of employment sites that are made accessible by Job Access and Reverse Commute transportation services; the goal for 2001 is 8,050 sites compared to 1,692 sites[3] in 1999. Increase transit ridership from 43.10 billion passenger-miles in 1999 to 43.97 billion in 2001.	By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent. Increase the percentage of key rail stations that are in compliance with the Americans With Disabilities Act (ADA) from 49 percent in 1999 to 58 percent in 2001. Increase the percentage of bus fleets that are ADA-compliant from 77 percent in 1999 to 83 percent in 2001. Increase the number of employment sites that are made accessible by Job Access and Reverse Commute transportation services; the goal for 2001 is 8,050 sites compared to 1,692 sites* in 1999. Increase transit ridership from 43.10 billion passenger miles in 1999 to 43.97 billion in 2001.	Federal: DOT (FTA lead agency, Office of the Secretary, FHWA, NHTSA, ITS Joint Program Office, RSPA); DOL; EPA; HHS (AOA, CDC, NIA); HUD. Other: state, local, and tribal agencies; MPOs; Area Agencies on Aging; housing authorities; associations; the private sector (information and communication system vendors, transit providers, employers); nongovernmental organizations; foundations (AAA Foundation for Traffic Safety, Easter Seals, Eno Transportation Foundation); and universities.
13. Enhanced Transportation Weather Services	A transportation system that is significantly safer, with far greater capacity and efficiency, by reducing the impacts of adverse weather.	Develop seamless, cost-effective transportation weather information systems.	By 2001, reduce the rate of highway-related fatalities to 1.5 per 100 million vehicle-miles traveled.[2] Reduce the rate of highway-related injuries from 119[3] in 1999 to 113 per 100 million vehicle-miles traveled in 2001. Reduce the fatal aviation accident rate for commercial air carriers from 0.040[2] fatal accidents per 100,000 flight hours in 1999 to 0.031 per 100,000 flight hours in 2001. Increase the number of runways that are accessible in low-visibility conditions from 1,084 runways in 1999 to 1,191 in 2001.	This partnership addresses the problems associated with adverse weather through the development of comprehensive weather information systems. One element, known as Foretell, makes use of state-of-the-art weather radars, observing systems, and forecasting methods to demonstrate and evaluate an integrated weather information system, first within a "pilot" Midwestern region and eventually throughout North America. A second component is the Aviation Weather Research Program, which will improve access to and delivery of aviation weather information and reduce the consequences of weather events by generating weather observations, warnings, and forecasts with higher resolution and greater accuracy.	Federal: DOT (ITS Joint Program Office, FAA, FHWA, FRA, FTA, RSPA, USCG lead agencies); DOD (USACE); FEMA; NWS; OFCM; USWRP. Other: Iowa DOT and other state DOTs, NCAR, MIT/Lincoln Laboratories, Forecast Systems Laboratory, National Severe Storms Laboratory, Environment Technology Laboratory, Cold Regions Research and Engineering Laboratory, Environment Canada, weather technology manufacturers and integrators, vehicle suppliers, ITS Service Centers, aviation industry, academia.

[1] 1999 preliminary data

[2] Preliminary estimates show this rate was achieved in 1999. If final 1999 data confirm this, the outcome goal may be adjusted downward.

[3] 1999 preliminary estimate

Table IV-2. Relationship Among Technology Partnerships, DOT Strategic Goals, and Related R&D Programs

Partnership	Primary DOT Strategic Goal(s)	Related DOT R&D Programs
Aviation Safety Research Alliance	*Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.	Aeromedical Research (FAA). Aging Aircraft (FAA, NASA, DOD). Aircraft Catastrophic Failure Prevention Research (FAA). Airport Safety Technology (FAA). Airport Systems (FAA). Aviation Performance Measuring System (FAA, NASA). Aviation Safety and Risk Analysis (FAA). Aviation Safety Reporting System (FAA, NASA). Aviation Weather Research Program (FAA). Fire Safety (FAA, NASA). Flight Deck Human Factors (FAA, NASA, DOD). Flight Safety and Atmospheric Hazards (FAA, NASA). Global Analysis Information System (FAA, NASA). Post-Crash Response (FAA, NASA). Propulsion and Fuel Systems (FAA). Structural Crashworthiness (FAA, NASA).
Next Generation Global Air Transportation	*Mobility:* Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of service. *Economic Growth and Trade:* Advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation.	Aviation Weather Research Program (FAA). Center for Advanced Aviation System Development (FAA). Free Flight Phase 1 (FAA, NASA). NAS Architecture (FAA). Safe Flight 21 (FAA).

Table IV-2. (cont.) Relationship Among Technology Partnerships, DOT Strategic Goals, and Related R&D Programs

Partnership	Primary DOT Strategic Goal(s)	Related DOT R&D Programs
Next Generation Transportation Vehicles	*Human and Natural Environment:* Protect and enhance communities and the natural environment affected by transportation. *Economic Growth and Trade:* Advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation.	Advanced Bus Propulsion Systems (FTA). Advanced Vehicle Technology Program (RSPA, FHWA). Electric Vehicle R&D (FTA, DOE). Fuel Cell R&D (FTA, DOE). Heavy Vehicles (NHTSA). Interagency Ship Structure Committee (MARAD, USCG). Motor Carrier Research (FMCSA). New Bus Vehicles and Infrastructure (FTA). Next Generation High-Speed Rail (FRA). Noise Reduction (FAA, NASA). Partnership for a New Generation of Vehicles (NHTSA, DOC, DOE). Propulsion Emissions Reduction and Propulsion Engine Systems (FAA, NASA). Safety of High-Speed Ground Transportation (FRA). Safety Systems (NHTSA). Shipyard Revitalization (MARAD).
National Intelligent Transportation Infrastructure	*Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage. *Mobility:* Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of service.	ITS Architecture and Standards (FHWA, FTA). ITS Deployment Incentives Program (FHWA). ITS Mainstreaming (FHWA, FTA). ITS Program Support (FHWA). Nationwide Differential GPS (FHWA, FRA, USCG).

Table IV-2. (cont.) Relationship Among Technology Partnerships, DOT Strategic Goals, and Related R&D Programs

Partnership	Primary DOT Strategic Goal(s)	Related DOT R&D Programs
Intelligent Vehicle Initiative	*Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage. *Mobility:* Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of service.	Advanced Public Transit Systems (FTA). Automated Vehicle Control and Information Systems (FHWA). Driver/Vehicle Performance (NHTSA). Motor Carrier Research (FMCSA).
Transportation and Sustainable Communities	*Human and Natural Environment:* Protect and enhance communities and the natural environment affected by transportation.	Environmental Justice (FHWA, FRA, FTA). Environmental Research (FHWA). Evaluation of MOBILE Emissions Factor Model (FHWA, EPA). Livable Communities (FTA). Metropolitan & Rural Policy Development (FTA). Policy Research (FHWA, FTA). Right-of-Way Research (FHWA). TEA-21 Metropolitan and Statewide Planning (FHWA). Transportation and Community and System Preservation Pilot Program (FHWA). Transportation Planning Research (FHWA). Travel Demand Forecasting (FHWA, FTA, EPA). Travel Model Improvement Program (FHWA, FTA, EPA).
Transportation Infrastructure Assurance	*National Security:* Advance the nation's vital security interests by ensuring that the transportation system is secure and available for defense mobility and that our borders are safe from illegal intrusion.	Aircraft Hardening (FAA). Airport Security Technology Integration (FAA). Aviation Security Human Factors (FAA). Explosives and Weapons Detection (FAA). Safety and Security (FTA).

Table IV-2. (cont.) Relationship Among Technology Partnerships, DOT Strategic Goals, and Related R&D Programs

Partnership	Primary DOT Strategic Goal(s)	Related DOT R&D Programs
Enhanced Goods and Freight Movement at Domestic and International Gateways	*Economic Growth and Trade:* Advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation. *Mobility:* Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of service.	Cargo Handling Cooperative Program (MARAD). Commercial Vehicle Operations (FHWA). Coordinated Border Infrastructure Program (FHWA). Industry Competitiveness (MARAD). Intermodal Development (MARAD). National Corridor Planning and Development Program (FHWA). Ship Operations Cooperative Program (MARAD).
Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure	*Mobility:* Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offers flexibility of service. *Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.	Airport Pavement Technology (FAA). Applied Research and Technology (FHWA). Communication-based Train Control (FTA). Highway Innovative Technology Evaluation Center (FHWA). Local Technical Assistance Program (FHWA). Pavement Research (FHWA). Seismic Research and Development Program (FHWA). State Planning and Research Program (FHWA). Strategic Highway Research Program (FHWA). Structures Research Program (FHWA). Technology Assessment and Deployment (FHWA). Track, Structures, and Train Control (FRA). Transit Cooperative Research Program (FTA). Turnkey Demonstration Program (FTA).

Table IV-2. (cont.) Relationship Among Technology Partnerships, DOT Strategic Goals, and Related R&D Programs

Partnership	Primary DOT Strategic Goal(s)	Related DOT R&D Programs
Maritime Safety Research Alliance	*Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.	Intermodal Development (MARAD). Marine Safety (USCG). Maritime Safety (MARAD). Prevention Through People (USCG). Servicewide Safety and Environmental Compliance (USCG). Ship Structures Cooperative Research Program (MARAD, USCG, Navy). Shipyard Revitalization (MARAD). Waterways Safety and Management (USCG).
Space Transportation Technologies	*Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage. *Economic Growth and Trade:* Advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation.	Commercial Space Transportation (FAA).
Accessibility for Aging and Transportation-Disadvantaged Populations	*Mobility:* Shape America's future by ensuring a transportation system that is accessible, integrated, efficient, and offer flexibility of service.	Advanced Public Transit Systems (FTA). Advanced Rural Transportation Systems (FHWA, FTA) Autonomous Dial-a-Ride Transit (FTA). Bus Rapid Transit (FTA). Highway Safety Research (NHTSA). Metropolitan and Rural Policy Development (FTA). Project Action (FTA). Rural Transit Assistance Program (FTA). Transit Cooperative Research Program (FTA). Transportation and Community and System Preservation Pilot Program (FHWA).
Enhanced Transportation Weather Services	*Safety:* Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.	Aviation Weather Research Program (FAA). Strategic Highway Research Program (FHWA). Weather Information for Surface Transportation (FHWA).

Description of the NSTC Partnerships

Aviation Safety Research Alliance

This initiative addresses the need to reduce the aviation accident rate as air traffic doubles over the next decade, as called for by the White House Commission on Aviation Safety and Security. Together with other partners, the FAA, NASA, and DoD will accomplish this through a coordinated program to (1) identify and conduct the research needed to meet the safety goal and (2) work with industry to deploy research results in the form of new safety technologies. (Additional information about partnership activities involving the FAA is shown in Box IV-1.)

Next Generation Global Air Transportation

Anticipating the future growth in air traffic, this government-industry partnership is developing the communication, navigation, and surveillance and air traffic management systems required to make "free flight" a reality. "Free flight" refers to an airspace system that greatly increases user flexibility to plan and fly preferred routes, saving both fuel and time and affording more efficient use of air space. This activity essentially transfers the free flight concept to an operational setting prior to full deployment.

RSPA's Human Factors Research Program also is an essential part of the Aviation Safety Research Alliance. As mentioned earlier, human errors are the leading cause of aviation fatalities, injuries, and accidents. This program is of vital importance for the Next Generation Global Air Transportation partnership, which aims at incorporating advanced operating concepts such as free flight into the air traffic system. The successful and safe implementation of free flight requires the highest standards of human performance, both on the part of pilots and on the part of air traffic controllers.

Next Generation Transportation Vehicles

This partnership addresses the problems of petroleum dependence, global warming, and pollution through research leading to the development of highway vehicles, locomotives, and ships that are better designed and more efficient. It has three major thrusts: (1) continue the PNGV and Advanced Technology Transit Bus (ATTB) activities and supplement them by also focusing on improvements in medium- and heavy-duty-vehicle fuel efficiency; (2) support the development, test, and demonstration of non-electric high-speed rail technology; and (3) demonstrate and develop the marine application of fuel cells.

- The FTA Equipment and Infrastructure program includes R&D for transit vehicles with advanced propulsion systems. The USCG Technology Investment program includes development of a fuel cell power plant for the Coast Guard's own use – an activity that is also linked to this partnership initiative.

- The USCG Technology Investment program includes development of a fuel cell power plant for the Coast Guard's own use – an activity that is clearly linked to this partnership. The partnership is also coincident with the Advanced Vehicle Technologies Partnership led by RSPA.

Box IV-1. Note on FAA Partnerships

The FAA's human factors R&D partnership programs are linked to those of NASA, DOD, and the NTSB. Programs with NASA include cockpit automation, fatigue, crew resource utilization, team decision-making, free flight, air-ground communication, and a five-year integrated safety research plan. DOD joint efforts involve fatigue, team performance, decision-making, and controller performance research with the USAF. The efforts with the NTSB include fatigue, flight deck automation, and error mitigation. Evaluations of controller applicant selection are shared with Eurocontrol countries. The FAA's Human Factors Office has grants with universities to support R&D on air carrier training, flight deck automation, human performance integrity, and aviation maintenance technician training. It has R&D efforts with the U.S. Navy to develop enhanced teamwork in flight deck crews and air traffic control teams. Elements of the Office's R&D on controller performance are conducted in concert with the U.S. Air Force, and collaborative research in shift work and fatigue is conducted with the U.S. Coast Guard.

The FAA's Office of Aviation Medicine cooperates with the manufacturers of safety products (e.g., seats, restraint systems, oxygen masks, and evacuation slides). It collaborates with the military to study crashworthiness and eye injury from lasers. It collaborates with the National Institute of Safety and Health to address R&D for the cabin environment and flight attendant and passenger symptomatology and diseases. It also works with industry to address cabin air quality status.

The FAA and many other governmental agencies have established a Federal Interagency Committee on aviation noise. The Committee conducts public forums in different geographical regions, soliciting input on aviation noise impacts with the intent to better align research with the public's concerns.

The FAA's Airport Technology Program has established research partnerships with the following organizations:

1. The U.S. Army on pavements,
2. The University of Illinois and Northwestern University on pavements,
3. The U.S. Air Force on aircraft rescue and fire fighting,
4. Canada on pavements,
5. NASA on runway traction research.

The FAA has established many partnerships with academia, industry, government labs, and state organizations in an Airworthiness Center of Excellence to do research on: aircraft crashworthiness; advanced materials; propulsions and fuel system safety technologies; and maintenance, inspection, and repair. They also have partnerships on fire research with academia, the Air Force, NIST, industry, and Japanese, Canadian, British, and other European aviation authorities.

National Intelligent Transportation Infrastructure

The National Intelligent Transportation Infrastructure (NITI) refers to the integrated electronics, communications, and hardware and software elements that can support intelligent transportation systems (ITS). It is a communication and information "backbone" that will enable ITS products and services to work together to save time and lives. Analogous to the local- and wide-area networks used in many workplaces, the NITI will allow surface transportation to be managed as a seamless entity by integrating transportation and management information systems across both modal and jurisdictional lines within a region and, where appropriate, across the country.

The FTA Fleet Operations and Equipment and Infrastructure programs include ITS technology in their scope, while the FTA Metropolitan/Rural Policy Development and Planning program, the Project Development program, and the Rural Transit Assistance program include planning for local ITS deployments. Thus, all five of these programs are linked to the National Intelligent Transportation Infrastructure initiative. A sixth FTA program with links to this initiative is the International Mass Transportation program, which monitors the state of the art in ITS operational management in foreign countries for potential adoption by domestic operators.

Intelligent Vehicle Initiative

The Intelligent Vehicle Initiative (IVI) is a government-industry program to accelerate the development and commercialization of safety- and mobility-enhancing driver-assistance systems. Overall emphasis is on four key areas: (1) evaluation of the benefits of IVI products, including collision-avoidance technologies, vision enhancements, and adaptive cruise control; (2) development of industry-wide standards for these products; (3) system prototyping; and (4) field test evaluations of the most promising products.

The FTA Fleet Operations program and Equipment and Infrastructure program include R&D on intelligent transit vehicles with collision warning and avoidance systems, night vision systems, GPS-based navigation systems, and other advanced features. The International Mass Transportation program researches foreign technologies in these areas. Thus, these FTA programs are a part of the Intelligent Vehicle Initiative.

This initiative has the objective of matching technology with human behavior to design effective collision warning and avoidance systems for vehicles. Hence, the RSPA Human Factors Research Program forms an important part of this initiative.

Transportation and Sustainable Communities

This initiative explores how sustainable transportation and land use can help to achieve a balance among the often-conflicting goals of economic growth, environmental quality, and sustainability. It will further Federal agencies' efforts to work with each other and with other governments, the private sector, and the public to expand understanding of the consequences of transportation choices; develop better forecasting, planning, and assessment tools; conduct technology research; and develop sustainable community and transportation initiatives.

- While the primary focus of the FY 2000 Livability Initiative is to provide funding for programs directed toward mass transit, congestion relief and air quality improvement, community-based transportation programs, and "smart growth" strategies, research and development activities are supported. Therefore, the Livability Initiative will stimulate and link to a wide range of research activities.

- All the FTA programs associated with local transit planning – the Metropolitan/Rural Policy Development and Planning program, the Project Development program, and the Rural Transit Assistance program - include planning for local sustainability through researching VMT reduction, incentives for transit use, and other innovative approaches to improve air quality and optimize land use. The FTA Equipment and Infrastructure program includes development of low-emissions transit vehicles to increase sustainability of transit systems and the communities in which they operate.

- The USCG Marine Environmental Protection program protects the environment of coastal communities, and communities along inland waterways, by preventing spills of hazardous substances, and mitigating them effectively in case they do occur.

- The RSPA pipeline safety and hazardous material R&D programs are concerned with prevention of adverse environmental impacts, and are therefore a part of the vision of this initiative.

- The RSPA-led Advanced Vehicle Technologies Program has significant goals in the area of emissions reduction and energy efficiency, contributing to the focus of this initiative.

Transportation Infrastructure Assurance

This partnership is developing and implementing measures to improve the security of transportation information systems, passenger and freight terminals, and other infrastructure, as well as of the people and cargo using or transiting them. It addresses (1) the physical security of transportation terminals; (2) the security of vital communication and information systems; and (3) the development and dissemination of information about security incidents and assessments of threats to transportation facilities and operations. The security component of the FTA Safety and Security R&D program is also relevant to this initiative.

Enhanced Goods and Freight Movement at Domestic and International Gateways

Building on earlier investments in technology, port infrastructure, and freight terminals, this partnership facilitates information exchange and technology demonstrations to promote the deployment of innovative logistics practices and information technologies at freight gateways. Initial efforts will focus on technology applications and demonstrations at the Nation's border crossings and corridors.

The USCG Waterways Safety Management and Aids to Navigation program, by improving the efficiency of use of waterways at the international border, reduces delays in the flow of goods across the border. This is of great significance because the Great

Lakes – St. Lawrence waterway system forms a significant part of our border with Canada, and Canada is our largest trading partner. In addition, the flow of goods in and out of seaports handling foreign trade will also be facilitated.

With growing freight volumes at both the Canadian and Mexican borders, as well as at other ports of entry (such as seaports), it has become essential to develop efficient and effective methods of inspecting for hazardous cargo without causing undue delays in freight movement. The hazardous materials research programs of RSPA therefore have an important role to play in the success of this initiative.

Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure

This partnership will create an environment that fosters an unprecedented level of collaboration and synergy on infrastructure research, demonstration, testing, evaluation, and technology transfer to state and local agencies. The partners will collaborate both on developing new technologies and on accelerating market acceptance of existing products.

A part of the focus of this initiative is rapid disaster response and recovery. This links it to RSPA hazardous materials research programs, which also deal with response to hazardous material releases, one of several kinds of disasters which can adversely impact the transportation infrastructure. The RSPA-led Transportation Infrastructure Assurance R&D program is also relevant to this initiative, since it works to mitigate, and improve the response to, a particular type of threat to the integrity of the infrastructure – threats arising from deliberate human actions.

Maritime Safety Research Alliance

This partnership's focus is the prevention of maritime casualties through targeted research and development in the areas of human factors, vessel technology, and advanced information systems. It will address advanced training technologies for mariners; improved small vessel designs and structures; real-time weather systems; GPS applications; and integration of sea-based and land-based intelligent systems for traffic management and rapid emergency response.

Several R&D programs of the USCG – the Waterways Safety Management and Aids to Navigation, Marine Safety Research, and Improved Search and Rescue Capability programs – constitute a part of the activities of this initiative.

Human factors account for about 75 percent of accident causes for maritime transportation. This underscores the importance of programs such as the RSPA Human Factors Research Program in advancing the goals of this initiative.

While hazardous materials account for less than 1 percent of accident causes for maritime transportation, hazardous material accidents such as the Alaska oil spill of 1989 have serious environmental consequences. This makes the RSPA hazardous materials R&D program relevant to this initiative.

Space Transportation Technology

Without affordable and reliable access to space, the future of the space program and the U.S. space transportation industry are hindered by the high cost, low reliability, and poor operability of payload launch. The unprecedented partnership among FAA, NASA and U.S. aerospace companies takes advantage of the respective strengths of government and industry. It does this by supporting NASA's efforts to develop and demonstrate pre-competitive, next-generation technology that will enable the commercial launch industry to develop full-scale, highly competitive, and reliable reusable space launchers.

Accessibility for Aging and Transportation-Disadvantaged Populations

This partnership focuses on improving the mobility of the elderly and transportation-disadvantaged through better management of paratransit, advanced technologies, and livable communities. One component consists of developing, deploying, and testing a regional paratransit program that uses selected information technologies, including automatic vehicle location, geographic information systems, computer-aided dispatch, and electronic fare collection.

The FTA Specialized Customer Services program coincides with this initiative. The FTA Metropolitan/Rural Policy Development and Planning program, the Project Development program, and the Rural Transit Assistance program include planning for local paratransit services for aging and transportation-disadvantaged populations.

Enhanced Transportation Weather Services

This partnership addresses the problems associated with adverse weather through the development of comprehensive weather information systems. One element makes use of Doppler radar, observing systems, and forecasting methods to demonstrate and evaluate an integrated weather information system – first within a "pilot" Midwestern region and eventually throughout North America. A second component is the Aviation Weather Analysis and Forecasting Program, which will improve access to and delivery of aviation weather information and reduce the consequences of weather events by generating weather observations, warnings, and forecasts with higher resolution and greater accuracy.

- The FTA Fleet Operations program addresses the incorporation of weather information, and user-friendly on-board weather information dissemination technologies to assist decision making by transit fleet dispatchers and individual transit vehicle operators, thus addressing the goals of this initiative.

- The USCG Waterways Safety Management and Aids to Navigation program seeks to improve navigation services for waterway users; this includes providing better information on weather conditions.

- Technologies such as ITS and the USCG Vessel Traffic Services (VTS) are making it possible to provide critical weather information to transportation users for important decision-making thresholds. To be comprehensible to users, however, information

displays must be designed to assist in effective decision making. Thus, the RSPA Human Factors Research Program is also highly relevant to this initiative.

Table IV-3. Relationship of DOT Research Programs to NSTC Strategic Partnership Initiatives, FY 2001

Mode/Program/Project Title	NSTC Partnership Initiatives (PI): see endnote												
	PI 1	PI 2	PI 3	PI 4	PI 5	PI 6	PI 7	PI 8	PI 9	PI 10	PI 11	PI 12	PI 13
FHWA													
Structures													
Bridge inspection				W			S		S				
High performance materials				W			S		S				
Engineering applications				W			S		S				
Pavements													
Asphalt concrete pavements				W			S		S				
Portland cement concrete (PCC) pavements				W			S		S				
Long term pavement performance (LTPP)				W			S		S				
Pavement technology tools				W			S		S				
Recycled materials													
Asset Management													
Systems integration				W		W	S		S				
Management systems				W			S		S				
Network preservation				W			S		S				
Operations													
Operations-MUTCD, work zone ops., weather				W		W							S
Freight management operations			W	W	W	W							
Surveillance equipment				W			S						
Policy													
Investment performance				W					W				
Value pricing				W									
Improving economic productivity				W					W				
Highway cost allocation				W									
Research cooperation with international				W									
Highway Performance Monitoring System				W									
Travel and mobility				W		W			W				
Fuels and finance				W									
Federal Lands													
Advance materials/pavements				W			S		S				
High performance materials/bridge				W			S		S				
Reduce user delays				W	W	W			W			W	S
Integration of AWIPS weather data				W		W	S		W			W	S
Integration of road closure information				W		W	S		S			W	
Highway Safety													
Run-off road safety			W	W	S		S		S				
Pedestrian and bicycle safety				W	W	W			W			S	
Human centered technical support				W	S							W	
Safety management				W		W	W					W	
Speed management				W	S		W					W	
Work zones				W	W								
Designated problems-study adv. trauma plan				W									
Planning and Environment													
STECRP advisory board				W									
Real estate services				W		S							
Environment-air quality/climate, global change				W		S		W				W	
Planning-transportation and land use				W		S		W				W	
Agency-wide Initiatives													
R&T technical support -- TRB coop, report ctr., SBIR				W									
International outreach				W				S					
Advanced research – diagnostic methods				W									
Resource centers				W									
MIHE reserve				W									
R&T strategic planning			W	W	W	W	W	W	W			W	
RD&T computer support				W									

Table IV-3. Relationship of DOT Research Programs to NSTC Strategic Partnership Initiatives, FY 2001

Mode/Program/Project Title	NSTC Partnership Initiatives (PI): see endnote												
	PI 1	PI 2	PI 3	PI 4	PI 5	PI 6	PI 7	PI 8	PI 9	PI 10	PI 11	PI 12	PI 13
Innovative financing				W		W							
Knowledge management				W			W						
Civil rights				W		S						W	
ITS JPO													
ITS Research and Development													
Traffic management and control			S	S	S		W		W			W	S
Intelligent vehicle research				S	S							S	S
Rural research			S	S	S	S	W		W				S
Advanced transit management			W	S	S								W
Commercial vehicle operations			S	S	S								
Enabling research			W	S	S							W	W
Intermodal freight research			W	S	S			S					W
ITS Deployment Incentives													
ITS Deployment Incentives-metro/rural				S	S	W	W		W				S
Commercial vehicle operations-deployment			W	S	S			S					W
Hazardous materials monitoring systems			W	S	S			W					W
Texas Transportation Institute			W	S	S			S				W	
FMCSA													
Crash causation and profiling				W	W								
Regulations and enforcement				W					W				
Driver related research and technology				W	W				W				
Hazmat safety & cargo tank integrity			W	W					W				
management			W										
Physical qualifications			W										
Car-truck proximity					S	W							
R&T mgt., media and special projects				W									
FAA													
Air Traffic Services													
WJHTC technical labs	S	S					S	W			S		S
Center for Advanced Aviation System Development	S	S					W				S		
Aviation weather analysis and forecasting	S	S						W					S
Information systems security	S	S					W	S					
Advanced technology development and prototyping	S	S	S				W	S			S		W
Airports													
Airport technology	S	S				W	S	S			S		W
Aircraft safety													
Fire resistant materials/aircraft fire safety research	S	S											
Structural safety & advanced materials/structures	S	S					S				W		
Propulsion and fuel systems	S	S	S				W				S		
Flight safety/atmospheric hazards research	S	S	W				W				S		S
Aging aircraft	S	S	S				S						
Aircraft catastrophic failure prevention research	S	S	S				S				W		
Aircraft safety risk analysis	S	S	S				W				S		W
Security													
Explosive and weapons detection	S	S	W				S	W					
Security of civil aviation airports and air carriers	S	S					S	S					
Human systems integration	S	S					S	W					
Explosive/advanced threat vulnerability	S	S	W				S	S					
Human Factors and Aviation Medicine													
Flightdeck/maintenance/system integration human factors	S	S											S
Air traffic services human factors	S	S											S

Table IV-3. Relationship of DOT Research Programs to NSTC Strategic Partnership Initiatives, FY 2001

Mode/Program/Project Title	NSTC Partnership Initiatives (PI): see endnote												
	PI 1	PI 2	PI 3	PI 4	PI 5	PI 6	PI 7	PI 8	PI 9	PI 10	PI 11	PI 12	PI 13
Aeromedical research	S	S											
Environment and Energy													
Environment and energy	S	S				S	W	W	S			S	S
NHTSA													
Data analysis program					W								
Driver/vehicle performance					S								
National Automotive Sampling System (NASS)					W								
National Transportation Biomechanics Research					S								
Special Crash Investigations (SCI)					W								
Vehicle Research and Test Center					W								
Technology transfer					W								
Safety systems (crashworthiness)					S								
Fatality Analysis Reporting System (FARS)					W								
State data program													
Highway safety research													
Heavy vehicles					W								
Seat belt use and occupant protection (flagship)					S								
Partnership for a new generation of vehicles (PNGV) (flagship)					W								
FRA													
Locomotive safety			W						W				W
Passenger car safety performance									W				
On-board monitoring systems				S					W				W
Wayside monitoring systems				S					S				S
Material and design improvements			W										W
Train operations				S									W
Yard and terminal				S					W				
Hazmat transportation safety				W			S	W					W
Tank car structural integrity (Hazmat)							W		W				
Damage assessment, damage tolerance analysis & inspection (Hazmat)							S		W				
Grade crossings - human factors issues				S			W	W	S			W	W
Material and rail inspection							S		S				W
Track strength									W				S
Vertical track support									W				
Bridge safety							S		W				W
Track geometry									W				W
Wheel/rail interaction									W				W
Special trackwork									W				
Electrification safety									W				
Heavy axle load safety									W				
Vehicle/track interaction safety standards									W				W
Advanced train control			S	S			W	W	S				W
Grade crossing safety (infrastructure)				W					S				W
Signal systems safety				S					S				W
Grade crossing safety (equipment & operations)						W			S				
Performance-based regulations									S				
Accident avoidance (HSGT)				S									W
Accident survivability (HSGT)													
Infrastructure (HSGT)				S		W		S	S				W
Test support equipment for Transportation Technology Center			W										
High-speed rail safety support			S					W					W

Table IV-3. Relationship of DOT Research Programs to NSTC Strategic Partnership Initiatives, FY 2001

Mode/Program/Project Title	NSTC Partnership Initiatives (PI): see endnote												
	PI 1	PI 2	PI 3	PI 4	PI 5	PI 6	PI 7	PI 8	PI 9	PI 10	PI 11	PI 12	PI 13
Environmental impact analysis			S	W		S	W	W	S			S	S
Track inspection research vehicle			S				W						
Transportation Technology Center			W	W									
USCG													
Waterways safety management and aids to						W		S		S			S
Comprehensive law enforcement							W	W					
Marine safety research						W				S			W
Marine environmental protection						S							
Improved search and rescue capability										S			
Technology investment			S			S	S	S	S	S			S
FTA													
Safety and security							S						
Fleet operations				S	S								S
Specialized customer services												S	
Research and technology program support			S	S	S	S	S		S			S	S
Performance and review/evaluation			S	S	S	S	S		S			S	S
International mass transportation			S	S	S								
Transit Cooperative Research Program (TCRP)			S	S	S	S	S		S			S	S
National Transit Institute			S	S	S	S	S		S			S	S
University transportation research			S	S	S	S	S		S			S	S
Equipment and infrastructure			S	S	S								
Metropolitan/rural policy development				S		S						S	
Planning and project development				S		S						S	
Human resources			S	S	S	S	S		S			S	S
Rural Transportation Assistance Program (RTAP)				S		S						S	
RSPA													
Pipeline Safety R&D													
Information systems						S	S		S				
Risk assessment						S	S		S				
Mapping						S	S		S				
Nondestructive evaluation						S	S		S				
Pipe location and monitoring technology						S	S		S				
Research and Technology													
R&D planning and management	S	S	S	S	S	S	S	S	S	S	S	S	S
Advanced vehicle technologies (flagship)			S		S	S							
Human factors research program (flagship)	S	S	S	W	S		S	W	W	S	W	W	S
Transportation Infrastructure Assurance R&D							S	W	S				S
Response Management Support						W	S	S	S	W		S	S
Hazardous Materials Safety													
Information systems						S		S	S	S			
Research and analysis						S		S	S	S			
Regulation compliance						S		S	S	S			
OST													
Services for persons with disabilities						S						S	
Safety and travel pattern analysis of U.S. motor carrier operations								S	W				
Mitigating environmental impacts			S			S							
Economic & international trade trends: implications for freight						W		S					
Improving ground access to airports	S	W	W				S		S				
DOT's transportation livability initiative						S						S	

Table IV-3. Relationship of DOT Research Programs to NSTC Strategic Partnership Initiatives, FY 2001

Mode/Program/Project Title	NSTC Partnership Initiatives (PI): see endnote												
	PI 1	PI 2	PI 3	PI 4	PI 5	PI 6	PI 7	PI 8	PI 9	PI 10	PI 11	PI 12	PI 13
Radionavigation and Positioning													
Preparation of the Federal Radionavigation Plan	W			W			W			S	W		
Technical support of GPS modernization				W	W				W				
GPS vulnerability study follow-on requirements				W	W		S		W				
Technical support of GPS spectrum protection &				W	W		S						
Aviation and International Policy	S	S	W				W	S	W				
Intermodalism Studies				S		W	W	S	W	W		W	
MARAD		Does not do R&D											
BTS		Does not do R&D											

Note: S denotes a strong relationship, W denotes a weak relationship.

Key	
PI 1: Aviation Safety Research Alliance	PI 7: Transportation Infrastructure Assurance
PI 2: Next Generation Global Air Transportation	PI 8: Enhanced Goods and Freight Movement at Domestic and International Gateways
PI 3: Next Generation Transportation Vehicles	PI 9: Monitoring, Maintenance and Rapid Renewal of the Physical Infrastructure
PI 4: National Intelligent Transportation Infrastructur	PI 10: Maritime Safety Research Alliance
PI 5: Intelligent Vehicle Initiative	PI 11: Space Transportation Technology
PI 6: Transportation and Sustainable Communities	PI 12: Accessibility for Aging and Transportation-Disadvantaged Populations
	PI 13: Enhanced Transportation Weather Services

Chapter V
Transportation R&D and Enabling Research

A 1996 General Accounting Office report (GAO 1996) concluded that current Federal transportation R&D "gives too little emphasis to basic, long-term, high-risk surface transportation research." Moreover, the long-term nature and diffuse benefits of this research mean that market forces may be insufficient to motivate private investment. Clearly, there is a Federal role in bringing together all elements of the transportation enterprise to conduct the enabling research, both short and long term, that will make the next century's transportation breakthroughs possible.

The National Science and Technology Council (EOP NSTC 1999a) identifies seven high-priority research areas (see Box V-1).[1] Each is consistent with the principles of the President's Committee of Advisors on Science and Technology and meets the following criteria: (1) it supports long-term transportation goals; (2) it offers benefits that are too widely spread for any one company to recover its investment; (3) it has a cost or risk too great for one company to bear; and (4) its benefits are too far in the future to meet private investment criteria. All areas require Federal support as well as concerted efforts and partnerships among the various levels of government, private industry, and academic institutions.

The DOT *Strategic Plan* (DOT 1997a) specifically focuses on efforts that will "foster innovative and cutting-edge research," building upon work conducted by "other Federal agencies, institutes of higher learning, and the private sector" The enabling research areas (EOP NSTC 1999b) have the potential to advance technology and performance both within individual transportation modes and across all modes.

Table V-1 shows the relationships between DOT R&D FY 2001 programs and the 7 areas identified as enabling research. For each program, a table entry appears that identifies the relevant enabling research area as well as whether the relationship appears to be either a strong (S) or a weak (W) one.

Within the DOT, this research includes both near-term (5 years or less) and long-term (more than 5 years) programs. Many of the near-term efforts will yield results that will be incorporated into the partnerships described in the previous chapter. Because their objectives are immediate, most of the near-term programs are conducted by a single DOT agency. About half of the long-term programs, however, are multi-modal in nature, and many are conducted jointly with other Federal agencies, industry, or academic institutions.

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[1] Note: there are some slight changes in the enabling research areas from the last year's *DOT R&D Plan* (DOT 1999). The main change is the addition of a seventh enabling research area: social and economic policy issues. Other areas have undergone some minor changes in wording.

Box V-1. Enabling Research Areas

Human Performance and Behavior
Advanced Materials
Computer, Information and Communication Systems
Energy, Propulsion, And Environmental Engineering
Sensing & Measurement
Tools for Transportation Modeling, Design and Construction
Social and Economic Policy Issues

Human Performance & Behavior

For transportation systems to achieve high performance and low cost, their design, realization, and use must be based on the following: (1) extensive knowledge of user needs; (2) limitations associated with human performance and behavioral characteristics, and; (3) understanding of the many factors affecting the interaction between humans and automated systems.

Human error or inadequacy in vehicle or system operation, maintenance, or inspection is a leading factor contributing to safety and security problems. This arises in part because basic system design, operational procedures, or training programs do not take fully into account the characteristics of the people responsible for operating the system. Research in the behavioral sciences provides a critical foundation for building the needed transportation knowledge base to avoid such flaws.

As stated in the National Strategy, the priorities for research in this area are advanced instructional technology; enhanced alertness and work readiness; and humans and automated systems. The sections below describe the near-term DOT efforts in these areas and the related long-term research.

Near Term

Advanced Instructional Technology

Even with a greatly improved understanding of human performance, training, education, and testing are critical for ensuring that vehicle operators are knowledgeable about their vehicles' safety systems and safe operational procedures. Several activities are occurring in this area. NHTSA is constructing the National Advanced Driving Simulator (NADS), a large and sophisticated automobile simulator to test many different types of driver performance. NHTSA is also developing assessment and rehabilitation tools to enable older people to drive longer.

Table V-1. Relationship of DOT Research Programs and Projects to NSTC Enabling Research Areas

Mode/Program/Project Title	Relationship to NSTC Enabling Research Areas						
	Human Performance & Behavior	Advanced Materials	Computer, Information & Communication Systems	Energy, Propulsion & Environmental Engineering	Sensing & Measurement	Tools for Transportation Modeling, Design & Construction	Social & Economic Policy Issues
FHWA							
Structures						W	
Bridge inspection		S				W	
High performance materials		S				W	
Engineering applications		S					
Pavements							
Asphalt concrete pavements		S				S	
Portland cement concrete (PCC) pavements		S				S	
Portland cement concrete (PCC) pavements		S				S	
Pavement technology tools		S				S	
Recycled materials		S		W		S	
Asset Management							
Systems integration						W	S
Management systems			W			S	
Network preservation						S	S
Operations							
Operations-MUTCD, work zone ops., weather	W		S		W	W	S
Freight management operations			S	S			S
Surveillance equipment		W			S		
Policy							
Investment performance			W			S	S
Value pricing						S	S
Improving economic productivity			W			S	S
Highway cost allocation			S			S	S
Research cooperation with international organizations						S	S
Highway Performance Monitoring System			S				S
Travel and mobility							S
Fuels and finance							S
Federal Lands							
Advance materials/pavements		S					
High performance materials/bridge		S					
Reduce user delays	W		S				W
Integration of AWIPS weather data	W		S				W
Integration of road closure information	W		S				W
Motor Carrier Safety							
Crash causation and profiling	W		S		W		W
Regulations and enforcement	W				W	S	W
Driver related research and technology	S				W		
Media/special projects, deductions	W	W	W		S	W	
Highway Safety							
Run-off road safety	S		W		S	S	
Pedestrian and bicycle safety	S				S	S	
Human centered technical support	S		W				
Safety management	S		S			S	
Speed management	S		W		W		
Work zones	S					S	
Designated problems-study adv. trauma plan	S						

Table V-1. Relationship of DOT Research Programs and Projects to NSTC Enabling Research Areas

Mode/Program/Project Title	Relationship to NSTC Enabling Research Areas						
	Human Performance & Behavior	Advanced Materials	Computer, Information & Communication Systems	Energy, Propulsion & Environmental Engineering	Sensing & Measurement	Tools for Transportation Modeling, Design & Construction	Social & Economic Policy Issues
Planning and Environment							
STECRP advisory board				S			S
Real estate services				S			S
Environment-air quality/climate, global change				S	W	S	W
Planning-transportation and land use				S		W	S
Agency-wide Initiatives							
R&T technical support -- TRB coop, report ctr., SBIR							S
International outreach							S
Advanced research – diagnostic methods					S	S	S
Resource centers							S
MIHE reserve							S
R&T strategic planning							S
RD&T computer support							S
Innovative financing							S
Knowledge management							S
Civil rights							S
ITS JPO							
ITS Research and Development							
Traffic management and control	W		S	W	S	W	S
Intelligent vehicle research			S		S	S	S
Rural research			S	W	S	W	S
Advanced transit management			S		S	S	S
Commercial vehicle operations	S		W		W	S	S
Enabling research			W	W	S	W	S
Intermodal freight research							
ITS Deployment Incentives							
ITS Deployment Incentives-metro/rural			S	W	S	W	S
Commercial vehicle operations-deployment	S		S		S	W	S
Hazardous materials monitoring systems			S		S	S	S
Texas Transportation Institute			W	W	S	S	S
FMCSA							
Crash causation and profiling	W		S		W		W
Regulations and enforcement	W				W	S	W
Driver related research and technology	S				W		
Hazmat safety & cargo tank integrity		W		S			
Commercial driver training and performance	S		W			W	W
Physical qualifications	S						W
Car-truck proximity	S		W		S		
R&T mgt., media and special projects	S						W
FAA							
Air Traffic Services							
WJHTC technical labs	S	S	S	S	S	S	W
Center for Advanced Aviation System Development		S	S		S	S	
Aviation weather analysis and forecasting			S	S	S		W
Information systems security			S		S		
Advanced technology development and prototyping		S			S		

Table V-1. Relationship of DOT Research Programs and Projects to NSTC Enabling Research Areas

Mode/Program/Project Title	Relationship to NSTC Enabling Research Areas						
	Human Performance & Behavior	Advanced Materials	Computer, Information & Communication Systems	Energy, Propulsion & Environmental Engineering	Sensing & Measurement	Tools for Transportation Modeling, Design & Construction	Social & Economic Policy Issues
Airports							
Airport technology	W	S			S	S	
Aircraft safety							
Fire resistant materials/aircraft fire safety research		S					
Structural safety & advanced materials/structures		S			S		
Propulsion and fuel systems		S	S	W			
Flight safety/atmospheric hazards research			S	S	S	S	
Aging aircraft		W	W			S	S
Aircraft catastrophic failure prevention research		S				S	S
Aircraft safety risk analysis	S		W		S	S	
Security							
Explosive and weapons detection		S			S		
Security of civil aviation airports and air carriers	S				S		S
Human systems integration	S		S		S		
Explosive/advanced threat vulnerability		W	S		S		S
Human Factors and Aviation Medicine							
Flightdeck/maintenance/system integration human	S		S			W	
Air traffic services human factors	S		W		W	W	S
Aeromedical research	S				W	S	S
Environment and Energy							
Environment and energy				S	S	W	S
NHTSA							
Data analysis program	S		S			S	
Driver/vehicle performance	S		W				W
National Automotive Sampling System (NASS)	S		S			S	
National Transportation Biomechanics Research	S				S	S	W
Special Crash Investigations (SCI)	S		W	W	w	S	W
Vehicle Research and Test Center	S	W			S		
Technology transfer	S	W	W		W	S	
Safety systems (crashworthiness)	S	S	W				W
Fatality Analysis Reporting System (FARS)	S		S				S
State data program	S		S			W	
Highway safety research	S		W		S	W	
Heavy vehicles	S	W					
Seat belt use and occupant protection (flagship)	S	S			S		S
Partnership for a new generation of vehicles (PNGV) flagship	W	S		S			S
FRA							
Locomotive safety		W			W		
Passenger car safety performance	S		S		S		S
On-board monitoring systems	S		S		S	S	
Wayside monitoring systems			S	S	S	S	
Material and design improvements		S		W	W	W	
Train operations			S		W		
Yard and terminal			W		W		
Hazmat transportation safety		S		S		W	
Tank car structural integrity (Hazmat)							
Damage assessment, damage tolerance analysis & inspection (Hazmat)				S		S	W

Table V-1. Relationship of DOT Research Programs and Projects to NSTC Enabling Research Areas

Mode/Program/Project Title	Relationship to NSTC Enabling Research Areas						
	Human Performance & Behavior	Advanced Materials	Computer, Information & Communication Systems	Energy, Propulsion & Environmental Engineering	Sensing & Measurement	Tools for Transportation Modeling, Design & Construction	Social & Economic Policy Issues
Grade crossings - human factors issues	S				W		S
Material and rail inspection		S					
Track strength		S				W	
Vertical track support		S				W	
Bridge safety		S				W	
Track geometry		W			S	W	
Wheel/rail interaction		W				W	
Special trackwork		S				W	
Electrification safety		W				W	
Heavy axle load safety		W				W	
Vehicle/track interaction safety standards		W			S		
Advanced train control		S	S		S	S	W
Grade crossing safety (infrastructure)	W	W			W		S
Signal systems safety			S		S	W	
Grade crossing safety (equipment & operations)		S			W		
Performance-based regulations	W		W			W	
Accident avoidance (HSGT)	S				S	S	W
Accident survivability (HSGT)	S				W	S	S
Infrastructure (HSGT)		S	W		S		W
Test support equipment for transportation technology center		W					
High-speed rail safety support					W	S	S
Environmental impact analysis	W		W	S		S	S
Track inspection research vehicle		W			S	W	
Transportation Technology Center			S		W	W	
USCG							
Waterways safety management and aids to	S		S		S	S	S
Comprehensive law enforcement	S		S		S		W
Marine safety research	S		W	W	W	W	W
Marine environmental protection	S		S	S	S	S	S
Improved search and rescue capability	S		S		S	S	S
Technology investment	S	S	S	S	S	S	W
FTA							
Safety and security	S		S		S		
Fleet operations			S		S	S	
Specialized customer services			S			S	S
Research and technology program support	S	S	S	S	S	S	S
Performance and review/evaluation	S	S	S	S	S	S	S
International mass transportation		S	S		S		
Transit Cooperative Research Program (TCRP)	S	S	S	S	S	S	S
National Transit Institute	S	S	S	S	S	S	S
University transportation research	S	S	S	S	S	S	S
Equipment and infrastructure		S	S	S	S		
Metropolitan/rural policy development			S	S		S	S
Planning and project development			S	S		S	S
Human resources	S	S	S	S	S	S	S
Rural Transportation Assistance Program (RTAP)			S	S		S	S

Table V-1. Relationship of DOT Research Programs and Projects to NSTC Enabling Research Areas

Mode/Program/Project Title	Relationship to NSTC Enabling Research Areas						
	Human Performance & Behavior	Advanced Materials	Computer, Information & Communication Systems	Energy, Propulsion & Environmental Engineering	Sensing & Measurement	Tools for Transportation Modeling, Design & Construction	Social & Economic Policy Issues
RSPA							
Pipeline Safety R&D							
Information systems	S	S	S	S	S	S	W
Risk assessment	S	S	S	S	S	S	W
Mapping	S	S	S	S	S	S	
Nondestructive evaluation	S	S	S	S	S	S	
Pipe location and monitoring technology	S	S	S	S	S	S	
Research and Technology							
R&D planning and management	S	S	S	S	S	S	S
Advanced vehicle technologies (flagship)		S		S	W		
Human factors research program (flagship)	S		S		S	S	
Transportation Infrastructure Assurance R&D	S	W	S		S	S	W
Response Management Support	S		W	S	W	W	W
Hazardous Materials Safety							
Information systems	S	W	S	S	W	S	
Research and analysis	S	S	S	S	S	S	S
Regulation compliance	S	W	S	S	W	S	
OST							
Services for persons with disabilities	S			W			S
Safety and travel pattern analysis of U.S. motor carrier operations	S			W			S
Mitigating environmental impacts				S			S
Economic & international trade trends: implications for freight				S			S
Improving ground access to airports	W			S			S
DOT's transportation livability initiative	W						S
Radionavigation and Positioning							
Preparation of the Federal Radionavigation Plan			S	W	S	W	S
Technical support of GPS modernization			S	W	S	W	S
GPS vulnerability study follow-on requirements			S		S	W	S
Technical support of GPS spectrum protection &			S	W	W		S
Aviation and International Policy	S		W	S		W	S
Intermodalism Studies	S			S		W	S
MARAD		Does not do R&D					
BTS		Does not do R&D					

Note: S denotes a strong relationship, W denotes a weak relationship.

The FAA is implementing line-oriented flight training for airline pilots and advanced training of general aviation pilots. FAA human factors research is developing human-centered flight controls and displays, and is increasing consideration of human factors in aircrew training. This research also explores prospects for safety enhancement through automated statistical analysis of flight-recorded data and through certification of new aircraft and equipment design and modification. In general aviation (GA), safety is enhanced through understanding and improving pilots' decision-making skills. In aviation maintenance, human factors research develops methods that are more effective for maintenance technician and inspector training, and it improves aviation maintenance technician and inspector task performance.

Enhanced Alertness and Work Readiness

Building on existing research, the DOT is studying and quantifying the effects of fatigue, work–sleep cycles, working environment and culture, boredom, and drug and alcohol use; readiness to perform duties; and interactions among co-workers.

The FHWA is evaluating driver behavior and performance at complex intersections, such as traffic circles, as well as highway design factors that may influence driver maneuver errors. The results of this activity will be used to help design driver-error taxonomies and an interactive highway safety design model. Placing special emphasis on the increasing number of older drivers, the FHWA is developing highway design guidelines and handbooks based upon empirical human performance data collected both in the laboratory and in controlled, on the road tests.

NHTSA is developing a portable data acquisition tool to understand driver/vehicle interactions. The device will unobtrusively monitor driver behavior and vehicle response in circumstances such as reduced road visibility, drowsiness, or increased disabilities with age.

NHTSA's highway safety research program determines the causes of crashes, identifies target populations, acquires the research for developing countermeasures, and evaluates the effectiveness of programs that will reduce traffic deaths, injuries, and associated monetary costs. The program provides the scientific basis for NHTSA's national leadership in highway safety through studies of driver, passenger, and pedestrian attitudes and behaviors, the circumstances and situations of crashes, and the most effective ways to reduce crashes. For FY 2001, new activities develop and test programs that address driver fatigue and inattention among shift workers and students, and determine changes in differential enforcement practices.

In conjunction with the FMCSA, NHTSA is developing and testing an on-board truck driver alertness measurement tool. Research is also under way on the relationship between hours-of-service requirements and commercial drivers' fatigue.

The FMCSA plans to focus on specific safety initiatives aimed at highway users, looking at driver fatigue, pedestrians, and behavior. For motor carrier operations, it will focus on

increased enforcement, identifying and targeting high-risk carriers, and using penalties more effectively to sustain compliance.

Within the FRA, human factors represent major research foci on performance and behavior for train operations, rail yards, and terminals. This includes the analysis of workload requirements and stress, fatigue, equipment complexities operating rules, and ergonomics. The FRA is researching the effects of work schedules on fatigue and stress for locomotive engineers (including high-speed train operators), dispatchers, and other railroad personnel. The agency will evaluate the effects of these factors on safety and performance. A related question concerns the amelioration of fatigue and stress by adjustments in work schedules, crew calling procedures, high- service requirements, and the work environment. As part of its grade-crossing safety program, the FRA is also investigating automobile driver behavior to determine why drivers go around crossing gates when they are down and the lights are flashing.

Security-oriented programs, such as the RSPA-led Transportation Infrastructure Assurance R&D program, and the USCG Comprehensive Law Enforcement program, also emphasize the performance and behavior of personnel who prevent security breaches as well as personnel who respond to security emergencies.

Similarly, programs concerned with response to hazardous material spills and other environmental emergencies, such as the USCG Marine Environmental Protection program and the RSPA hazardous materials R&D programs, also emphasize the performance and behavior of responding personnel. The same logic also applies to search and rescue programs, such as the USCG Improved Search and Rescue Capability program. FAA R&D into aviation security human factors improves the human element of the aviation security system by developing methods to select the screener as well as measure and maintain screener performance levels as aviation security components merge into future integrated systems. Emphasis focuses on the capabilities and constraints of manpower, personnel, training, human factors engineering, and health and safety aspects of human performance.

The Coast Guard is conducting research on fatigue countermeasures for crews on deep-draft, towing, and cutter vessels.

The FAA is undertaking fatigue-related research to assess the effects of duty times, shift rotations, and napping on performance, and is assessing the effectiveness of various fatigue countermeasures. The FAA is studying improved flight-deck human engineering and the mitigation of environmental factors affecting the performance of flight crews and maintenance and inspection personnel.

Research in aeronautical medicine improves the health, safety, and survivability of aircraft passengers and aircrews by identifying human failure modes and developing formal recommendations for counteracting measures. Through this research, the FAA

develops bioaeronautical[2] guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a basis for regulatory action to enhance appropriate human performance. New medical criteria, standards, and assessment/certification procedures are also developed to ensure full performance capability. Assessing flight attendant and passenger behavior and disease issues will lead to the development of guidelines to protect the health and improve the safety of cabin occupants.

Humans and Automated Systems

This research will provide critical information for designing systems and technology that enhance, rather than hamper, performance. For example:

NHTSA is undertaking driver/vehicle integration research to evaluate advanced crash-avoidance technologies and their potential for preventing crashes, as well as consumer acceptance of such technologies.

The NHTSA R&D programs focus heavily on human factors. Nearly 90 percent of motor vehicle crashes are the result of driver error. Many of these errors could be reduced if the vehicles' collision avoidance systems were improved to be more compatible with the capabilities and behaviors of the driving population. NHTSA's program on Driver/Vehicle Performance is developing the scientific basis for improving the collision avoidance capabilities of the driver/vehicle combination. Research areas include vehicle braking, handling, stability, direct and indirect visibility, vehicle lighting/signaling, and controls and displays, as well as human factors issues associated with the interaction between the driver and vehicle.

The Coast Guard is investigating enhancements to communications systems and coordination between marine pilots and vessel bridge teams.

The FAA is performing research to improve safety and productivity through a reduction of system and human errors when the major changes to air traffic services occur as "free flight" is implemented in the future.

The FAA is also studying shared information displays and interface designs for air traffic controller and maintenance workstations and the human factors of air-to-air communications via digital data links.

The FAA is researching the characteristics required for operators to use airport security systems based on emerging technologies, such as x-ray tomography (which identifies predetermined planes of solid objects while blurring the images of others). This program, which involves collaboration with other Federal agencies, industry, and academic institutions, will be leveraged with other research.

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[2] Bioaeronatics research involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is to enhance personal performance and safety by maximizing crew and passenger health and physiological integrity.

As part of its air traffic services program, the FAA is developing human factors guidelines for shared information displays in air-to-ground communications. In addition, the FAA program in human factors and aviation medicine directly addresses human performance and behavior. This research increases NAS safety and efficiency by developing scientifically validated information and guidance for improving performance and productivity of air traffic controllers and NAS system maintenance technicians.

The FHWA is assessing user interface issues in ITS traffic management systems and is developing human factors guidelines for intelligent vehicle technologies (see the Intelligent Vehicle Initiative, above).

The ITS JPO continuing sponsorship of research for Intelligent Vehicle Research holds long-term promise of mitigating the problem of human performance and behavior in vehicle operations. The Intelligent Vehicle Initiative (IVI) seeks to expedite the commercial availability of advance vehicle control and safety systems that will reduce driver workload and improve decision making in complex traffic or hazardous situations. The IVI is a problem-based program. It focuses on services of high potential payoff in safety. These include several types of collision avoidance systems, vision enhancement systems, vehicle stability, and driver condition warnings. Driver fatigue is a factor in 3 to 6 percent of fatal crashes involving large trucks, and 8 percent of single-vehicle, large truck fatal crashes. The introduction of cellular telephones and traveler information systems into the vehicle may contribute to increases in driver error.

Any R&D program focusing on safety as its major objective needs to address this enabling area since human errors are the leading cause of transportation fatalities and incidents in most modes. The entire focus of R&D in a safety-related program, however, need not focus on this enabling area. Thus, several Coast Guard programs: Waterways Safety Management and Aids to Navigation, Marine Safety Research, and Improved Search and Rescue Capability, are concerned with human performance and behavior.

The RSPA Human Factors Research Program addresses this enabling area directly.

Long Term

The DOT Human Factors Coordinating Committee is addressing long-term issues that are common to every mode of transportation, including instructional technology, alertness enhancement, and new methods for fatigue detection. In the future, the committee will establish cooperative research directions for all DOT agencies that may lead to changes in near-term programs. In addition, the Department will participate in multi-agency research to incorporate work-related and environmental factors and the restorative effects of countermeasures within existing human factors alertness models. Other efforts include the following:

NHTSA and FHWA research will be extended to analyze driver/vehicle performance systems using fixed-base and moving-base driving simulators. These could be made available at roadside stops to advise drivers of the onset of fatigue and other deterioration

in driving abilities. The system costs can be significantly reduced through the use of recent advances in microelectromechanical systems (MEMS). (See the section on "Micro/Nano," below.) This same approach will be applied to NHTSA research to develop in-vehicle performance aids and individualized advisory alerts for aging drivers.

The FHWA has three long-term programs: (1) developing human factors guidelines for the Intelligent Vehicle Initiative; (2) issuing a comprehensive human factors highway safety handbook, including driver performance and older driver issues; and (3) defining the needs of younger drivers in terms of driving performance, operational features, and geometric design.

Advanced Materials

Technical advances in the defense and consumer sectors have produced a rich inventory of materials and associated structural concepts, tools, and techniques for their use. Enabling research in this area supports applications of these materials to transportation, advancing an understanding of their behavior and properties, demonstrating their safety and effectiveness and, often, reducing costs to a competitive level. The National Strategy identifies three areas for high-priority materials research: advanced infrastructure materials, materials for transportation vehicles, and advanced manufacturing and construction.

Near Term

Advanced Infrastructure Materials

Research in this area examines the properties and performance of materials and technologies with physical infrastructure applications. Examples include high-performance concrete, new steel alloys, innovative composite materials and adhesives, imaginative structural concepts, and computer-aided design techniques. For example:

The Long Term Pavement Performance (LTPP) program, initiated in 1987 under the FHWA Strategic Highway Research Program (SHRP), is a 20-year study of the characteristics of different asphalt and pavement concepts involving 2,800 separate in-service test segments across the United States and Canada.

The FHWA also is evaluating the durability and maintenance characteristics of high-performance concrete bridges and testing ultra-high-strength steel in the laboratory.

The FHWA is researching the engineering properties of composites, such as fiber-reinforced plastics, and assessing the feasibility of concepts such as composite guardrails and timber-reinforced composites.

The Structures program of the FHWA sponsors considerable research aimed at maintaining and renewing the Nation's road infrastructure, and improving its performance. As part of technology deployment, FHWA enables and furthers the

application of innovative technology, including high-performance structural materials. These include variations of the more familiar construction materials such as steel and concrete and the more exotic materials such as fiber reinforced polymer (FRP) composites and aluminum. FRP research contracts for bridge deck panels, adhesives, and accelerated durability testing are nearing completion and some of the work on high-performance steel and concrete are making good progress.

More than fourteen high-performance concrete (HPC) bridge projects are currently underway. Several states have recently expressed interest in working with FHWA on such projects. High-performance steel (HPS) is still in the early stages of development. FHWA, working with the Navy and the steel industry, has developed affordable new steel that possesses increased strength and toughness and improved durability. The TEA-21 Innovative Bridge Research & Construction (IBRC) program is a major new initiative to deploy and demonstrate the application of high performance materials in high bridges and other structures. Under this program, FHWA is providing grants to the states to build or repair bridges with innovative materials.

The FAA has a research program to develop an integrated method for airport pavement design that employs layered elastic theory. The agency also manages an Airport Pavement Technology program, and has designated the University of Illinois at Urbana-Champaign as its "Center of Excellence" for airport pavement research.

The FRA is investigating new alloying and heat-treating methods to improve the safety and increase the service life of rails, rail track switches, and rail wheels.

The FTA is studying the development of low-cost, low-maintenance rails for heavy, medium, and light transit railroads.

The RSPA Pipeline Safety R&D program includes research on causation and detection of corrosion and failure of pipeline materials.

Materials for Transportation Vehicles

This research looks at materials with potential use in the manufacture of aircraft, ships, and surface transportation vehicles, for example, the use in body structures of high-performance steel, aluminum, magnesium, and glass- and carbon-fiber composites.

One of NHTSA's responsibilities in the PNGV program is to determine the safety implications related to the structural integrity of aluminum and composite-intensive, and other materials used in the construction of these future vehicles.

The FAA's Aircraft and Container Hardening program seeks to reduce the damage caused by small explosive detonations in commercial aircraft and air freight containers by using advanced materials in their construction.

The FAA is researching the possibility of developing ultra-fire-resistant cabin materials. One project is scaling up benzoxane chemistry to produce fire-resistant, non-toxic interior

panels; the agency aims to develop plastic and composite materials that reduce the release of heat by 50 percent.

Another FAA program, Advanced Materials/Structural Safety, is investigating the mechanical properties of composite and other advanced materials used for aircraft bodies and interior components.

Under its aviation safety program, the FAA promotes advanced materials and structural safety by ensuring both the safety of U.S. civil aircraft constructed of advanced materials and passenger survival in case of an accident. The advanced materials area focuses on standardized analysis and test methods for worldwide harmonization, better understanding of the effects of repeated loads, damage, and joint configurations on remaining strength and life of composite aircraft structure, and reliability methods as they apply to the design of composite aircraft components and criteria for acceptable risk. The structural safety area focuses on enhanced occupant survivability and reduced personal injury in the event of an accident; improved crash characteristics of aircraft structures, cabin interiors, auxiliary fuel tank systems, and occupant seat/restraint systems, and; improved analytical and modeling capabilities to develop improved structural, occupant, and seat restraint systems

MARAD, working with the Interagency Ship Structure Committee, is studying the use of composites in its Shipbuilding Standards Program.

The Coast Guard is investigating the fire safety of composite airframes.

Advanced Manufacturing and Construction

This research supports the development of advanced technologies for infrastructure construction and materials manufacturing, particularly technologies that improve the sustainability of producing and using transportation materials. DOT work in this area is discussed below with the Department's other long-term efforts.

Long Term

In the longer term, the DOT will begin a new program to coordinate multi-modal research on damage-tolerant structures and high-performance materials for surface, air, and marine applications. In addition:

Managed for DOT by the Transportation Research Board, the IDEA (Innovations Deserving Exploratory Analysis) program addresses many advanced technologies for pavement construction and maintenance. Concepts include layered systems for surface hardening, instant fix composites for structural repair, and the application of robotics to the construction process.

A number of FHWA projects promise important research results in the future. These include distress analysis of high-performance concrete; evaluating high-performance steel; characterizing the performance, structural shapes, and repair requirements of installed composite materials; and continuing data analysis for the LTPP.

The FAA's Aircraft and Container Hardening program may lead to low-cost, lightweight, hardened container materials that could eliminate or mitigate the threat of explosives aboard commercial aircraft.

The FRA is exploring new technologies and materials to improve the safety of rails, switches, wheels, freight cars, and passenger cars.

The RSPA Advanced Vehicle Technologies Program entails research on materials for fuel cells, advanced batteries, and lightweight, strong materials for vehicle bodies.

Computer, Information and Communication Systems

Worldwide, transportation is being transformed by the growing overlay of an information infrastructure on the existing physical infrastructure, creating a system in which information technologies and ready access to many types of information are integrated into virtually all transportation elements and functions. Effective and rapid exploitation of these innovations will require a substantial and ongoing enabling research and development effort associated with system concepts, characterization of alternative configurations and technical choices, and development and harmonization of a wide range of standards. Priorities for partnerships are summarized below.

Spectrum Allocation

Summary: Research in this area would provide the technical and economic knowledge needed to support policy decisions regarding allocation and efficient use of the electromagnetic spectrum and sophisticated mobile data communication technologies.

Communications technologies form the backbone of virtually all ITS services, functions, and capabilities. Early in the ITS Architecture program, a number of communications issues were identified that were critical to the implementation of ITS. The communications research has been oriented to examining those issues, performing the technical analyses, testing, and evaluation of communication alternatives and new technologies that could be used to support ITS functions. This program continues in the rapidly evolving communications field. One key result of this effort has been the identification of the communication link between vehicles to the roadside to be critical, and the current frequency spectrum used for this link will become crowded causing severe interference in the future. Therefore, late in FY 1996 an effort was initiated to obtain a spectrum allocation for this crucial communications link by supporting a petition to the FCC.

In October 1999, the FCC granted this petition. Hence, the spectrum allocation will provide for a wide range of vehicle to infrastructure communications. These include safety services as part of IVI, electronic clearance as part of CVISN, automatic toll collection, and numerous private-sector applications. The enabling research program is centered on this critical issue and its interaction with other ITS communications functions.

Participants: DOC; DOD; DOT (ITS Joint Program Office); NSF; state and local agencies; the telecommunications industry.

Global Positioning System Issues and Applications

Summary: Many important transportation applications use the highly accurate GPS for position finding and navigation. Among the areas this research would address are (1) the broad financial and institutional issues that must be resolved to assure that this system evolves in a manner that fully reflects the needs of civil transportation users and (2) the integration with GPS of geographic information system (GIS) and remote sensing technologies.

Approximately 20 accidents each year result from failures of existing train control methods and procedures. New positive train control (PTC) systems, utilizing digital data radios, automatic positioning systems, and on-board computers hold out the promise of significantly reducing the probability of collisions and overspeed accidents. FRA is facilitating the deployment of PTC within the railroad industry by completing the installation of a Nationwide Differential Global Positioning System (NDGPS) network.

Participants: DOC; DOD (Air Force); DOT (ITS Joint Program Office, FAA, FHWA, FRA, FTA, USCG); NASA; NSF; transportation service providers and other GPS users; manufacturers of GPS-based equipment; GPS service providers; state and local agencies; universities.

Software Assurance and High-Confidence Systems

Summary: The growing complexity of intelligent systems, and our ever-greater dependence on them, requires a high level of reliability, robustness, and security. Two critical areas for research partnerships are (1) system development, modeling, and verification techniques; and (2) high-confidence systems that protect and enhance the security and reliability of computer and communication networks.

Nowhere in the transportation system are communications and information sources more critical than in aviation. Aircraft separation based on a well-defined set of standards is the keystone of ATS' safety-related service. The ATS R,E&D program invests in projects to determine safe separation distances under varying conditions and ways to more accurately determine and predict aircraft positions and to reduce weather-related accidents and passenger injuries. The effects of weather phenomena on the aircraft, including clear-air turbulence, cause a large percentage of aviation accidents and passenger injuries. Additionally, an investment in airborne collision avoidance systems is included to provide a safety net beyond traditional separation methods. Overall technological improvements in information displays, automation tools, decision support systems, communications, navigation, and surveillance will support better determination of aircraft position and resolution of potential conflicts both in the air and on the airport surface.

Improving communications involving database sources within the NAS is critical to improving safety and reducing delays. Advances in both air- and ground-based

automation capabilities enable airspace to be utilized more safely and efficiently. Without improved communications to integrate these systems, the transition from air traffic control to air traffic management will be difficult to complete and will preclude the air/ground automation system integration required for the next generation of free flight.

Another class of R&D programs which emphasize CI&C systems are programs which involve development of better procedures for emergency response, whether for a hazmat release, a terrorist threat, or a search-and-rescue operation. Thus, the RSPA hazardous materials safety R&D programs, the RSPA-led Transportation Infrastructure Assurance R&D program, the USCG Marine Environmental Protection program, the USCG Comprehensive Law Enforcement program, and the USCG Improved Search and Rescue Capability program, all include development of communication systems for prompt, effective response.

The RSPA Pipeline Safety program includes development of Geographic Information System-based databases and other computer-based tools for mapping pipelines and identifying regions prone to outside force damage incidents.

Programs that are developing vehicle location and collision warning systems, such as the USCG Waterways Safety Management and Aids to Navigation program, require development of sophisticated CI&C systems.

The FRA and the railroad industry are examining ways to develop Intelligent Track/Train Systems that would incorporate the new digital communications technologies into train control, braking systems, grade crossings, and defect detection. Thus, some of the ideas of the ITS program are leveraged across modal lines. The new communications-based train control systems are a key element in making the railroad system safer and new intercity passenger services both safe and economically viable. New electronic sensors and transmission systems will help railroads achieve the long-sought-after goal of advanced detection of hazardous conditions in equipment and track.

Participants: DOD; DOT (ITS Joint Program Office, FHWA, FAA, FTA); NASA; NSF; state and local governments; manufacturers; universities.

Energy, Propulsion, And Environmental Engineering

Transportation contributes to many environmental problems. Because market forces tend to promote transportation research with near-term applications, there is a need for a Federal role in broad-based partnerships to explore long-term, high-risk strategies to address environmental issues, for example, the Administration's PNGV. Other cost-shared efforts in energy and environment include research on renewable fuel sources, low-emission propulsion systems, and advanced monitoring of transportation-related pollution and energy use. Among the high-priority areas for additional enabling research partnerships are:

Advanced Energy Storage and Conversion

Summary: Among candidate technologies for energy storage, fuel cells perhaps offer the most significant potential benefits in terms of energy conversion and mitigation of adverse environmental impacts. This research would address the properties and characteristics of fuel-cell technology and potential applications to transportation vehicles.

The FRA is sponsoring research on the Advanced Locomotive Propulsion System (ALPS). This project is to develop and demonstrate a prototype locomotive using a turbine-electric propulsion system with an energy-storage flywheel device. The flywheel will permit a locomotive with only one prime-mover system to accelerate for a period up to several minutes - as if it had two prime mover units. This additional "boost power" is a key to the necessary high acceleration rates; it improves energy efficiency by storing braking energy, and it permits "load leveling" for turbine prime movers which can substantially improve their operating efficiency while lowering their life cycle maintenance costs.

Participants: DOC; DOD (Army, Navy, DARPA); DOE; DOT (FTA, MARAD, RSPA, USCG); EPA; NSF; vehicle, engine, and fuel-cell manufacturers; state authorities; universities.

Alternative Transportation Fuels

Summary: A variety of petroleum alternatives hold promise for transportation, each with strengths and weaknesses in terms of economics, practicality, and indirect impacts. Research partnerships in this area would explore the costs, benefits, and safety and infrastructure requirements of these various alternative fuels.

Participants: DOD, DOE, DOT, EPA, fuel producers, universities, state and local agencies.

Sensing and Measurement

The wide range of information technologies now being incorporated into transportation systems has steadily increased the value of real-time monitoring and inspection of vehicles and infrastructure. Today, low-cost devices are available that make an extremely wide range of physical measurements and then are coupled to computer chips capable of generating warnings or adjusting operations. A virtually unlimited number of physical mechanisms and sensing concepts are potentially available, but devices of special importance to transportation will be identified and brought to fruition only to the degree that the transportation community makes these needs known and establishes their potential economic and operational value. Priorities for research partnerships are listed below.

Smart Structures and Vehicles

Summary: "Smart structures"—roads, bridges, runways, and others with a network of embedded sensors—can lower maintenance costs while improving safety and

performance by continually providing detailed condition information. Likewise, "smart vehicles" sense their environmental and operating circumstances. This research would identify and quantify the potential benefits and costs of coupling sensing and computing in this manner.

The FAA's Project SOCRATES provides direct wake turbulence measurement and support for FAA Air Traffic and Flight Safety capacity and safety initiatives. In addition, the wake turbulence activities are closely coordinated with NASA and international research efforts. The FAA weather program sponsors R&D aimed at sensing and measurement of meteorological phenomena that may affect airline operations. The Terminal Doppler Weather Radar (TDWR) and Integrated Terminal Weather System (ITWS) are two good examples of these types of technologies.

Another application of sensing and measurement technology is the measurement of pollutant concentrations in air, water, and other media to determine the environmental impacts of transportation activities. Representative examples include the USCG Marine Environmental Protection program.

A very critical application of sensing and measurement technology is the detection of people in life-threatening situations, as in the USCG Improved Search and Rescue Capability program.

Programs that are concerned with developing collision warning and avoidance require research in sensing and measurement technologies. Thus, the USCG Waterways Safety Management and Aids to Navigation program includes research on the effectiveness of sensors for vessel traffic control.

Participants: DOD (USACE); DOT (FHWA, MARAD, USCG); NASA; NSF; state transportation agencies; Civil Engineering Research Foundation; manufacturers; construction firms; universities.

Micro/Nano Devices

Summary: Partnerships in this area would support research and development of micro- and nano-scale devices with potential transportation applications, for example, sensors and micro-controllers for airbags, "smart" antilock brakes, engine controls, and vehicle vibration sensors.

The New Ultrasonic and Magnetic Analyzer for Cracks (NUMAC) has been successfully developed, demonstrated, and delivered to FHWA. Global bridge deflections or vibrations are measurable by a coherent laser radar system. The measurement can be used to detect changes in the condition of the bridge and for modal analysis as an inspection device. It is currently in use at the Turner Fairbanks Highway Research Center (TFHRC) Structures Laboratory to measure deflections of the curved steel bridge test frame. The Precision Electromagnetic Roadway Evaluation System (PERES) for detailed high-resolution bridge deck inspection is operational and available for use.

Likewise, the High Speed Electromagnetic Roadway Mapping & Evaluation System (HERMES) has been fully developed and is being field tested around the country.

The FAA program in explosives and weapons detection develops new, improved methods and technologies to detect explosives in checked, and carry-on baggage, on passengers, in air cargo, and in mail. Weapons detection for passengers, personnel, and their carry-on luggage prevents the armed takeover of aircraft. These improved methods and technologies are used in airports prior to aircraft boarding. This program area also develops standards and specifications for test and certification or approval of detection equipment.

Some programs are developing technologies for non-invasive, cost-effective ways of detecting dangerous and illegal goods. Thus, the RSPA-led Transportation Infrastructure Assurance R&D program includes detection technologies to detect explosive, toxic, and biological agents. Similarly, the USCG Comprehensive Law Enforcement program is developing technologies to detect illegal drugs and other contraband aboard vessels without the necessity of boarding the vessels.

Another possible application of sensing and measurement technology is the cost-effective early detection of corrosion and failure of critical structural components of infrastructure and vehicles. The RSPA Pipeline Safety program is developing "smart pig" and other detection technologies to provide low-cost, effective early warning of pipeline corrosion.

A part of the mandate of the RSPA Human Factors Research program is to develop real-time operator performance measurement and fatigue detection technologies.

Participants: DOD; DOT (NHTSA, RSPA); NSF; vehicle, component, and equipment manufacturers; universities.

Tools for Transportation Modeling, Design and Construction

Enabling research in this area provides tools and procedures for simulation, modeling, design, and analysis of transportation systems and their components. Such research focuses on developing information and techniques to evaluate system design improvements, alternative operational concepts and strategies, and performance characteristics likely to result from innovations. Priority areas include:

Transportation System Design Tools

Summary: The focus of this research would be to develop improved tools and methods that support transportation system design, with an emphasis on process re-engineering. Including computer models and simulations (for example, the Transportation Analysis Simulation System, or TRANSIMS), as well as computer-aided design, such tools would be integrated across all institutions involved in the transportation design and planning process.

Another application of these tools is in the modeling of flows, which is relevant to a large number of DOT R&D programs. Thus, the USCG Waterways Safety Management and Aids to Navigation program includes research on developing decision tools for waterway managers based on modeling vessel traffic flows. An unfamiliar example of this application is the RSPA-led Transportation Infrastructure Assurance R&D program, which addresses such issues as modeling passenger and bag flow analysis at airports, and passenger flow at transit terminals, to develop effective screening and security interventions as well as effective evacuation strategies.

Participants: DOD (USACE); DOT (Office of the Secretary, FHWA, MARAD, USCG); NSF; state and local agencies; universities.

Modeling and Simulation of System Performance and Impacts

Summary: This research would provide the analytical methodologies and supporting data to forecast system use and impacts at the level of the individual vehicle. These tools would be capable of interfacing with real-time infrastructure condition reporting systems (see National Intelligent Transportation Infrastructure) to support both short- and long-term planning and would be applicable to transportation policy development, economic and contingency planning, and impact assessment.

NHTSA's Partnership for a New Generation of Vehicles (PNGV) program includes the development of vehicle/occupant system models to evaluate the crashworthiness performance of PNGV conceptual designs. It also is developing an analytical model of the U.S. traffic environment, including vehicles, crash modes, and crash frequencies. In FY 2001, the program will apply the developed models to evaluate the baseline platforms upon which the PNGV vehicles are based.

The RSPA-led Human Factors Research program includes development of models for human-machine interaction.

Participants: DOD (USTRANSCOM, MTMC); DOE (LANL); DOT (BTS, FAA, FHWA, FRA, FTA, MARAD, NHTSA, USCG); EPA; Federal Geographic Data Committee; state and local agencies; industry; universities.

Transportation and Logistic System Operations and Management

Summary: In this area, research partnerships would look at applications of information technology and other tools to support operation and management of transportation and logistic systems and to assure seamless integration across organizations, modes, and institutions.

The FAA's Advanced Technology Development and Prototyping program recognizes that a capability is needed to operate a modeling and simulation tools network to include environmental noise impact analysis tools, all of which are needed to engineer the airspace redesign function.

A typical application of modeling, design and construction tools is the development of decision tools for emergency situations. The RSPA-led Transportation Infrastructure

Assurance R&D program and the RSPA hazardous materials R&D programs include modeling the effect of disasters on the infrastructure and developing procedures for effective emergency response based on these models. Similarly, the USCG Marine Environmental Protection program and Improved Search and Rescue Capability program are developing information systems for better coordination of emergency cleanup efforts and search and rescue efforts, respectively.

Participants: DOD; DOT (FHWA, ITS Joint Program Office, MARAD, USCG); state and local agencies; port and airport authorities; transportation service providers; universities.

Social and Economic Policy Issues

An important component of any R&D program is the evaluation of costs and benefits and measurement of program effectiveness in terms of quantifiable performance goals that link program activities to social and economic outcome goals.

Whether made in the public or private sector, transportation decisions must address a widening range of considerations: safety and environmental impacts, economic effects for the Nation as a whole and for various segments of the population, energy and petroleum consumption, and global competitiveness. Many stakeholders are involved, and the realities and uncertainties are complex. In particular, national policies place heavy burdens on state and local agencies for planning and decision making in many complicated areas related to transportation. There is a need for research leading to the development of a broad knowledge base that can support decision-makers as they assess transportation options and alternatives. Some priority areas are:

Transportation Planning, Economics, and Institutions

Summary: The objective of this research would be to identify and characterize the needs and interests of all parties involved with the transportation system and to understand transportation's economic, financial, and institutional context.

The FAA's program on Energy and Environment sponsors a large amount of research in this area. A 1995 NSTC report noted that "Environmental issues are likely to impose the fundamental limitation on air transportation growth in the 21st century." Thus, scientific assessment and development of safe and affordable options for mitigating the impacts of aircraft noise and emissions are important to protect the environment and to sustain the growth of aviation. The FAA has adopted the following strategies:

- Balance noise reduction with adequate airport capacity through a cooperative development effort
- Minimize adverse environmental consequences and comply with all Federal statutes
- Reduce noise, emissions, and energy consumption by the aviation sector by stimulating private industry and Government sponsored research
- Harmonize international aircraft noise and engine emissions certification standards

The environment is directly impacted by highway transportation, and the FHWA addresses such concerns through R&D efforts. Transportation facilities, including highways, are major contributors to the quality of life in communities. They can be major factors affecting the quality of the natural environment, especially air quality. FHWA's major objectives in this area are to enhance community and social benefits of highway transportation and improve the quality of the natural environment by reducing highway-related pollution and by protecting and enhancing ecosystems. Initiatives in planning, environment, analytical models, new technologies, and research will help to ensure that highway facilities balance local, regional, and national concerns with the natural environment while also adding value to the community.

The RSPA Research and Technology program has significant activity in this area, encompassing all DOT R&D. The RSPA Hazardous Materials Research and Analysis program performs social and economic analysis of hazardous materials safety programs. The RSPA Pipeline Safety and hazardous materials programs, and the USCG Marine Environmental Protection program are concerned with prevention, detection, and mitigation of environmentally destructive hazardous material releases.

Participants: DOC; DOE; DOL; DOT (BTS, FAA, FHWA, FRA, FTA, MARAD, NHTSA, OST-P, RSPA, USCG); NSF; USDA; state and local agencies; international organizations; industry; universities.

Social Impacts of Transportation Systems and Operations

Summary: Research in this area would explore the complex relationship between transportation and society, including transportation's impact on wealth, poverty, and inequality; the social consequences of transportation innovations; transportation and race; and the relationship between mobility and well-being.

The Department has led an aggressive program to facilitate the transportation of older adults. To this end, the Office of the Secretary (OST) Policy Office recently led a study of how older adults interact with the transportation system (DOT 1997b). NHTSA has developed a notebook that provides guidance to states and local communities on how to develop and implement safe driving and transportation programs for older drivers. FTA plans to develop a workbook describing exemplary transportation services for older persons. The Department recently participated in seminars and workshops dealing with older adults transportation issues, including focus groups with older adults themselves. NHTSA, with TRB, is leading the development of a new slate of needed research. Work is well under way toward the development of a national agenda and strategic plan.

OST is developing and implementing a transportation economic policy through several R&D projects. One such project – economic and international trade trends and implications for freight transportation – will examine the rapid changes forecast for both the composition of the U.S. economy and the nature and level of international trade. This research will be an important element in the Department's strategic objective of

identifying and developing global transportation corridors and the movement of freight thereon.

The general objectives of the OST transportation economic policy program are threefold:

- Identify current and emerging transportation policy issues, analyze the economic and institutional factors relevant to those issues, and develop legislative and program management recommendations as part of this process
- Develop policies, program guidance and data analyses that foster the integration of transportation system components into an efficient, interrelated modal system serving national goals and objectives
- Determine the economic and other impacts of Federal financial assistance and regulation of public transportation facilities and services

Participants: DOT (Office of the Secretary, BTS, FHWA, FTA, NHTSA, RSPA); EPA; HHS; HUD; NSF; USDA; state and local agencies and organizations; not-for-profit organizations; foundations; industry; universities.

Transportation Trends and Projections

Summary: The inherently long lifetime of transportation vehicles and infrastructure, sometimes measured in centuries, requires a forward-looking perspective in transportation planning and investment. This research activity would examine the likely consequences of current trends and project realistic future scenarios that bear on the supply of and demand for transportation services.

Participants: DOC; DOD; DOE; DOL; DOT (BTS, FAA, FHWA, FRA, FTA, MARAD, RSPA, USCG); NSF; state and local agencies; international organizations; industry; universities.

Chapter VI
Education and Training Aspects of Transportation R&D

One of the most important components of the Department's R&D management strategy is to assure continued investment in the skills and abilities of the professionals responsible for designing, constructing, operating and maintaining our Nation's transportation system. That transportation work force now consists of more than ten million persons. Education and training strategies ensure a continuing investment in the human capital of those who plan, design, construct, operate and maintain the transportation system. Hence, they are a critical underpinning of transportation R&D occurring within the U.S. Department of Transportation and other agencies.

The integration of research and education is the hallmark and strength of our research and education system. Indeed, an important rationale for the Federal investment in university-based research is derived from training a new generation of scientists and engineers. Without people to create, apply, and exploit new ideas, there is no innovation process. Innovation demands not only a trained cadre of scientists and engineers to fuel the enterprise, but a literate and numerate population to run it. The transportation system of the 21st century will require the human capital necessary to develop, apply and use advanced research and technology to the Nation's transportation system.

As the world community enters the next century, the quality of research and education remains a major factor in the Nation's ability to excel. The United States has been historically fortunate in achieving high returns on its investments in learning. Past achievements and investments, however, do not ensure future success. While many policy areas in the U.S. have long established commitments to learning, transportation issues are relatively nascent.

Overview and DOT Involvement

Traditional concepts that involve learning, encompassing both research and education, are radically changing. They are now overshadowed by new realities brought about by technology, globalization, changing demographics and innovative learning opportunities. Sophisticated research can now be done via computer simulations and the Internet in addition to the traditional laboratory setting. New education concepts, such as virtual learning, both challenge and build upon traditional teaching mechanisms.

All of this is important to the field of transportation since a vibrant system is based not only on a physical infrastructure, but also on human capital. Human capital develops the next generation of transportation professionals and acts as the 'engine of growth' for future innovation. Investments in human capital are far-reaching -- from the mechanic who repairs equipment; the policy planner who envisions solutions, to the administrator who is responsible for the entire system. Such investments also benefit students

contemplating a career in transportation or individual citizens interested in learning more about transportation issues.

The Department's new *Transportation Research and Education Plan* (EOP NSTC 2000b)[1] provides insight into the current Federal transportation learning initiatives with a specific focus on institutions at the post-secondary level. It also builds on the legacy that the Secretary of Transportation, Rodney Slater, is working to establish through the Garrett A. Morgan Transportation and Technology Futures Program. This Plan consolidates the Department's overall options for supporting research and education at the post secondary school levels, and includes a compilation of current, federal research and education activities. Long term, the plan's goal is to exploit the vast potential that can result in an international network where research and learning support new transportation endeavors. It thus begins a portfolio of collective investment in transportation learning mechanisms that complements the DOT's strategic goals.

Developments in the Field

Formal transportation programs have broadened beyond traditional disciplines like civil engineering and physical science. The Federal government now provides resources — matched by state or local funding — through the national University Transportation Centers (UTC) network.[2] This includes funding for teaching and research, as well as a technology transfer to link transportation education needs. The UTC program benefits academicians and practitioners who wish to learn new skills or to enhance their current knowledge. This is one of the key components of the Garrett A. Morgan Transportation and Technology Futures Program that seeks, as part of its mandate, to support the efforts of the traditional higher education learning process through colleges and universities, as well as at the vocational level. In FY 2001, the DOT intends to create a departmental University Research and Education Program that builds on the UTC and provides the research and workforce base required for the transportation system of the 21st century.

The Federal government's research commitments are critical elements of the innovation process. Basic research supports the development of products and services that will create the transportation enterprise of the future. Enabling research supports the transformation of existing products and services. Advancing innovation through research and education is recognized as a key "enabler" for reaching the DOT strategic goals. Federal funding and incentives for transportation activities also involve coordination with

[1] Forthcoming.

[2] From legislative authority originating from the 1987 Surface Transportation and Uniform Relocation Assistance Act (STURAA), Congress mandated a series of university transportation centers--later supplemented by university research institutes--to specifically provide leadership in transportation education teaching and research. In 1991, the Intermodal Surface Transportation Efficiency Act, and then the 1998 Transportation Equity Act for the 21st Century (TEA-21), PL 105-178, expanded the number, the funding, and the scope of these programs.

policy constituencies, such as defense, communication, energy, environment, and urban-rural affairs.

These factors support the evolving focus of the "transportation professional." Transportation education is no longer viewed as just a series of college courses, and transportation research is no longer viewed as simple incremental improvements to the existing infrastructure. Rather, the transportation policy paradigm is shifting away from "bigger is better" to managing the existing infrastructure systems more effectively and building new infrastructures more efficiently. This is being done through enhanced management systems, improved products and intelligent transportation systems that are dependent upon, in part, federally funded investments in research and education.

The University-based Transportation Research and Education Community

University-based research and training in transportation involves several distinct partnerships. The largest, formal network revolves around the UTCs, a national grouping of universities, each with a specific policy focus. These Centers interact directly with the various modes within the Department, and other Federal and state agencies. The UTC goals are to foster excellence in the areas of teaching, research, and technology transfer for those interested in transportation issues.

DOT modal administrations have their own learning-based programs based on areas of specialization (see Table VI-1): some have an education focus (e.g., FRA Operation Lifesaver Program) while others have a research focus (e.g., FTA Transit Cooperative Research Program). The Department also supports specialized initiatives. For example, one of the objectives of the Eisenhower Fellowship Program is the improvement of minority representation in transportation.

Additionally, the Department supports White House Initiatives aimed at the Nation's Historically Black Colleges and Universities (HBCU), Hispanic Serving Institutions, and Tribal Colleges. Several departmental organizations support initiatives aimed at introducing minority students to careers in transportation, including the provision of opportunities directed at involving Minority Serving Educational Initiatives in DOT R&D.

DOT efforts increasingly include partnerships with other groups. The trend shows every indication of continued growth. Some partnerships involve coordination with the network of Federal research laboratories. Other opportunities exist through coordination with professional associations. Nonprofit organizations are another potential source for partnership activity to build and expand learning in transportation.

"Products and services" in the transportation learning enterprise traditionally have been through formal degree programs in transportation and transportation-related disciplines Non-degree training packages initially provided enhanced skills or new expertise through

Table VI-1. Matrix of Learning Opportunities Offered by DOT Modal Agencies

Learning Opportunity	FAA	FRA	FTA	RSPA	NHTSA	FHWA	MARAD	USCG	SLSC	BTS
Grants	X	X	X		X	X	X	X		X
Fellowships	X	X	X		X	X	X	X		X
Internships	X	X	X	X	X	X	X	X		
Joint University Programs	X	X	X	X	X	X	X	X	X	
Centers of Excellence	X	X	X	X	X	X	X	X		
Mentoring Programs	X	X	X	X	X	X	X	X	X	X
Public/Private Partnerships	X	X	X	X	X	X	X	X	X	

SOURCE: from briefing materials provided at DOT University Research and Education Plan Meeting, August 26, 1999, Arlington, VA

either short courses or in-service lecture series. Traditional beneficiaries include students at the undergraduate and graduate level. Research is the second line of "products and services." Traditional research was often narrowly focused for a specific audience (e.g., building a better road) but the situation is now changing. Current topics include human factors, environmental concerns, energy alternatives, and financial considerations. This creates new opportunities for non-traditional, transportation-oriented scholars.

Technology usage and technology transfer is growing in importance. Both education and research are becoming more dependent upon computerization, communication, and technology. The collective investment in transportation learning activities and products results in a massive sharing of knowledge and ideas that benefits the academic community, practitioners, and the end users, the citizens who pay for and use the system.

Transportation learning offers other potential benefits beyond a formal, technical education. Transportation educators and advocates realize the importance of providing opportunities that lead to: 1) networking and career development; 2) diversity awareness; 3) historical consciousness. Spin-off benefits support not only transportation, but also engineering, environmental, management, human resource, and diversity programs. All these serve to increase the multidisciplinary aspect of the learning process and make it a more attractive lifelong learning endeavor. As transportation careers become more global in character and approach, these benefits will be of great value.

Twenty First Century Challenges and Opportunities

As we begin the 21st Century, four major trends will help drive the education and research innovation process:

- Impacts of globalization
- Role of technology

- Challenges of changing demographics
- Implications of curricula development

Globalization

Private sector transportation organizations provide products, services, and research capabilities to a diverse and increasingly competitive world community. Public sector transportation is responsible for the development, implementation, and maintenance of existing and evolving transportation infrastructures. Transportation education and partnerships act as catalysts to bind these forces together by supporting innovation and change.

Globalization will impact the changing academic environment. In a direct sense, it supports the internationalization of resources, not only in the individual classroom, but also in the research facility and the workplace. Innovations in learning and transportation R&D also facilitate the drive toward globalization. Global transportation education supports industrialization, the movement of goods and people, enhanced resources, better communication, and improvements in the quality of life for all countries. Because globalization enhances competition, education stakeholders can show leadership through innovative research projects as well as by utilizing technology and communication to share resources and knowledge.

Technology

By combining technology and education, there is the opportunity to build new technology, improve existing infrastructure, develop world class facilities, enhance capital investments, create alternative energy sources, improve the environment, and make better communication alternatives. Just as transportation innovations acted as an "engine of growth" during the Industrial Revolution, they are part of the new drivers of the technology revolution.

This technology revolution will have a major impact on transportation education. Within the teaching environment, the use of computers as learning tools is revolutionizing how students study existing theoretical and practical problems, and how they devise solutions to future transportation scenarios. Within the learning environment, research methodologies and outcomes are bringing about continuing change in tabulating and evaluating complex quantitative problems, and in information storage and retrieval. Distance learning opportunities available through the Internet now present themselves to academics and practitioners, even in remote locations. Technology is also being used as an information and learning tool to interest young students as well as those who wish to know more about the field.

Demographics

Transportation education must take into account the changing demographics in the workplace. The traditional scope of jobs and careers is broadening to include women and minorities in key managerial and leadership positions. Education is an essential component in preparing and sustaining these individuals throughout their careers within the transportation hierarchy. The Eisenhower Fellowship Program, for example, is a

catalyst for training and technology transfer, and a means of enhancing teaching for transportation faculty.

Opportunities exist to extend the learning process down to the secondary and elementary levels, thus capitalizing on students' interest in computers and high technology. At the other end of the spectrum are the needs of the older, established practitioners who need to maintain their existing knowledge and skills in the face of massive technological and policy changes.

Curricula Development

The traditional foci of engineering curricula are now supplemented by skills that emphasize management concepts and policy issues. Intermodal education is another important change taking place in transportation. In the past, transportation options were tied to specific modes, but shippers and passengers now often use a combination of modes that travel time and cost can be optimized. Emerging technological innovations are making intermodalism increasingly viable, and the needs of the profession in this area offer challenges for transportation education.

Transportation professionals must also have the ability to see how their work impacts the environment and the use of energy. They must have the skills to understand how their decisions relate to community stakeholders. At the same time, there is the ongoing upgrade of curricula, based on the impacts of technology on infrastructure development, communications, and product design.

Components of a Transportation-Focused Research and Education Plan

The Department's efforts have traditionally centered on the University Transportation Centers Program. Their mission is to advance U.S. technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research, and technology transfer at university-based centers of excellence. Communication and support are provided by formal and informal means.

Participants and Partnerships

In order to understand the research and education focus on transportation, one must understand the participants and what they contribute. Because of the vast number of activities, the challenge is not to try to learn everything, but to set up and publicize what is available. This might involve innovations in classroom learning or cutting edge research. We also need to develop a framework so that transportation-related learning materials and opportunities are transferred to those who can benefit. It is an ongoing effort supported by Internet technology and communication mechanisms, as well as linkages to other resources.

The Department needs to build partnerships as it builds resources. DOT is a logical focal point to establish and maintain this type of effort — strengthening internal linkages and

coordinating with other Federal agencies and labs in order to share information, avoid duplication, and develop complimentary resources. Additional opportunities exist to collaborate with state, local, and municipal governments, especially those with special needs or limitations. Beyond the public sector, partnerships with traditional allies — universities, non-profits, and labor unions — continue to offer fruitful possibilities for joint efforts. The overall challenge is to build these concentric linkages together in order to promote transportation learning in a seamless manner.

Tracking and Measurement

A good tracking system is needed for the research and education plan. Resources for learning are limited and finite. While technology brings about improvements in speed and capacity, it may involve large initial or ongoing expenditures that are beyond the means of many learning establishments. At the same time, needs and expectations are continually changing as research opens new opportunities. Government investment in transportation learning is a commitment to building and maintaining the public interest in education.

Research and education are sometimes seen as separate entities. From a traditional viewpoint, research provides the innovative direction for future education efforts. It builds fundamental skills, maintains those that already exist, and develops new ones. The research process can also be an effective tool to generate interest in a topic, either among established researchers or by those considering career choices.

Research provides a powerful opportunity to develop an interest in transportation topics among the next generation of professionals. Examples include policy research that interests traditionally under-represented portions of the population, research aimed at the vocational and technical school level, and research infusion to other countries that are building or rebuilding their transportation enterprise.

Measuring success involves different factors — tangible and intangible, quantitative and qualitative, short term and long term. Benefits include development of the next generation of transportation leadership, creation of a transportation learning infrastructure, new learning opportunities, and innovation that meets known and unforeseen challenges. The *DOT Research and Education Plan* will support a safe and efficient transportation system, and serve as a benchmark for research, education, training, and technology transfer in a highly competitive, global environment.

In order to compete and to demonstrate leadership, students and practitioners must have: 1) technical knowledge and skills; 2) analytical ability; 3) communication and intercultural skills; and 4) technology skills. At the same time they need non-traditional skills, such as the ability to negotiate between diverse interests, insights into strategic management of human and capital resources, as well as specialized policy skills. Educators and administrators must meet changing demands through curricula development and research opportunities provided by their institutions. As part of this there must be an ongoing commitment to broaden the focus beyond "traditional learning" to "students" of all ages.

Government and educational establishments are unable to accomplish these challenges on their own. There must be a commitment by numerous stakeholders in order to supply tangible items like funding, scholarships, grants, research opportunities, internships, mentorships, laboratories, and technology resources. These must be interlaced with vision and ongoing leadership. New partnerships are needed to supplement existing solutions and to develop new opportunities, thus bridging the gap between academic, public and private sector interests. In a world of highly competitive resources, the partners need to market their accomplishments to the outside world in order to build interest and support for their programs.

Chapter VII
State and Local Research and Technology Development Activities

State and Federal transportation agencies in the United States conduct a wide range of research projects aimed at improving the safety, operation, ride quality, environmental impact, and performance of the nation's highway system as well as other transportation modes. Agencies strive to coordinate their work and avoid duplication of effort, but further gains are attainable by developing a comprehensive, coordinated national research and technology program that will leverage available resources.

Until recently, detailed and comprehensive information about state transportation R&D activity has been relatively scarce at the national level. One recent study, an effort sponsored by the National Science Foundation (NSF) using FY 1995 budget activity, found that total state R&D in FY 1995 was $3 billion (see Battelle and SSTI 1998). Of that, total state transportation R&D from all funding sources (Federal, State, industry, and other) amounted to $171 million.

That study went on to report that transportation R&D funded wholly from state funds was $83 million. The five largest state-funded transportation R&D programs in FY 1995 were Texas $28.7 million, California $17.2 million, Michigan $5.1 million, Kansas $4.2 million, and Pennsylvania $3.8 million.

The AASHTO Study

Much more recent and detailed is an October 1999 survey of state DOTs by the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC). The questionnaire requested information on research, development and technology (RD&T) priorities, funding, and program trends occurring at the state level. Other parts of the survey sought information on the coordination of transportation research, and evaluation and peer exchange. Thirty-one states had responded to the survey at the time that this report was prepared (see Appendix D for a copy of the AASHTO questionnaire). Where opportunities exist for partnerships and regional state cooperation, there is good evidence from survey results that effective coalitions, communications and information sharing are in place and working as planned.

R&D Program Funding

States that responded had $125 million in funding for R&D activities in FY 1999. This includes all R&D activities — including State Planning and Research (SP&R) funds, state matching funds, other Federal funds, other state funds, and other funds — for all modes. The maximum reported by any state was $18 million, while the lowest was just $250 thousand. By source of funds, states received about 64 percent of their R&D dollars from SP&R funds. By mandate, states must spend a minimum of 25 percent of all

their SP&R funds for research. On average, the 31 states reported spending just over 26 percent of SP&R funds on R&D, with a maximum of 48 percent reported by one state.

State matching funds accounted for about 11 percent of the total, while "other state funds" comprised almost 17 percent of total available R&D funds. In terms of R&D programs, university researchers received 44 percent of funds (see Table VII-1). Agencies in-house staff received 24 percent of funds. The next largest program category was for NCHRP support, which claimed about 11 percent of all state R&D funds.

Research activity directed at roadways and bridges is a primary activity of most state DOTs. Not surprisingly, results obtained from the RAC survey indicate that the majority of state R&D funds — 85 percent — were invested in the highway mode. By contrast, expenditures on aviation and marine modes consumed less than one percent of state R&D money.

Table VII-1. State R&D by Program

R&D Program	Percent of Total State R&D (avg.)
University researchers	44.6
In-house Staff	24.1
NCHRP Support	11.3
Consultants	5.2
LTAP Support	4.4
University Transportation Centers Support	3.2
Regional Pooled Funds Studies	3.0
National Pooled Fund Studies	2.1
Other	4.1

Respondents also estimated future transportation R&D expenditures out to the year FY 2005. Starting from a base year of FY 1998, the 31 states estimated a total growth of 74 percent in R&D expenditures over this period. By fund category, states estimated that "other state funds" would grow the fastest over the FY 1998-2005 time frame, calculated as a percent change of 110 percent. Other Federal funds (non-SP&R) were estimated to have the slowest growth (45 percent) over the same period.

In response to a question — "in your ideal program, by what percentage would you change the funding allocated to each of the following RD&T activities?" — States most frequently cited the "implementation of research results" among such activities (see Table VII-2). The average state would increase funding for this activity by over 56 percent. This may signal that states are becoming more anxious to see quicker, real-world results from sponsored research. The same trend toward technology transfer and implementation was also borne out in other parts of the questionnaire. Other areas for which states would like to increase funding are listed in the table.

Respondents were asked about their RD&T program trends and how funding has changed over the past three years, and how it is anticipated to change over the next three years (see Table VII-3). Partnerships and cooperative activities appear to be dynamic aspects of many states' R&D efforts. Similar to trends firmly established at the Federal level,

Table VII-2. State R&D Funding Ideals

RD&T Activity	Percent Change for Ideal Program (avg.)
Implementation of research results	56.3
Hire research staff	24.1
Perform staff research	18.9
Sponsor research cooperatively with other states	17.9
Support university research	15.7
Intelligent Transportation Systems activities	12.5
Perform contract research	11.8
Provide training and technology transfer	9.9
Purchase computers, instrumentation, or equipment	8.8
Implementation of SHRP results	0.5

state agencies find it productive and more efficient to form coalitions in the conduct of R&D. This helps to leverage increasingly scarce resources, gives breadth and perspective, and speeds technology transfer to projects that might otherwise have been limited in scope or geography. Some of the strongest growing categories of the past few years are expected to assume lesser importance in the next three years. For example, university research, the total RD&T budget, state RD&T finding, and testing/evaluation activities are all anticipated to increase but at more modest rates. On the other hand, aviation, rail, and contract research activities are anticipated to assume higher levels of funding in the next few years. Only funding for marine activity shows an absolute decline in among survey respondents.

Table VII-3. State RD&T Program Funding Trends

Program Category	Percent Change in Past 3 Years	Anticipated Percent Change in Next 3 Years	Expected Trend*
Partnerships/alliances (cooperative research)	70.9	102.1	Rising
University research activities	64.5	16.9	Rising at decreasing rate
Total RD&T budget	49.6	8.6	Rising at decreasing rate
Intelligent Transportation Systems activities	31.9	20.6	Rising at decreasing rate
Highways	30.0	24.2	Rising at decreasing rate
Testing and evaluation activities	24.8	5.4	Rising at decreasing rate
State RD&T funding	24.7	10.1	Rising at decreasing rate
Intermodal	12.0	8.7	Rising at decreasing rate
Transit	11.3	8.2	Rising at decreasing rate
Motor Carrier	9.6	8.5	Steady
Department research staff size	8.8	4.2	Rising at decreasing rate
Marine	5.0	-2.4	Falling
Aviation	4.8	22	Rising
Rail	0.9	23	Rising
Contract research activities	0.1	16.0	Rising

*Data in this column were not part of survey.

State R&D as Part of a National Research Agenda

Respondents were also asked how important it was that AASHTO adopt a national research agenda. Such an agenda would identify common research needs, priorities and goals, and would list specific research projects that state, Federal, academic, and industry groups could sponsor or perform to achieve these goals. On a scoring scale of 1 to 5, with 5 being "vitally important," the average answer was 3.97. This indicates a general preference on the part of state DOTs to work with the Federal sector through coordination efforts and through R&D activities that have overlapping areas of concern.

If AASHTO were to adopt a national research agenda, states were also asked to identify major gaps in transportation RD&T or significant duplication of effort that should be addressed.

Research Gaps and Duplication of Effort

Respondents were asked to comment about possible research gaps and duplication of efforts within their states. The following types of responses were obtained.

Gaps in Transportation R&D

- University research is out-of-touch with real needs of state agencies
- Not enough emphasis placed upon development of simple evaluation procedures of existing infrastructure
- Not sure if it is major, but we need to push to technology limits on Internet and other forms of communications, not follow others. We are so distributed that this effort would hopefully lead to less duplication of effort
- Need to "close the gap" or partner more with public and private organizations that share similar goals, examples: insurance industry on safety related research – don't we all want to reduce number of crashes, fatalities; Transportation Association of Canada
- Insist on documented research. This is important given FHWA staff reductions.
- Strategies to deal with high density rail corridors
- Economic development as an issue in transportation
- Performance standards for pavement markings
- Elimination of concrete cracking in bridge decks
- Accelerated deployment of the National Transportation Product Evaluation Program's (NTPEP) and the AASHTO Product Evaluation List (APEL) Program to take the product evaluation burden off states with little staff
- Optimization of mineral admixtures in Portland Cement Concrete (PCC) in combating Alkali Silica Reaction (ASR) and delayed Ettrignite formation
- The problems of numerous uncoordinated transportation databases have made it difficult for researchers to keep track of existing, planned and developing research efforts. It has become very time consuming and costly for researchers to conduct thorough review of all ongoing efforts, a crucial task to avoid unnecessary duplication of efforts. Several efforts such as the National Transportation Library (NTL) are addressing this issue

- Environmental policy research for historic resource preservation/mitigation and for wetland mitigation
- Updating highway safety standards and countermeasures related to wet weather accident mitigation and testing standards
- Benefit/cost determinations for light rail transit as alternative to urban highway capacity improvements
- Best practices in DOT administration
- Technology transfer and peer exchange at the operational/middle-management level. We need a national teleconferencing network and initiatives to share knowledge, programs and policy

Duplication of Effort

- Accelerated pavement testing
- Need streamlined process; timely research results
- Currently there are four National Research agendas: 1) National Science and Technology Council; 2) TRB-STRS-2; 3) FHWA R&T Partnership Forum; 4) AASHTO SCOR/RAC National Agenda. If these efforts are not coordinated there will be duplication because the themes are the same
- Work performed by University Transportation Centers (UTC) is susceptible to duplication and focuses on low priority issues. The portion of a UTC program influenced by DOTs (because of the need for matching funds) is less susceptible
- Better coordination in the area of ITS research development will enhance cost-effectiveness. There is a need for systematic approach to information sharing. Also, there are numerous environmental research needs. Researchers will benefit from a more effective mechanism for research coordination and a strengthened channel of coordination with national, region and state entities associated with transportation research. Those links will ensure that duplications are avoided and maximum return on research investment is achieved.

Relationship of State Transportation R&D to DOT Strategic Goals and Performance Measures

Transportation R&D in the Department of Transportation is formulated by adherence to the goals of the DOT Strategic Plan and the National Science and Technology Council's Technology Plan. The states were asked to estimate the percentages of their RD&T activities that address the five strategic goals of the USDOT (see Table VII-4). Mobility-related R&D ranks first among state activity. The FHWA R&T program is also linked most to the mobility goals (information in the third column below is derived from FHWA, not the RAC survey). Safety ranked second in both the state DOT responses and the FHWA mapping.

Table VII-4. State RD&T by DOT Strategic Goals

USDOT Goal	Percentage of State RD&T(avg.)*	Comparative FHWA R&T by DOT Goal (FY 2001 Request)
Safety	12.2	13.3
Mobility	19.3	43.4
Economic Growth and Trade (Productivity)	10.8	10.2
Human and Natural Environment	8.5	13.9
National Security	0.2	0.5

*Totals did not have to add up to 100 percent

States were also asked if their transportation R&T program was tied to stated or published strategic goals or performance measures. Those who indicated that they did provided the following types of goals and performance measures.

- Conduct, coordinate and support transportation research
- Develop and apply new technologies in transportation
- Encourage a positive problem-solving approach to transportation problems
- Implement transportation research results
- Disseminate findings of transportation research
- Pavement condition: increase sufficiency rating 20 percent by FY 2001
- Bridge condition: reduce deficient bridges by 10 percent by FY 2001
- Congestion: reduce growth of congestion lane-miles, reduce lane-miles by 20 percent by FY 2001
- Highway Safety: reduce four-year average of deaths and serious injuries by 1-2 percent by FY 2001
- Environmental quality: to be established
- Implement QC/QA process according to established plan
- Implement SHRP products according to established plan
- Goals in printed material. These goals provide a focus for research activity, but they don't limit us from conducting other research activities.
- Safety
- Preservation
- Managing the state transportation system
- Promoting economic growth
- Providing taxpayer value
- Malcolm Baldrige Initiative
- Percent cost by study
- Percent time for studies
- Estimate of program benefit/cost

Chapter VIII
Measuring the Success of Transportation R&D Investments

Essential to a plan for research and development is an evaluation framework that links together at a very early phase the goals of specific R&D projects and programs with the transportation operations they seek to address. As described in previous chapters, transportation research and technology development projects are the products of investments targeted toward specific outcomes derived from high-level strategic goals. Time horizons may vary, but ultimately expectations for a set of downstream payoffs require measurement criteria that will yield insights and knowledge about project success or failure. Outcomes are likely to be very distant in time from the research that contributes to them. The relationship between the R&D process and societal impacts is suggested in Figure VIII-1. The process may even continue further. Feedback gleaned from societal impacts may be used to guide new research ideas, with lessons learned from one R&D life cycle applied to emergent transportation problems.

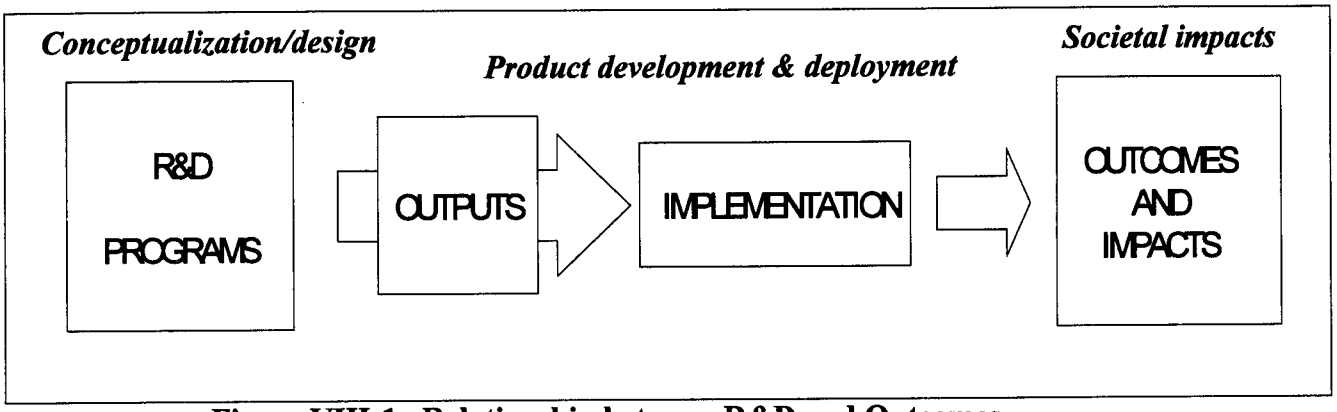

Figure VIII-1. Relationship between R&D and Outcomes

Performance measures and program evaluations show if intended outcomes are occurring as a result of investments in R&D. They are also helpful in assessing trends, or in making midstream calibrations to research designs and implementation strategies. Program evaluation uses analytic techniques to assess the extent to which R&D programs are contributing to those outcomes and trends. Among its many requirements, GPRA (see Box VIII-1) requires agencies to develop a schedule of program evaluations for inclusion in their strategic plans.[1]

[1] The DOT schedule was included in the 1997-2002 plan as an initial list, and extended considerably in the FY 2000 Performance Plan. Later, this chapter lists program evaluations planned for FY 2001, and summarizes DOT's plan for managing program evaluation within the Department.

Box VIII-1. The Government Performance and Results Act (GPRA)

The Government Performance and Results Act (GPRA), P.L. 103-62, enacted on August 3, 1993, requires the development and use of performance measures for agency management.

GPRA focuses on assessment of the broad outcomes of government programs, rather than particular outputs produced by agency expenditures. The difference between "outcomes," "outputs" and "impacts" is central to GPRA (see Table VIII-1). These distinctions are conceptually straightforward:

- **Outputs** -- *The direct, tangible result of an activity.* Products or services generated by a program or organization and provided to the public or to other programs or organizations. Generally, outputs can be measured on an annual basis.

- **Outcomes** -- *A result, effect, or consequence of the output in the performance or characteristics of the transportation system, including its effect on the Nation.* An outcome is typically the cumulative result of actions of many parties throughout the transportation enterprise, and is always affected by factors external to the organization.

- **Impacts** *–a level of consequence even broader than outcomes.* This relates outcomes to changes as perceived by users and providers of transportation, and the society as a whole. Impacts can have a long time frame and be difficult to quantify. They can include both beneficial and adverse effects.

In most cases, DOT research organizations respond to the mission-related needs of operating administration. Examples include improvements in equipment and system needed by the FAA and U.S. Coast Guard, research and analysis to guide regulatory responsibilities, and technical studies to guide and support policy decisions. R&D is often directed specifically at advancing the system in general, such as improvements in highway construction materials and processes or the application of information technology to transportation operations. Customers or beneficiaries of R&D programs include those people and organizations involved with the total transportation enterprise: state and local governments, providers of transportation services and equipment, shippers and consignees, and individual travelers.

Table VIII-1. Illustrative Examples of Outputs, Outcomes and Impacts for DOT R&D

R&D Output	Intermediate Outcome	Outcome	Impact
Consensus on information infrastructure, national architecture and standards	Guidance to state and local implementers	Interoperable and consistent national system; faster implementation	Reduced highway congestion, greater safety, better system performance
Operational NEXRAD weather radar technology	Widespread deployment of improved weather radar	Reduced air traffic delays and accidents due to weather conditions	Improved aviation system safety, efficiency and service levels
Available new technologies for marine search & rescue	Deployment of improved search & rescue tools	More effective search and rescue activities	Improved marine safety, Additional lives saved
Increased technical understanding of motor vehicle crashworthiness and biomechanics	Regulatory crashworthiness standards	Reduced injuries and fatalities in highway crashes	Improved highway safety, Additional lives saved
Available alternate-fuel buses and operating understanding of them	Purchase and deployment of new buses by transit agencies	Reduced air pollution from bus operations	Improved air quality in urban areas

DOT Annual Performance Plan

As required by GPRA, the Department has prepared the FY 2001 *Performance Plan* (DOT 2000) based on the *DOT Strategic Plan 1997-2002* (DOT 1997a). The *Performance Plan* defines performance indicators and goals, the measures and targets that will be used to judge progress in advancing the Nation's transportation system. The *Performance Plan* serves as a link between the Department's strategic goals, annual goals, and the DOT budget. It includes a basic set of system-level indicators that DOT will use to measure progress toward its goals in FY2001; these indicators provide the starting point for development of performance measures for long-term outcomes and impacts.

The FY 2001 *Performance Plan* includes 60 specific measures, each with one or more explicit performance goals, associated with the five DOT strategic goals (see Table VIII-2).

Specific examples of performance goals that are linked to strategic goals are displayed in Table VIII-3. These show quantitatively the expected baseline improvement over a given time period.

For each measure, the Department's FY 2001 *Performance Plan* presents a detailed characterization of the scope, source, baseline, limitations, verification and validation factors, and relevant comments. An example of a performance measure is shown in Table VIII-4. One of the measures used by the Department to gauge progress in highway safety R&D is the *rate of highway-related fatalities per 100 million vehicle-miles traveled (VMT)*. The highway fatality rate is often thought to be one of the more accurate yardsticks by which to look at our efforts to improve safety. It normalizes the actual number of deaths by a legitimate exposure measure, in this case VMT. Table VIII-4 also tells us about the source and scope of the data employed to construct this performance measure. It also indicates the quality of underlying data, the computation of those data, and the statistical reliability of both the numerator and denominator used to construct the performance measure. This secondary information is very important to analysts whose job it is to discern whether a given trend in rate is statistically significant and whether the outcome sought has indeed occurred.

R&D and Performance Goals

Implementation of research results often takes considerable time. Hence, current research can have only very modest impact on attainment of specific performance goals for FY 2001. In the longer term, however, on-going and future research programs will shape progress on the performance measures delineated earlier in Table VIII-2. Research provides the means to achieve stated goals, but also enables the realistic setting of even more ambitious goals. The definition and attainment of performance goals for future years will benefit from well-designed and implemented research activities that increase understanding of the issues and challenges, provide the foundation for solutions, demonstrate benefits, and generally support implementation of successful innovations.

Measuring the contributions of research, development and technology activities to the achievement of those goals poses a special challenge. R&D is generally a component of broader programs directed toward specific mission responsibilities and the achievement of the DOT strategic and performance goals. Ultimate realization of those goals, however, depends in large part on many factors that can be distant from the underlying research. Further, in the transportation world, Federal activities are generally only a part – often a small part – of achieving outcomes. Much of the responsibility for implementation falls to the private sector and state and local public agencies. Moreover, final consequences are determined largely by the actions and choices of transportation system users, providers and other affected parties.

The difficulty of linking R&D to specific outcomes does preclude the application of performance-oriented management processes to DOT research programs or the incorporation of R&D activities into the broader framework of the Annual *Performance Plan*. Likewise, it does not prevent meaningful consideration of the real or potential contribution of specific research to particular future accomplishments.

Table VIII-2. FY 2001 Performance Measures for DOT Strategic Goals

Safety (16)	
Surface	Highway Fatality and Injury Rates
	Alcohol-Related Highway Fatalities
	Seat Belt Use
	Large Truck-Related Fatalities and Injuries
	Rail Accident and Fatality Rates
	Rail Grade-Crossing Crash Rate
	Transit Fatality and Injury Rates
	Pipeline Failures
	Hazardous Materials Incidents
Air	Air Carrier Fatal Accident Rate
	General Aviation Fatal Accident Rate
	Runway Incursions
	Operational Errors (Air Traffic)
Marine	Recreational Boating Fatalities
	Mariner Rescue
	Passenger Vessel Safety
Mobility (15)	
Surface	Highway Pavement Condition
	Highway Bridge Condition
	Highway Congestion
	ITS Integration
	Amtrak Ridership
	Transit Ridership
	Bus and Rail Transit Fleet Condition
	Transportation Accessibility
Air	Runway Pavement Condition
	Aviation Delays
	All Weather Access to Airports
	Essential Air Service
Marine	Maritime Navigation
	Impediments to Port Commerce
	St. Lawrence Seaway Lock Availability
Economic Growth and Trade (9)	
Surface	Appalachian Highway System
	Highway Border Crossings
	Access to Jobs
Marine	Great Lakes Winter Navigation
	Commercial Shipbuilding
Air	Flight Route Flexibility
	International Air Service
Cross-Modal	Transportation and Education
	Disadvantaged Business Contracting
Human and Natural Environment (11)	
Surface	Mobile Source Emissions
	Wetland Protection and Recovery
	Livable Communities – Transit Service
	Pipeline Spills
Air	Aircraft Noise Exposure
Marine	Maritime Oil Spills
	Fisheries Protection
Cross-Modal	Greenhouse Gas Emissions
	Energy Efficiency
	DOT Facility Cleanup
	Environmental Justice
National Security (9)	
Air	Aviation Security
Marine	Sealift Capacity
	Mariner Availability
	DOD-Designated Port Facilities
	Ready Reserve Force (RRF) Activation
	Military Readiness (USCG)
	Drug Interdiction
	Migrant Interdiction
Cross-Modal	Critical Infrastructure Protection

Table VIII-3. Examples of Transportation Performance Goals Linked to DOT Strategic Goals

Strategic Goal	Performance Goal
Safety	• Reduce the rate of highway-related fatalities per 100 million passenger miles traveled from 1.7 in 1996 to 1.5 in 2001. • Reduce the rate of rail-related fatalities from 1.48 per million train miles in 1999 to 1.30 or less in 2001. • Decrease the number of natural gas transmission pipeline failures from 4,933 in 1994 to 4,375 in 2001.
Mobility	• Reduce the percentage of ports reporting landside impediments to the flow of commerce from 41 percent in FY 1998 to 37 percent in FY 2001. • Increase the percentage of bus fleets that are ADA-compliant from 73 percent in FY 1996 to 83 percent in FY 2001.
Economic Growth And Trade	• Reduce the hours of delay of NHS border crossings per 1000 vehicles processed in FY 2001. • Increase the number of flight segments that aircraft are able to fly off ATC-preferred routes from 75 percent in FY1996 to 80 percent in FY 2001.
Human and Natural Environment	• In FY 2001 increase to 11.78 percent the percentage of urban population living with a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour), compared to 11.22 percent in FY 1996. • Increase the cumulative number of students reached through the Garrett A. Morgan Technology and Transportation Futures Program from 1,031 in FY 1999 to 5,000 in FY 2001.
National Security	• Increase the seizure rate for illegal drugs from a 1995-1978 average to 8.7 percent of the total amount shipped to 15 percent or more in FY 2001. • Increase ship capacity (in 20 foot TEUs) available to meet DOD's requirements for intermodal sealift capacity from 161,258 in FY 1999 to 165,000 in FY 2001.

Table VIII-4. Detailed Characterization of a Performance Measure: the Highway Fatality Rate

Measure:	**Fatalities per 100 million vehicle-miles traveled (VMT)**
Scope:	Number of fatalities come from Fatality Analysis Reporting System (FARS) data, a census of fatal traffic crashes within the 50 states, D.C. and Puerto Rico. To be included in FARS, a crash must result in the death of an occupant of a vehicle or a non-motorist within 30 days of the crash. The FARS database is a 100 percent count of fatal crashes collected from police crash reports, and other state data. FARS data cover all roadways open to the public, using the National Highways System classification of roads. Pedestrian and bicycle fatalities that occur on public highways but do not involve a motor vehicle are not recorded in FARS; however, this is a small number of fatalities. Vehicle Miles of Travel (VMT) data are calculated using FHWA 's Traffic Volume Trends (TVT), a monthly report based on hourly traffic count data in the Highway Performance Monitoring System (HPMS). These data, collected at approximately 4,000 continuous traffic counting locations nationwide, are used to determine the percentage in traffic for the current month to the same month the previous year. This percentage change is applied to the travel for the same month the previous year to obtain an estimate of nationwide travel for the current month. The data are recorded as monthly totals and cumulative yearly totals.
Source:	NHTSA's Fatality Analysis Reporting System (FARS) for fatality data. VMT data derived from FHWA's Traffic Volume Trends (TVT) monthly report. Information is transmitted to NHTSA and entered into the system after undergoing data review by NHTSA.
Limitations:	VMT data are subject to sampling errors whose magnitude depends on how well the locations of the continuous counting locations represent nationwide traffic rates. Also, HPMS is subject to estimating differences in the states, even though FHWA works to minimize such differences and differing projections on growth, population, and economic conditions which impact driving behavior estimating differences in the states, even though FHWA works to minimize such differences and differing projections on growth, population, and economic conditions which impact driving behavior.
Statistical Issues:	The primary source of uncertainty in estimating fatality rates is the denominator. Although the numerator estimate of total fatalities is relatively accurate, the estimate of total vehicle miles in the denominator is far more variable. Additionally, using data from 1993-1998, the annual variation in the fatality rate attributable to random chance has a regression standard error of 0.032.
Verification and Validation:	Data are reviewed and analyzed by NHTSA's National Center for Statistics and Analysis. Quality control procedures are built into data collected at 6 and 9 months, and at year's end. A study was completed in 1993, looking at samples of FARS cases in 1989-90 to assess the accuracy of data being reported. VMT data is reviewed by FHWA for consistency and reasonableness.
Comment:	The data programs have been around many years and are generally accepted for describing safety on the Nation's highways. Adjusting raw highway fatalities and injuries by VMT provides a means of portraying the changes in highway fatalities on a constant exposure basis—to facilitate year-to-year comparisons.

Measures of Success for R&D

Research and Development Management: Advance transportation research and technology to shape a safe, fast, efficient, accessible and convenient transportation system for the 21st century through strategic planning, world class research, better exchange of information on useful technological innovations, partnerships, and research, education and training.

To implement its Research and Development strategy, DOT led Congressional efforts to create a Federal strategic planning process for transportation R&D in partnership with state and local governments, industry and academia. The following are our major efforts and achievements:

- DOT and NSTC released the *National Transportation Science and Technology (S&T) Strategy* (EOP NSTC 1999a) and related plans. These documents focus public-private partnerships, enabling research, education and training activities on national transportation goals. They also help to accelerate the use of innovative transportation products, processes and services in the market place. The process was positively peer reviewed by the National Research Council's Transportation Research Board.

- The NSTC also released a *Transportation Strategic Research Plan* (EOP NSTC 1999b) that starts to integrate and leverage research from other Federal agencies (notably DOD, DOE, EPA, DOC, NSF and NASA) to foster innovative solutions to the transportation challenges of the 21st century.

- DOT released its first *U.S. Department of Transportation's Research &Development Plan* (DOT RSPA 1999) that integrates and focuses the R&D activities of the modal administrations on achieving the goals in the *DOT Strategic Plan*, the *FY 1999 Performance Plan* and the *National Transportation S&T Strategy*.

GPRA provides an important and useful framework for managing R&D and assessing its value, but it is focused primarily on the degree to which specific budget items have achieved their expected results. The Department's research and technology activities, singly or aggregated, can be characterized and evaluated in numerous other ways that respond to different basic questions. The nature of transportation research as an enabling element, rather than an end in itself, imposes an inherent uncertainty on any attempt to measure success and ultimate impacts, but meaningful results can be obtained. At the project or program level, it is highly appropriate to consider the *efficiency* of a particular research effort – the degree to which minimal resources and/or minimal time were required to meet the objectives of the work with a high quality effort. Particularly for exploratory research, and for R&D activities in the aggregate, one can also qualitatively assess *effectiveness*: the degree to which investment, policy, regulatory and operational decisions are affected by the research, and viable new options and solutions are created and characterized.

These two notions – efficiency and effectiveness – can be combined in seeking to assess the cost-effectiveness of research, which requires the ability to quantify potential impacts in

economic terms. The ultimate economic impacts of R&D often are far in the future and depend on many externalities and unknowns. Therefore, only rough estimates of cost-effectiveness are likely to be possible in the near term.

When assessing R&D outputs and intermediate outcomes, the focus is on satisfying the expectations of the "direct" customers. These are the entities that requested the work, the one to whom the research product will be delivered, or the party that takes the next step in implementing or applying the results. From a broader perspective, however, transportation has a significant impact on the Nation as a whole by playing a pivotal role in economic development, productivity and global competitiveness. The performance of the transportation system shapes the level of personal mobility and the quality of life of virtually everyone. Thus, the whole society is ultimately affected by the outcomes and impacts of R&D and in this sense can be seen as a customer. It is this "customer" that is being considered in assessing the degree to which research outcomes and impacts support national and departmental strategic goals. Measures of these impacts are typically indicators of overall transportation system performance, such as number of fatalities, degree of congestion, and availability and cost of services. Table VIII-5 suggests a set of candidate measures relevant to the long-term impact of R&D on the Nation's transportation system for each of the DOT strategic goals. The linkage is not direct since many factors, in addition to R&D, affect changes in these indicators.

Application of Performance Measurement to R&D

Performance of R&D should primarily be assessed based on its direct output – how well and efficiently it is performed – and the degree to which it meets the needs of the programmatic function it is supporting. In compliance with GPRA, the following general approach has been developed for application at the level of R&D projects:

1. **Definition of Customer(s)**: definition of the direct customer(s) and primary stakeholders – entities with a strong and active interest in the research itself, or in the downstream outcomes associated with it.

2. **Definition of Goals**: delineation of explicit goals for the research – what the customer expects to get at the end of the measurement period. These goals are to have a clear link to the overall program and organizational goals defined by the Department's Strategic Plan.

3. **Definition of Performance Measures**: consultation with customers and primary stakeholders to identify the performance measures by which attainment of their goals for the research can be judged and the means by which they will be evaluated. Major categories include efficiency, effectiveness, scientific and technical quality, and customer satisfaction with the results. Possible specific performance measures depend on the topic of the research effort and its application, but could include one or more of the following examples:

   % improvement in accuracy
   % improvement in maintainability

% improvement in reliability
% increase in capacity
% increase in energy efficiency
% increase in speed
% increase in strength
% reduction in emissions and/or waste products
% reduction in life-cycle costs

The way in which DOT's R&D projects contribute to outcomes and to national goals is primarily through the organizations and programs supported. The terms by which R&D is measured thus vary by the primary DOT roles that R&D supports: operational missions, regulatory functions, or national needs.

R&D to Support Operational DOT Missions

Much of the Department's R&D is in support of DOT programs responsive to specific operational functions embodied in legislation and agency mandates. For example, a substantial portion of the FAA R&D budget is associated with evolution and renewal of the Nation's air traffic control. Research also provides a necessary foundation for the wide spectrum of services provided by the U.S. Coast Guard. Measures for R&D contributing to these roles would logically be based on aviation mobility (e.g., number of traffic-related delays per 100,000 flight operations) and marine safety (e.g., number of recreational boating fatalities).

R&D to Support DOT Regulatory Functions

Many other DOT responsibilities, primarily concerned with safety, involve development and promulgation of regulations, standards and specifications. NHTSA's motor vehicle regulatory process, for example, requires research to understand crash causes, identify and assess alternative approaches to their elimination or mitigation, and economic and other adverse impacts on affected parties. In addition, rigorous cost-benefit analyses assure that regulations or standards are warranted, and establish that the proposed approach is the most cost-effective. R&D can also foster the development of tools and procedures to reduce costs borne by the government, and for the parties affected by certification, inspection and enforcement activities associated with regulations. A possible measure, reflecting the success of R&D underlying a regulatory program, for example, might be the number of hazardous material pipeline failures.

R&D Directly Responsive to National Needs

A large portion of the Department's research is primarily intended to bring about substantial technical improvements by direct stimulation of significant innovation in the transportation enterprise, rather than through mandated functional responsibilities. For example, the Department is extensively involved in guiding and shaping public investment in the transportation infrastructure through trust fund grants. More than $75 billion is spent annually by all levels of government on maintenance and construction of highways: about one-fifth of this amount is Federal funds. R&D that reduces the cost and extends the performance and lifetime of roadways and other transportation infrastructure can be a very worthwhile investment.

DOT research and technology initiatives can play a significant part in stimulating and accelerating activity in the private sector, resulting in major innovations in transportation. Although development of advanced transportation technology and improved operations is largely the responsibility of non-Federal government entities and the private sector, focused Federal investment in research, development, testing, evaluation, and prototype deployment can have significant impacts. This is particularly true when market-driven R&D efforts are delayed by technological and other uncertainties or institutional impediments.

The Effect of Time on Performance Measurement

Just as in the case of research in support of specific DOT organizations and operational missions, the management and technical quality of specific outputs remain key for near-term (e.g., annual GPRA) performance measurement. However, these activities are large programmatic initiatives conducted for a very broadly defined "customer": the transportation enterprise and the Nation as a whole. The "customer needs" in these cases are inherently embodied in the DOT strategic goals, which thus become the focus of performance measurement. This shifts the emphasis from outputs to intermediate outcomes – closer to the final impacts, but requiring a substantially longer period to become manifest and allow substantive assessment.

Consider, for example, the problem of assessing the performance of a program that develops technical standards and a national architecture for the application of information technologies to road traffic management and operations. Initially, this would have to be based on technical quality of the process and the standards. After several years, however, the real value of the work would be more accurately reflected in the intermediate outcome, i.e., the degree to which program results are being incorporated in system planning and implementation. At that point, a sound basis exists for estimating or predicting potential changes that the innovation will generate through indicators associated with specific strategic goals (e.g., mobility gains, as evidenced by the annual hours lost to delay through highway congestion).

On a still longer time frame, real outcomes and societal impacts can be assessed, based on actual changes in pre-defined indicators. Many confounding factors necessarily blur the precision of the link between research and final results, but overall judgments are generally possible. For example, the introduction of seat belts, airbags and enhanced vehicle crashworthiness – based on extensive Federal and private research and development – have clearly had a dramatic and quantifiable impact in decreasing the automobile fatality rate and crash injury severity over the last two decades. Still, this example also illustrates the complexity of identifying the various elements and programs involved in achieving the outcome in order that the relative role of each can be assessed.

Identification of transportation system indicators that best characterize progress toward DOT strategic goals is essential to the Department's Annual *Performance Plan*. Quantitative linkage of these indicators to R&D projects may not be feasible in the near-term. The manner and magnitude in which the research is expected to improve transportation operations, however, should be identifiable over the long haul.

Performance data of the U.S. transportation system can affect multiple strategic goals. For example, congestion has an impact on every goal. Table VIII-5 suggests the relationship among the Department's strategic goals and system performance categories that have existing or buildable indicators for specific modal, functional or market subdivisions.

Table VIII-5. Transportation System Performance Categories in Relation to DOT Strategic Goals

Transportation System Performance Categories	Safety	Mobility	Economic Growth & Trade	Human and Natural Environment	National Security
Safety	XX	X		X	X
Security	XX		X	X	XX
Capacity	X	XX	XX	X	X
Cost (User and Provider)	X	XX	XX	X	X
Energy Efficiency		X	XX	XX	X
Environmental Impacts			X	XX	
Use of Natural Resources			XX	XX	X
Congestion and Other Delays	X	XX	X	X	XX
Availability and Accessibility		XX	XX		XX
Trip and Delivery Time	X	XX	XX		X
Reliability and Robustness	X	XX	XX		XX
Flexibility and Adaptability	X	XX	XX		XX
Ease of Use and Seamlessness		XX	XX		XX

(X indicates a relationship; XX indicates strong relationship

APPENDIX A
Transportation Equity Act for the 21st Century

Transportation Equity Act for the 21st Century [Public Law 105–178, as amended by title IX of Public Law 105–206]. An Act to authorize funds for Federal-aid highways, highway safety programs, and transit programs, and for other purposes.

Section. 5108. Surface Transportation Research Strategic Planning

Chapter 5 of title 23, United States Code (as added by section 5101 of this title), is amended by adding at the end the following:

``Sec. 508. Surface transportation research strategic planning

``(a) In General.--The Secretary shall--

``(1) establish a strategic planning process, consistent with section 306 of title 5 for the Department of Transportation to determine national transportation research and technology development priorities related to surface transportation;

``(2) coordinate Federal surface transportation research and technology development activities;

``(3) measure the results of those activities and how they impact the performance of the surface transportation systems of the United States; and

``(4) ensure that planning and reporting activities carried out under this section are coordinated with all other surface transportation planning and reporting requirements.

``(b) Implementation.--The Secretary shall--

``(1) provide for the integrated planning, coordination, and consultation among the operating administrations of the Department of Transportation, all other Federal agencies with responsibility for surface transportation research and technology development, State and local governments, institutions of higher education, industry, and other private and public sector organizations engaged in surface transportation-related research and development activities;

``(2) ensure that the surface transportation research and technology development programs of the Department do not duplicate other Federal, State, or private sector research and development programs; and

``(3) provide for independent validation of the scientific

and technical assumptions underlying the surface transportation research and technology development programs of the Department.

``(c) Surface Transportation Research and Technology Development Strategic Plan.--

``(1) Development.--The Secretary shall develop an integrated surface transportation research and technology development strategic plan.

``(2) Contents.--The plan shall include--

``(A) an identification of the general goals and objectives of the Department of Transportation for surface transportation research and development;

``(B) a description of the roles of the Department and other Federal agencies in achieving the goals identified under subparagraph (A), in order to avoid unnecessary duplication of effort;

``(C) a description of the overall strategy of the Department, and the role of each of the operating administrations of the Department, in carrying out the plan over the next 5 years, including a description of procedures for coordination of the efforts of the Secretary with the efforts of the operating administrations of the Department and other Federal agencies;

``(D) an assessment of how State and local research and technology development activities are contributing to the achievement of the goals identified under subparagraph (A);

``(E) details of the surface transportation research and technology development programs of the Department, including performance goals, resources needed to achieve those goals, and performance indicators as described in section 1115(a) of title 31, United States Code, for the next 5 years for each area of research and technology development;

``(F) significant comments on the plan obtained from outside sources; and

``(G) responses to significant comments obtained from the National Research Council and other advisory bodies, and a description of any corrective actions taken pursuant to such comments.

``(3) National research council review.--

The <<NOTE: Contracts.>> Secretary shall enter into an agreement for the review by the National Research Council of the details of each--

``(A) strategic plan or revision required under

section 306 of title 5;

``(B) performance plan required under section 1115 of title 31; and

``(C) program performance report required under section 1116,

with respect to surface transportation research and technology development.

``(4) Performance plans and reports.--In reports submitted under sections 1115 and 1116 of title 31, the Secretary shall include--

``(A) a summary of the results for the previous fiscal year of surface transportation research and technology development programs to which the Department of Transportation contributes, along with--

``(i) an analysis of the relationship between those results and the goals identified under paragraph (2)(A); and

``(ii) a description of the methodology used for assessing the results; and

``(B) a description of significant surface transportation research and technology development initiatives, if any, undertaken during the previous fiscal year that were not in the plan developed under paragraph (1), and any significant changes in the plan from the previous year's plan.

``(d) Merit Review and Performance Measurement.--<<NOTE: Reports.>> Not later than 1 year after the date of enactment of this section, the Secretary shall transmit to Congress a report describing competitive merit review procedures for use in selecting grantees and contractors in the programs covered by the plan developed under subsection (c) and performance measurement procedures for evaluating the programs.

``(e) Procurement Procedures.--The Secretary shall--

``(1) develop model procurement procedures that encourage the use of advanced technologies; and

``(2) develop model transactions for carrying out and coordinating Federal and State surface transportation research and technology development activities.

``(f) Consistency With Government Performance and Results Act of 1993.--The plans and reports developed under this section shall be consistent with and incorporated as part of the plans developed under section 306 of title 5 and sections 1115 and 1116 of title 31.".

APPENDIX B
DOT RAINBOW TABLES

Table B-1. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Modal Summary

Mode	Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
FHWA[2]	Subtotal R&D	231,064	258,119	257,158	332,907
	Subtotal Technology	193,290	209,772	232,510	445,450
	Subtotal Facilities	2,000	0	0	0
	Total	*426,354*	*467,891*	*489,668*	*778,357*
NHTSA	Subtotal R&D	41,621	50,350	50,569	95,258
	Subtotal Technology	21,247	22,041	21,871	35,388
	Total	*62,868*	*72,391*	*72,440*	*130,646*
FRA	Subtotal R&D	19,985	21,864	24,507	28,116
	Subtotal Technology	20,395	20,494	27,771	22,705
	Subtotal Facilities	770	500	500	1,350
	Total	*41,150*	*42,858*	*52,778*	*52,171*
FTA	Subtotal R&D	23,216	16,685	17,107	14,214
	Subtotal Technology	34,187	41,550	43,218	46,230
	Subtotal Facilities	0	0	0	0
	Total	57,403	58,235	60,325	60,444
FAA	Subtotal R&D	227,886	177,978	183,438	215,377
	Subtotal Technology	0	0	0	0
	Subtotal, Facilities	14,290	52,566	42,696	72,848
	Total	*242,176*	*230,544*	*226,134*	*288,225*
RSPA	*Total R&D*	*6,195*	*6,991*	*7,075*	*13,397*
USCG	Subtotal R&D	19,950	17,969	19,890	22,206
	Subtotal Technology	0	0	0	0
	Subtotal Facilities	260	260	303	314
	Total	20,210	18,229	20,193	22,520
OST	*Total R&D*	*3,530*	*8,859*	*3,142*	*4,658*
DOT SUBTOTALS	*Total R&D*	*573,447*	*558,815*	*562,886*	*726,133*
	Total Technology	*269,119*	*293,857*	*325,370*	*549,773*
	Total Facilities	*17,320*	*53,326*	*43,499*	*74,512*
DOT GRAND TOTAL[1]		**859,886**	**905,998**	**931,755**	**1,350,418**

[1] Includes appropriations for R&D accounts and parts of other accounts used for R&D.

[2] FHWA Research and Technology Program also includes R&D budgets for ITS JPO and FMCSA.

SOURCE: DOT, Office of the Secretary of Transportation

Table B-2. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Program Details

Mode and Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
FHWA[2]				
Surface Transportation Research	*84,647*	*85,208*	*84,052*	*136,500*
a. Safety	6,861	11,068	12,368	13,900
b. Pavements	9,243	11,611	11,367	11,240
c. Structures	8,447	14,216	13,065	14,260
d. Environment	2,971	4,680	5,400	0
e. Policy	4,123	4,768	3,484	7,000
f. Planning & Right-of-Way	5,856	3,854	3,484	11,275
g. Motor Carrier	5,572	5,651	5,574	0
h. Highway Operations	0	662	653	5,580
i. Freight R&D	0	0	436	0
j. Technical Assessment and Deployment	10,163	12,362	12,194	0
k. R&T Technical Support	8,711	6,623	6,533	0
l. Long-Term Pavement Performance	10,000	8,830	8,710	10,000
m. Advanced Research	0	883	784	0
n. National Advanced Driver Simulator	11,806	(9,000)	0	0
o. SHRP II/RSPA	894	0	0	0
q. International Outreach	0	0	0	0
r. Planning and Environment	0	0	0	0
s. Asset Management	0	0	0	1,400
t. Federal Lands	0	0	0	700
u. Agency-wide Initiatives	0	0	0	14,145
v. Supplemental Technology Deployment	0	0	0	7,000
w. Contract Authority	0	0	0	40,000
Technology Deployment Program	*31,185*	*30,905*	*34,840*	*51,000*
a. Applied Research & Technology	31,185	30,905	34,840	45,000
b. Applied Research & Technology	0	0	0	0
c. Contract Authority	0	0	0	6,000
Training and Education	*12,474*	*13,245*	*13,936*	*22,000*
a. National Highway Institute	4,455	5,298	5,226	7,000
b. Local Technical Assistance Program	6,237	6,181	6,968	9,000
c. Eisenhower Transportation Fellowship Program	1,782	1,766	1,742	2,000
d. Realigned Budget Authority (RABA)	0	0	0	4,000
Intelligent Transportation Systems	*174,636*	*176,600*	*183,956*	*338,000*
a. Research	40,429	33,554	41,151	46,500
b. Operational Test	6,580	15,011	6,500	11,820
c. Evaluation/Program Assessment	6,000	5,740	6,000	7,750
d. Architecture and Standards	10,662	15,894	14,000	13,750
e. Mainstreaming/Integration	10,837	5,298	9,116	11,080
f. ITS Program & System Support	8,654	8,388	8,766	9,100
g. ITS Deployment	91,474	92,715	98,423	238,000
h. Automated Highway Systems	0	0	0	0
i. Commercial Vehicle Operations	0	0	0	0
j. Advanced Technology Applications			Included in a. above.	
k. ISTEA Section 6058 Funds	0	0	0	0

Table B-2. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Program Details

Mode and Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
l. ISTEA Section 6058 Funds	0	0	0	0
m. Contract Authority	0	0	0	0
University Transportation Research	*22,854*	*22,649*	*23,735*	*27,250*
a. University Transportation Research	5,933	5,880	0	0
b. University Transportation Research	5,261	5,214	23,735	27,250
c. University Research Institutes	11,660	11,556	0	0
Other	*89,772*	*128,098*	*137,405*	*191,863*
a. Rehabilitation of Turner Fairbank (Facilities R&D)	2,000	0	0	0
b. Truck Dynamic Test Facility	0	0	0	0
c. State Planning & Research	86,772	123,098	132,405	128,163
d, Strategic Highway Research Program	0	0	0	0
e, Strategic Highway Research Program	0	0	0	0
f, Seismic Research & Development Program	(1,780)	Included in 1.c. above		
g. Fundamental Properties of Asphalts	(890)	Included in 1.b. above		
h. Timber Bridge Research	0	0	0	0
l. GPS Support	1,000	0	0	0
j. Advance Vehicle Technology Program	0	5,000	5,000	20,000
k, Commercial Remote Sensing	0	0	0	0
l. National Differential Global Positioning System	0	0	0	18,700
m Maglev	0	0	0	25,000
Administrative Expenses	*10,786*	*11,186*	*11,744*	*11,744*
Subtotal, Research & Development	**231,064**	**258,119**	**257,158**	**386,607**
Subtotal, Technology Investment	**193,290**	**209,772**	**232,510**	**391,750**
Subtotal, Facilities	**2,000**	**0**	**0**	**0**
Total FHWA	**426,354**	**467,891**	**489,668**	**778,357**
NHTSA				
Research and Analysis				
Crashworthiness	*21,422*	*26,509*	*22,090*	*43,070*
a. Safety Systems	8,338	10,558	8,858	16,384
b. Biomechanics	10,587	13,455	13,232	23,186
c. Partnership for a New Generation of Vehicles (PNGV)	2,497	2,496	0	3,500
Crash Avoidance	*1,595*	*3,000*	*4,840*	*25,423*
a. Driver/Vehicle Performance	1,000	1,608	2,948	20,531
b. IVHS, Human Factors, Driver Performance	0	0	0	0
c. National Advanced Driver Simulator	0	0	0	0
d. Heavy Vehicles	595	1,392	1,892	4,892
Data programs	*21,207*	*22,001*	*21,871*	*35,348*
a. Fatal Accident Reporting System (FARS)	5,242	5,213	5,213	6,479
b. National Accident Sampling System (NASS)	9,658	9,987	9,987	16,930
c. Data Analysis Program	1,935	1,924	1,924	4,024
d. State Data Program	3,041	3,024	2,344	3,024
e. Occupant Protection Survey	300	300	850	555
f. Special Crash Investigations	1,031	1,553	1,553	4,336
Technology Transfer Programs	*40*	*40*	*0*	*40*

Table B-2. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Program Details

Mode and Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
Vehicle Research and Test Center	*799*	*950*	*950*	*950*
Highway Safety Research	*4,723*	*5,437*	*7,152*	*7,446*
Administrative Expenses	*13,082*	*14,454*	*15,537*	*18,369*
Subtotal, Research & Development	**41,621**	**50,350**	**50,569**	**95,258**
Subtotal, Technology Investment	**21,247**	**22,041**	**21,871**	**35,388**
Subtotal, Facilities	**0**	**0**	**0**	**0**
Total NHTSA	**62,868**	**72,391**	**72,440**	**130,646**
FRA				
Railroad Research and Development	*20,755*	*22,364*	*22,464*	*26,800*
Equipment, Operations & Hazmat	5,659	7,468	9,300	12,250
Track & Vehicle-track Interaction	7,246	6,950	7,864	8,300
Safety of High-Speed Ground Transportation	4,650	4,800	4,800	4,900
a. Safety of High-Speed Ground Transportation	4,650	4,800	4,800	4,900
b. Safety of High-Speed Ground Transportation	0	0	0	0
R&D Facilities	770	500	500	1,350
Administration	2,430	2,646	0	0
Next Generation High-Speed Rail	*20,395*	*20,494*	*27,097*	*22,000*
High-Speed Train Control Systems	3,750	4,300	15,000	10,000
Non-Electric Locomotives	9,300	9,800	7,000	6,800
a. Non-Electric Locomotives	9,300	9,800	7,000	6,800
b. Non-Electric Locomotives	0	0	0	0
Grade Crossing & Innovative Technology	5,600	4,600	3,897	4,000
Track/Structures Technogy	1,200	1,200	1,200	1,200
Planning Technology	0	0	0	0
Administration	545	594	0	0
Safety and Operations	*0*	*0*	*3,217*	*3,371*
Salaries and Expenses (R&D)	0	0	2,543	2,666
Salaries and Expenses	0	0	674	705
Rail Initiatives Trust Fund	*0*	*0*	*0*	*0*
High-Speed Train Control Systems	0	0	0	0
Nationwide Differential GPS	0	0	0	0
Subtotal, Research & Development	**19,985**	**21,864**	**24,507**	**28,116**
Subtotal, Technology Investment	**20,395**	**20,494**	**27,771**	**22,705**
Subtotal, Facilities	**770**	**500**	**500**	**1,350**
Total FRA[3]	**41,150**	**42,858**	**52,778**	**52,171**
FTA				
National Program				
Safety and Security	*2,500*	*2,200*	*5,450*	*6,100*
a. Safety and Security	*0*	*250*	*1,050*	*750*
b. Safety and Security	2,500	1,950	4,400	5,350
Equipment and Infrastructure	*18,729*	*9,750*	*13,692*	*8,300*
a. New Bus and Rail Vehicles and Infrastructure	8,280	6,000	5,289	1,820
b. New Bus and Rail Vehicles and Infrastructure	10,449	3,750	8,403	6,480
Fleet Operations	*550*	*4,250*	*1,236*	*2,200*
a. Bus Rapid Transit	0	0	0	0

Table B-2. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Program Details

Mode and Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
b. Bus rapid Transit	550	4,250	1,236	2,200
Specialized Customer Services	*4,950*	*6,400*	*4,447*	*4,000*
Information Management Technology	*3,509*	*2,300*	*100*	*1,200*
a. Information Management & Technology	383	0	0	400
b. Information Management & Technology	3,126	2,300	100	800
Metropolitan / Rural Policy Development	*1,100*	*850*	*0*	*1,500*
a. Metropolitan/Rural Policy Development	300	0	0	100
b. Metropolitan/Rural Policy Development	800	850	0	1,400
Planning and Project Development	*1,312*	*1,700*	*544*	*2,200*
a. Planning and Project Development	100	0	0	500
b. Planning and Project Development	*1,212*	*1,700*	*544*	*1,700*
Human Resources	100	50	0	600
Performance and Reviews/Evaluation	*0*	*0*	*2,800*	*2,900*
International Mass Transportation Program	*0*	*0*	*988*	*500*
Subtotal National Program	32,750	27,500	29,500	29,500
Transit Cooperative Research Program	*4,000*	*8,250*	*8,250*	*8,250*
a. Transit Cooperative Research Program	1,000	2,000	2,000	2,000
b. Transit Cooperative Research Program	3,000	6,250	6,250	6,250
National Transit Institute	*3,000*	*4,000*	*4,000*	*4,000*
Rural Transit Assistance Program	*4,500*	*5,250*	*5,250*	*5,250*
Subtotal, Transit Planning and Research	*44,250*	*45,000*	*47,000*	*47,000*
Fuel Cell Bus & Bus Facilities (Development in MAX)	*4,850*	*4,850*	*4,850*	*4,850*
University Transportation Centers	*6,000*	*6,000*	*6,000*	*6,000*
a. University Transportation Centers	6,000	1,200	1,200	1,200
b. University Transportation Centers	0	4,800	4,800	4,800
Administrative Expenses	*2,303*	*2,385*	*2,475*	*2,594*
Subtotal, Research & Development	**23,216**	**16,685**	**17,107**	**14,214**
Subtotal, Technology Investment	**34,187**	**41,550**	**43,218**	**46,230**
Subtotal, Facilities	**0**	**0**	**0**	**0**
Total FTA	**57,403**	**58,235**	**60,325**	**60,444**
FAA				
Research, Engineering and Development	*199,183*	*150,000*	*156,495*	*184,366*
System Development and Infrastructure	*14,654*	*15,784*	*17,139*	*25,281*
a. Plans and Programs	1,164	1,164	1,164	1,350
b. Technical Laboratory Facility	8,046	9,730	11,075	13,431
c. Federally Funded Research Development Center	5,444	4,890	4,900	5,000
d. Administrative Expenses	0	0	0	5,500
Capacity and Air Traffic Management	*21,258*	*0*	*0*	*0*
a. Traffic Flow Management	2,986	0	0	0
b. Runway Incursion Reduction	6,000	0	0	0
c. System Capacity, Planning & Improvements	4,000	0	0	0
d. Cockpit Technology/Flight 2000	4,070	0	0	0
e. General Aviation Vertical Flight Technology Program	0	0	0	0
f. Flight 2000	0	0	0	0

Table B-2. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Program Details

Mode and Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
g. Operations Concept Validation	0	0	0	0
h. Software Engineering R&D	0	0	0	0
i. Oceanic Automation Program	4,202	0	0	0
Communications , Navigation, & Surveillance	*18,103*	*0*	*0*	*0*
a. Communications	4,706	0	0	0
b. Navigation	13,397	0	0	0
c. Surveillance	0	0	0	0
Weather	*15,300*	*18,684*	*19,300*	*27,789*
a. Weather Program	15,300	15,084	16,200	27,789
b. Juneau, Alaska	0	3,600	3,100	0
Airport Technology	*5,000*	*0*	*0*	*0*
Aircraft Safety Technology	*49,202*	*34,886*	*44,457*	*49,500*
a. Fire Research and Safety	6,993	4,750	4,750	6,751
b. Advanced Materials/ Structural Safety	3,065	1,734	2,338	2,891
c. Propulsion and Fuel Systems	5,000	2,831	3,126	3,563
d. Flight Safety/Atmospheric Hazardous Research	2,063	2,619	3,844	3,987
e. Aging Aircraft	21,540	14,694	21,594	23,498
f. Aircraft Catastrophic Failure Prevention Research	4,000	1,787	1,981	1,984
g. Aviation Safety Risk Analysis	6,541	6,471	6,824	6,826
System Security Technology	*44,225*	*51,690*	*50,147*	*49,298*
a. Explosives and Weapons Detection	34,200	41,700	37,605	37,460
b. Airport Security Technology Integration	2,485	2,708	2,285	2,462
c. Airport Security Human Factors	5,540	5,282	5,256	5,145
d. Aircraft Hardening	2,000	2,000	5,001	4,231
Human Factors (HF) and Aviation Medicine	*26,550*	*25,065*	*21,971*	*25,055*
a. Flight Deck/Maintenance/System Integration Human Factors	12,550	11,000	9,142	10,165
b. Air Traffic Control/Airway Facilities Human Factors	10,000	10,000	8,000	10,026
c. Aeromedical Research	4,000	4,065	4,829	4,864
Strategic Partnerships	*2,891*	*2,891*	*3,481*	*7,443*
Innovative/Cooperative Research	*2,000*	*1,000*	*0*	*0*
Facilities and Equipment (R&D)[4]	*0*	*52,566*	*42,696*	*72,848*
Facilities and Equipment (Facilities)	*14,290*	*14,290*	*12,800*	*13,683*
Airport Technology	*0*	*5,000*	*6,062*	*7,380*
Operations[5]	*28,103*	*8,088*	*7,481*	*9,348*
Commercial Space Transportation[6]	*600*	*600*	*600*	*600*
Subtotal, Research and Development	**227,886**	**177,978**	**183,438**	**215,377**
Subtotal, Technology Investment	**0**	**0**	**0**	**0**
Subtotal, Facilities	**14,290**	**52,566**	**42,696**	**72,848**
Total FAA	**242,176**	**230,544**	**226,134**	**288,225**
RSPA				
Research and Special Programs	*4,882*	*5,119*	*5,103*	*11,171*
Hazardcus Materials	1,200	1,200	1,200	1,234
Research and Technology	2,050	2,235	2,085	8,135

Table B-2. DOT, FY 2001 President's Budget: Research, Development and Technology Budget Authority[1] ($ thousands), Program Details

Mode and Program	FY 1998 Actual	FY 1999 Actual	FY 2000 Enacted	FY 2001 President's Request
Emergency Transportation	50	50	235	235
Administrative Expenses	1,582	1,634	1,583	1,567
Pipeline Safety	*1,165*	*1,719*	*1,894*	*2,144*
Administrative Expenses	*148*	*153*	*78*	*82*
Total RSPA	**6,195**	**6,991**	**7,075**	**13,397**
USCG				
RDT&E Account	*19,000*	*17,000*	*18,993*	*21,320*
a. Improved Search & Rescue Capability	1,875	570	1,162	457
b. Waterways Safety, Management & Aids to Navigation	1,225	1,716	1,444	1,196
c. Marine Safety	2,955	2,398	3,108	5,448
d. Support for Interagency Ship Structure Committee	437	289	159	381
e. Marine Environmental Protection	1,525	1,494	2,263	1,142
f. Maritime Law Enforcement	1,250		3,213	4,422
g. Technology Advancement and Assessment[7]	0	2,489	3,746	3,991
h. Safety & Environmental Compliance	3,125	0	0	0
i. Human Resources Management	0	0		0
j. Command, Control, Communication, Computer, & Intelligence Integration[7]	1,050	0	0	0
k. Technology Advancement[7]	1,463	0	0	0
l. R&D Personnel, Program Support & Operations	4,095	3,044	3,898	4,283
Facilities	260	260	303	314
k. Supplemental, Military Readiness, Overseas Contingency	0	5,000	0	0
Oil Spill Recovery, Prince William Sound	*1,210*	*1,229*	*1,200*	*1,200*
Subtotal Research & Development	**19,950**	**17,969**	**19,890**	**22,206**
Subtotal Technology Investment	**0**	**0**	**0**	**0**
Subtotal Facilities	**260**	**260**	**303**	**314**
Total, USCG	**20,210**	**18,229**	**20,193**	**22,520**
OST Total OST	**3,530**	**8,859**	**3,142**	**4,658**
DOT SUBTOTALS				
Research & Development	**573,447**	**558,815**	**562,886**	**726,133**
Technology Investment	**269,119**	**293,857**	**325,370**	**549,773**
Facilities	**17,320**	**53,326**	**43,499**	**74,512**
DOT GRAND TOTAL[1]	**859,886**	**905,998**	**931,755**	**1,350,418**

[1] Includes appropriations for R&D accounts and parts of other other accounts used for R&D.
[2] FHWA Research and Technology Program also inlcudes R&D budgets for ITS JPO and FMCSA.
[3] The FY 2001 request for Maglev is included in the FHWA budget.
[4] FY 1999/2000 includes personnel compensation and benefits in F&E.
[5] FY 2000 reflects OPS portion of R,E&D programs not transferred to F&E.
[6] Funded in OPS, but not included above.
[7] Accounts consolidated into "technology investment" account in FY 1999 submission.
SOURCE: Office of the Secretary of Transportation

Appendix C
Modal Program Descriptions

This appendix provides descriptive information about the R&D programs of each Department of Transportation (DOT) modal administration. Its purpose is to show a basic inventory of activities classified as research and development. The format is in three parts: the agency's mission statement, a profile of planned FY2001 R&D activity, and a forward-looking outlook – usually five years – of R&D plans that the agency would like to pursue. All budget numbers cited are from official DOT totals for research, development, and technology programs. Most of the operating administrations have R&D programs in support of their various missions. Each of these is described separately below.

Federal Highway Administration (FHWA)

Mission

The Federal Highway Administration (FHWA) coordinates highway transportation programs in cooperation with states and other partners to enhance the country's safety, economic vitality, quality of life, and the environment. Major program areas include the Federal-Aid Highway Program, which provides Federal financial assistance to the states to construct and improve the national highway system, urban and rural roads, and bridges. This program provides funds for general improvements and development of safe highways and roads. The Federal Lands Highway Program provides access to and within national forests, national parks, Indian reservations and other public lands by preparing plans and contracts, supervising construction facilities, and conducting bridge inspections and surveys. The FHWA manages a comprehensive research, development, and technology program in support of the above.

Recent organizational restructuring within FHWA has resulted in business units. These include five core business unit (CBU) areas of infrastructure, planning and environment, operations, safety, and Federal lands highway. There are also seven service business units (SBUs). Those focused on policy, professional development, and research, development, and technology (RD&T), are responsible for developing comprehensive R&T programs which address strategic and performance goals. Embedded in each program area are priority areas. Two types of support and funding categories – Surface Transportation Research (STR) and Technology Deployment Initiatives and Partnership Programs (TDIPP)[1], are another way to look at highway RD&T.

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[1] Section 5103 of TEA-21 created the Technology Deployment Program. This program tries to accelerate the adoption of innovative technologies by the surface transportation community. The program consists of the TDIPP and the Innovative Bridge Research and Construction Program. The program supports technology transfer, partnerships, and dissemination of research results. Under the TDIPP component, the DOT, in cooperation

FHWA Management Council

High-level program and budget decisions regarding the FHWA R&T program are the responsibility of the FHWA Management Council. These responsibilities include providing policy direction for the FHWA's R&T program; determination of R&T program priorities; and review of progress in meeting goals, accomplishments priorities, and milestones for the R&T program. For issues regarding the R&T program, the Office of Program Development and Evaluation within FHWA Research, Development and Technology serves as Secretariat to the Management Council.

The Management Council is chaired by the FHWA Executive Director. Members include Managers of the CBUs; (Infrastructure, Safety, Operations, Planning and Environment, and Federal Lands Highway), Directors of the Policy, Administration, and Corporate Management SBUs. As "owners" of specific goals, CBU managers have responsibility to develop and propose R&T activities to the Council, which support each business goal, including coordination with internal and external partners and stakeholders. This process includes:

- Identifying the transportation problems or issues that R&T investments can help resolve
- Determining FHWA's role in resolving the problem or issue
- Formulating elements of the R&T program budget, including information on goals products, and milestones, anticipated accomplishments, and major new initiatives
- Reporting to the Council on plans, products, and achievements

In addition, proposed efforts regarding policy and. agency-wide R&T activities are prepared for dissuasions by the Council; these elements for the R&T programs are consolidated with the business goal-directed activities, resulting in the comprehensive R&T program.

Current R&D Profile and Funding Levels

Initiatives for research and development in the FY 2001 budget request are concentrated in the CBUs of infrastructure, highway safety, and planning and environment, and with Policy SBU. Activities of the Intelligent Transportation System Joint Program Office (ITS JPO) and Federal Motor Carrier Safety Administration (FMCSA) are described in later sections of this appendix. The FHWA requests $136.5 million in FY 2001 for surface transportation R&T, $51 million in technology deployment, and $22 million training and education (see Table C-1).

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with representatives of the transportation community, uses domestic and international technology to develop strategies and initiatives to achieve deployment goals, including technical assistance in deploying technology and mechanisms for sharing information among program participants.

Table C-1. Comparative Summary of FHWA R&T Activity ($ 000)

Transportation Research	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
Surface Transportation Research	$85,208	$84,052	$136,500
Technology Deployment	30,905	34,840	51,000
Training and Education	13,245	13,936	22,000

FHWA projects span many disciplines and transportation topics, from highway design, engineering, and maintenance issues to economic analysis, human factors, travel surveys, outreach, and marketing. Projects that address structures and pavements are a traditionally important area. Safety projects are also highly visible.

Structures

The Structures Technology Program aims to improve the condition of the Nation's bridges by 2007. This program is designed to develop increased durability in new bridge construction and increase the service life of existing structures without degradation of either highway safety or the environment. Specific objectives are to: (l) Increase the reliability, speed and ease of using local nondestructive evaluation (NDE) methods for quality control during bridge fabrication; (2) Improve the ability to detect hazardous conditions during bridge inspections; (3) Develop quick and reliable global NDE systems for bridge monitoring; (4) Develop new technologies and techniques for integrating quantitative bridge NDE data into bridge management systems; (5) Develop definitive guidance and criteria for design, fabrication and performance of high-performance materials used in building and rehabilitating bridges; (6) Develop technology to reduce the sudden loss potential of bridges to natural hazards; (7) Make bridges more secure against corrosion; (8) Produce more cost-effective bridge foundations; and (9) Advance design practice.

Planned FY 2001 priority projects in the Structures program are in bridge inspection, high performance materials, and engineering applications. New initiatives include nondestructive evaluation (NDE) development for bridges, and new and high tech inspection systems for bridges. The NDE initiative concerns a new device to measure the cumulative fatigue loading of a highway bridge by using an innovative strain measurement technology. A forced vibration response will be used to determine the existence of piles and to evaluate the condition of the bridge substructures.

R&T initiatives in high performance materials dominate much of the budget request under Structures. New initiatives for FY 2001 encompass materials such high performance concrete, steel, composites. Another project deals with an innovative bridge research and construction program. Familiar high performance materials like steel and concrete, and the more exotic materials such as fiber reinforced polymer (FRP) composites and aluminum, each have outstanding individual properties which when integrated into the design of new bridges, or the repair or rehabilitation of existing bridges, will reduce construction time, improve durability, and reduce first cost and/or

life cycle construction costs. For FY 2001, an improved version of the existing high performance steel (HPS-70W) will be developed to go with the recently marketed HPS-100W steel. A final report will also detail the fatigue characteristics of HPS.

Engineering applications provides R&T results in support of the Nation's $8 billion a year bridge program. Other bridge owners, private sector consultants, and other technical staff routinely call upon the FHWA to contribute to the technical core of the Federal-aid program. Ongoing and planned new initiatives for FY 2001 are:

- Scour resistant bridges – predicting scour holes near wide piers
- Seismic vulnerability
- Coatings development – encapsulating lead paints on bridge rehabs
- Corrosion protection for bridge steels
- Cost-effective foundations – methods for load-testing
- Seismic engineering for bridges
- Aerodynamics – wind loading/vibration of stay cables on bridges

Many of these projects address natural hazards, the leading cause for bridge collapse and failure. Natural hazard R&T will: (1) Ensure emergency preparedness and minimize the time needed to return highways to full service following natural disasters by reducing the vulnerability of the highway system; (2) Increase national security by providing the reliability of the highway system by reduction of vulnerability to natural hazards; (3) Increase user satisfaction and confidence with the Nation's highway system by increasing the reliability and reducing the vulnerability of the system to natural hazards, and; (4) Reduce the life-cycle cost of highway systems by reducing user costs associated with system failures due to natural hazards.

Pavements

Pavement research is another traditional investment area at the FHWA. FY 2001 ongoing and new initiatives include specifications for backfilling of pipes and culverts, asphalt concrete pavements, Portland cement concrete (PCC) pavements, long term pavement performance (LTPP), and pavement technology tools.

The LTPP program is a 20-year project initiated under the Strategic Highway Research Program (SHRP) to develop improved tools to aid in the design and rehabilitation of better-performing and more cost-effective pavements. It includes data collection and analysis of nearly 2400 pavement sections at over 900 locations throughout the U.S. and Canada, and the development of improved pavement technology. Its goal is to extend the life of highway pavements.

Asset Management

Asset management initiatives develop the concepts, framework, tools, and analytical techniques that preserve and operate highway assets as an integrated system.

The 2001 budget seeks to refine asset management concepts and framework by utilizing engineering and economic analyses and processes derived from states' best practices and cutting-edge research initiatives. New initiatives include systems integration and economic analysis, management systems, and network preservation and the FY 2001 National Quality Initiative.

Operations

The FHWA Operations program aims to improve the operation of the highway systems and intermodal linkages to increase transportation access for all people and commodities. In FY 2001, some ongoing and planned new initiatives are:

- A Manual of Uniform Traffic Control Devices
- Work zone operations
- Improved weather response
- Information, measurement and constituency foundation for operations improvements
- Freight management and operations

Policy

Policy programs in the FHWA support the planning and analysis process. Research takes place in three broad areas: (1) efficient and timely data collection, management, and dissemination concerning highway transportation and its intermodal connections (2) more effective use of highway program funds, including highway financing and investment analysis and performance measurement and (3) enhancing highway program contributions to economic productivity, efficiency, and other national goals. The activities under the various Policy Priority Areas reflect the suggestions and recommendations of the Policy Analysis and Highway Information Research and Technology Partnership Working Group. Priorities for FY 2001 include investment performance analytical modeling, and value pricing and market-based demand management strategies.

Other policy program areas include improving economic productivity from highway investments, highway cost allocation/truck size and weight, research cooperation with international organizations, reduction of user delays through weather information, the Highway Performance Monitoring System (HPMS) revisions, Census transportation planning package, Nationwide Personal Transportation Survey NPTS), American Community Survey (ACS), new systems to collect traffic data, methods to verify state motor fuel data, and methods to access highway finance data, software development

Safety

FHWA's safety functions are one integrated unit for the first time. R&T programs — involving roadside design, roadside hardware, work zones, driver qualifications, human factors research, safety management systems — are tools to reduce fatalities and injuries. The motor carrier safety function was recently transferred to the new Federal Motor Carrier Safety Administration.

Planning and Environment

Other R&T priorities are contained in the programs for Planning and Environment.. Examples include:

- Surface Transportation Environment Cooperative Research Program (STECRP) advisory board
- Environment – air quality/climate, global climate change, water quality/ecosystems, noise research, environmental streamlining, communities, neighborhoods and people, environmental justice, pedestrian bicyclist, cultural/historic, livability
- Planning – transportation and land use, planning processes/decision making, forecasting transport demand/system changes, system management/operations

Agency-wide Initiatives

FHWA also conducts R&T projects that cut across organizational boundaries. These include:

- R&T crosscutting initiatives – TRB cooperative agreement, R&T report center, SBIR., marketing/communications
- International outreach
- Advanced research – diagnostic methods, material characterization, modeling and simulation methods, artificial intelligence and mathematics, advanced sensor and communications technology
- Other agency-wide initiatives – resource centers, MIHE reserve, R&T strategic planning, RD&T contractor support, innovative finance research, knowledge management, civil rights

Additional FHWA requests for FY 2001 include the following items:

- Expansion of R&T national partnership initiatives
- Information sharing (national transit database)
- Complete expansion of Nationwide Differential Global Positioning System
- Aging America – research, guidelines, MPO planning requirements
- Advanced vehicle technologies – development, demonstration, deployment

Longer-term Outlook for FHWA R&D

At this time, the FHWA does not publish a five-year plan, although many of its current programs are of a long-term nature. In addition, the *FHWA Performance Plan* for FY 2000 (DOT FHWA 1999) addresses some of the longer-term plans of the agency. Facilitation of long term planning should occur with the recent reorganization of the FHWA into business units, thus giving formal recognition to such core responsibilities as infrastructure, the environment, and operations.

The National R&T Partnership Initiative

The National R&T Partnership Initiative, facilitated by the TRB, will help the FHWA establish stronger working relationships with key partner and customer groups. The objectives of the partnership are:

- Broaden the range of contacts between the FHWA and the user community
- Help develop a national consensus on the need for highway R&T
- Determine priorities of highway R&T
- Establish a national R&T agenda
- Identify the appropriate roles of he Federal government, state and local government, universities and the private sector in implementing an R&T program.

Two "Partnership Forums" have been held (in 12/98 and 7/99) to discuss the need for such a coordination mechanism and develop an organizational approach. Altogether, 36 organizations were represented at these forums. The work of the Partnership will be accomplished primarily through topic-area working groups, with the TRB providing oversight for the process. The TRB is acting as the "secretariat" for the Partnership, appointing working group Chairs, convening meetings, and providing staff support. Five working groups have been established: safety, infrastructure renewal, policy analysis and systems monitoring, operations and mobility, and planning and environment. FHWA staff from CBUs and the Policy SBU act as key liaisons to each of these groups. The FHWA RD&T Office will track and facilitate the overall FHWA effort.

Intelligent Transportation Systems Joint Program Office (ITS JPO/FHWA)

Mission

The Intelligent Transportation Systems Joint Program Office (ITS JPO) has a Department-wide role that is overseen by the Deputy Secretary of Transportation and the ITS Management Council. The head of the CBU known as Operations also serves as the ITS JPO Director. Programs and priorities directly goals such as safety, operations and mobility, planning, and environment.

The ITS JPO fosters and supports application of advanced information technologies to improve surface transportation mobility, capacity, safety and environmental compatibility. Major program elements include development of an intelligent vehicle and supporting deployment of information infrastructure for rural and urban highway applications, commercial vehicle operations, and public transit systems.

Current R&D Profile and Funding Levels

The Federal interest in ongoing ITS research is to lead the research, development, testing and evaluation of new technologies in order to accelerate their market availability. Under the goals of safety, mobility, and productivity, the JPO plans to conduct a number of

performance initiatives in FY2001. Some of these include completion of the Intelligent Vehicle Initiative Generation 0, completion of all 80 ITS standards required to support the original national ITS architecture, deployment of ITS in a joint DOT/Department of Interior (DOI) operational test in Acadia National Park, and completion of a 10-state CVISN Level 1.0 network. There are two major headings for all activities conducted under the umbrella of ITS: 1) research and development, and 2) deployment incentives. The total FY 2001 budget request is $100 million of which $238 million is for deployment incentives (see Table C-2).

Table C-2. Comparative Summary of ITS JPO R&D Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
ITS research, development, and deployment	$176,600	$184,956	$338,000

ITS Research and Development

Research in support of the Intelligent Vehicle Initiative (IVI) is the largest of ITS R&D programs, with a FY 2001 budget request of $30 million. The IVI, is a government-industry program to accelerate the development and commercialization of these safety- and mobility-enhancing systems. Four areas are emphasized: (1) research and evaluation of the benefits of IVI services; (2) development of industry-wide standards: (3) integrated system prototyping; and (4) field-test evaluations of the most promising products. Among FY 2001 projects is the completion of the IVI "Generation 0," an assessment of performance and acceptance of driver information and assistance systems. The JPO plans to conduct an operational test of the Advanced Law Enforcement and Response Technology (ALERT) system. A major goal of ALERT is to provide a technology interface between law enforcement data bases and official vehicles. Additional research will occur into areas such as incorporating the complexities of weather and road geometry with the IVI. Other FY 2001 initiatives include tests of various collision avoidance systems and drowsy driver field tests.

Commercial Vehicle Operations (CVO) is another principal effort of the ITS. The CVO will develop systems that will reduce the rate of fatalities and injuries, while reducing the cost of highway freight movement. Some of the plans for FY 2001 include completing the linkage of the Safety and Fitness Electronic Records (SAFER) to a commercial drivers license information system, and developing a rule-making for CVISN standards and interoperability tests. The Commercial Vehicle Information Systems Networks (CVISN) is a major initiative aimed at developing information systems for improved safety practices and technologies among owners and operators of large trucks operating on U.S. highways.

Traffic management and control, another large R&D initiative, seeks to develop dynamic control systems for traffic management and flow control. Key FY 2001 projects are: Dynamic Traffic Assignment (DTA); Adaptive Control Systems (ACS); pedestrian safety systems; and traffic simulation models. The JPO expects DTA efforts to form the cognitive basis of the long-range goal of the program, dynamic control systems.

Rural research in FY 2001, work will focus on operational tests of technologies such as variable speed limit systems, statewide emergency management systems, traveler information systems, and transit coordination in rural areas. One example is the weather Traveler Decision Support System (TDSS). This will study the optimal mix and presentation of weather information for use by road users of all types.

An important recent decision by the Federal Communications Commission (FCC) allocated spectrum at 5.8 gigahertz for short-range, vehicle to roadside communication. This decision will assist in the implementation of ITS technologies.

ITS Deployment Incentives

This integration program seeks to deploy ITS infrastructure both rural and metropolitan areas of the country. Although rural problems are being addressed with current technology, metropolitan area deployment is at a critical juncture. Part of the problem in metropolitan areas is the existence of legacy information systems that impede the integration of new technologies. In FY 2001, the IYS JPO plans to solicit proposals for demonstration projects aimed at the integration of at least two different ITS elements (e.g., signal control, transit management, electronic toll collection) or the integration of one element across multiple jurisdictions.

Deployment of commercial vehicle operations is continuing. In the FY 2001 budget submission, $32 million is requested to support state planning efforts, while other states deploy technologies such as safety information exchange, credentials administration, and roadside electronic screening.

Longer-term Outlook for ITS JPO R&D

As a maturation process ensues, the next five years of ITS activity may experience a transition that emphasizes deployment initiatives over pure research. This will help transform regional and statewide transportation into systems that are highly automated, interactive and efficient conveyors of freight and passengers. Moreover, they will operate under a consistent and integrated set of national standards. There are four ITS program areas that bear on the outlook for the next five years: metropolitan ITS infrastructure; rural and statewide ITS infrastructure; commercial vehicle infrastructure; and the intelligent vehicle initiative.

Metropolitan ITS Infrastructure

Seventy-five of the largest US metropolitan areas are included. Foremost among ITS concerns is the integration of ITS architecture within those sites. To date, about half the sites have either a medium or high level of integration. Research strategies aim to achieve higher levels of integration. Examples include traffic management strategies such as adaptive and dynamic control systems. These include changes in signal timing in response to monitored traffic conditions (adaptive) and employing historical data to predict traffic conditions (dynamic). Delivery of new modeling and analysis tools, such as the ITS Deployment Analysis System, will provide prototype traffic analysis and planning tools that help metropolitan planning organizations (MPOs).

Transit management research will also play an important role in metropolitan settings. Transitioning from single-mode ITS systems to multimodal and multi-regional ITS approaches is a promising area for exploration and development. Innovative techniques such as electronic fare payment technologies, traveler information systems, and social initiatives like welfare-to-work offer a stream of potential benefits to metropolitan areas with integrated ITS deployments.

In addition to research, seven other complementary strategies – accelerating the development of standards, training and education, funding incentives, technical assistance, consistency with national ITS standards, program evaluation, and showcasing benefits – should hasten the full and effective deployment of ITS in the 75 metropolitan areas.[2]

Rural and Statewide ITS Infrastructure

By 2003, the DOT expects that ten states will have installed statewide platforms that integrate rural intermodal ITS services in their region. The rural program will focus on research through operational tests. Some of the rural research tracks that are targeted in the five-year plan include surface transportation weather and winter mobility, traveler information infrastructure, crash prevention, system mobility, traffic management, and highway operations and maintenance.

Commercial Vehicle ITS Infrastructure

At the center of this program is the deployment of CVSN, a set of techniques and methodologies for linking disparate databases and enabling the electronic exchange of information. The CVSN pilot program will be eight states. Foremost among the goals of CVSN is safety. Information about risky drivers, motor carriers, and vehicles is more easily collected and disseminated with CVSN technology.

The Intelligent Vehicle Initiative (IVI)

The ultimate objective of the IVI program is work cooperatively with industry to develop intelligent vehicles for the driving public. Benefits include greatly enhanced safety, improved traffic and vehicle information to the driver, better communications between vehicles, and minimization of human factors to optimize vehicle and driver performance. Crash avoidance technologies are at the forefront of planned research efforts and work will proceed concurrently with other initiatives to build intelligent components into roadways and roadside infrastructure.

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[2] The national ITS program is guided by these 8 program strategies that work together to advance the state of ITS across the country. The strategies are common to all four long-range activities.

Federal Motor Carrier Safety Administration (FMCSA)

Mission

The primary goal of the Federal Motor Carrier Safety Administration (formerly the Federal Highway Administration Office of Motor Carriers) is to reduce the number and severity of commercial motor vehicle (CMV) crashes through regulation and enforcement, education/outreach, and promotion of safety-effective technology. The Motor Carrier Research and Technology (MCR&T) program supports FMCSA safety activities and initiatives through the discovery, application, and dissemination of new knowledge (research); and the assessment, development, deployment, and promotion of new devices and systems (technology).

Current R&D Profile and Funding Levels

The MCR&T program is organized into eight focus areas, as follows: crash causation and profiling; regulatory evaluation and reform; compliance and enforcement; hazmat safety and cargo tank integrity; commercial driver training and performance management; driver alertness & fatigue; driver physical qualifications; and car-truck proximity. The FMCSA has requested $9.5 million for R&D in FY 2001 (see Table C-3).

In response to an increasing demand for studies to help improve the safety of commercial motor vehicle operations in the United States, the MCR&T program has grown considerably in recent years. The FCMSA supports a number of cooperative research efforts, both with other modal administrations within the U.S. DOT (e.g., FHWA, NHTSA, and the FRA), and with research partners in the private sector. The MCR&T program is managed primarily by the Research Division of the FMCSA Office of Research, Technology, and Information Management.

Longer-term Outlook for FMCSA R&D

Over the next few years the FMCSA will emphasize safety initiatives in four main areas: Highway Users - focusing on driver fatigue, pedestrians, and behavior; Highway Design - focusing on roadside hazards and operations management; Vehicles and Cargo, focusing on improving the general condition of vehicles through streamlined, targeted roadside inspections; and Motor Carrier Operations, focusing on increased enforcement, identifying and targeting high risk carriers, and using penalties more effectively to sustain compliance.

At present, there is no published long-term outlook for R&D. The FMCSA is a new DOT operating administration as of January 2000 and will be conducting strategic planning over the next year.

Table C-3. Comparative Summary of FMCSA R&D Activity ($ 000)

MCR&T Funding (in thousands)	FY 1999 Actual	FY 2000 Planned	FY 2001 Request
Crash Causation And Profiling	$570	—*	$1,200
Regulatory Evaluation & Reform	$439	$919	$1,260
Compliance & Enforcement	$954	$1,325	$1,625
HAZMAT Safety & Cargo Tank Integrity	$205	$270	$400
Commercial Driver Training and Performance Management.	$198	$835	$1,345
Driver Alertness & Fatigue	$703	$1,000	$1,592
Physical Qualifications	$499	$200	$660
Car-Truck Proximity	$174	$490	$822
R&T Management, Media, and Special Projects	$187	$535	$642
Deductions (e.g., Obligation Limitation)	$2,471**	$826	$TBD
Motor Carrier R&T Total:	**$6,400**	**$6,400**	**$9,550**

* Supported through other funding sources

** Included $1,321K deduction for the National Advanced Driving Simulator (NADS).

Federal Aviation Administration (FAA)

Mission

The FAA mission is to provide a safe, secure, and efficient aerospace system that contributes to national security and promotion of U.S. aerospace safety. As the leading authority in the international aerospace community, the FAA is responsive to the dynamic nature of customer needs, economic conditions, and environmental concerns. Key mission elements are (1) the regulation of civil aviation and commercial space transportation to promote safety, and (2) the safe and efficient use of airports and the airspace by both civil and military aircraft.

To accomplish this mission, the FAA's R&D program develops and validates technology, systems, design, and procedures that directly support six of the agency's principal operational and regulatory responsibilities: acquisition, air traffic services, certification of aircraft and aviation personnel, operation and certification of airports, civil aviation security, and environmental standards for civil aviation R,E& D activities undertaken by the FAA are done through a variety of mechanisms, including in-house initiatives, partnerships with other agencies, universities, nonprofit organizations, international organizations, and industry, and technology transfer to the private sector

Current R&D Profile and Funding Levels

The FAA R&D program represents the largest such program in the DOT, with a budget request of over $288 million in FY 2001 [see Table C-4). The program supports the goals and objectives of the agency's strategic plan, as well as the requirements associated with the evolving air traffic system architecture. A major FAA challenge today is modernizing an aging infrastructure of air navigation facilities. A major infusion of new technology and procedures is essential if air traffic services are to continue to support safe and efficient flight operations in the future. The system architecture provides the road map for this continuing modernization process, and the R&D program provides the necessary system development initiatives.

Table C-4. Comparative Summary of FAA R&D Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
R&D	$177,978	$183,438	$215,377
Facilities	$52,566	$42,696	$72,848
Total	$230,544	$226,134	$288,225

FAA's research is directed towards improving the security, safety, and efficiency of operations in the National Airspace System. Components of this program include research in security technology, aviation weather products, continued airworthiness of existing aircraft and airworthiness of new aircraft technologies, advanced air traffic management technologies and procedures, the role of human performance in safe operation, maintenance, and renewal of both air traffic control systems and aircraft, advanced airport pavement design methodologies, aircraft crash rescue and firefighting technologies, airport runway and taxiway lighting, marking and signage systems and wildlife hazard mitigation and management techniques for airports.

Partnerships with NASA, DoD, states and industry comprise another strategic research area. These assure low-cost access to space through improved technology and operations for the rapidly growing commercial space transportation sector. It also relates to the safe integration of new spaceports and routine launch operations of reusable vehicles into the National Air Space Management System.

A safe and efficient air transportation system also is essential to both the Nation's economic prosperity and for national defense. A viable FAA R&D program is critical to assure the continued safety and efficiency of the air transportation system and continued U.S. technical and economic leadership in aviation.

The FAA's R&D program is functionally divided into six program areas:

Air Traffic Services

The ATS R&D program is one part of an integrated strategy to increase the value of the air traffic services. The program is a vehicle for making long-term investments in

improving services, procedures, and infrastructure, and integrating new concepts and technology to meet the increasing demands of safety, capacity, efficiency, and productivity. Human factors considerations are central to all program outcomes for a totally effective solution.

The FAA test beds located at the William J. Hughes Technical Center (WJHTC) support R&D program goals that address safety, efficiency, capacity and the environment. The WJHTC maintains and operates agency test bed laboratories utilized by R&D programs in achieving these goals. These centralized test beds consist of non-operational NAS systems, aircraft, simulation facilities, communication systems, and a Human Factors Laboratory.

The Center for Advanced Aviation System Development (CAASD) research program provides detailed reports, briefings, and concept demonstration systems used in the evaluation of new air traffic management (ATM) and control operating concepts and/or infrastructure replacements. These products are critical elements in beginning development of a more efficient, more available, and safer next generation ATM and control system.

CAASD provides new technology research for applications for global air traffic management, including developments in traffic flow management, navigation, separation assurance, surveillance technology, and system safety.

The aviation weather program focuses on conducting applied research to solve operational problems leading to the development of new and improved algorithms. These models predict weather events that affect aviation as well as procedural and policy changes/updates. The algorithms were developed for implementation on appropriate national air space (NAS) platforms, including the weather and radar processor (WARP), the integrated terminal weather system (ITWS). The algorithms also apply to National Weather Service (NWS) systems. They continue to be transferred to private weather service companies that support the NAS. This enables companies to develop specialized aviation weather products based on FAA research efforts. Algorithm development depicts current and forecasted in-flight icing, produces high resolution and gridded weather information, and provides location, timing, and severity of convective weather hazards. Through Project SOCRATES the weather program is also developing and deploying sensors to provide a tactical safety net for aeronautical weather-dependent hazards with an initial focus on wake turbulence hazards for closely spaced, parallel runway operations.

Presidential Decision Directive (PDD-63) calls for a national-level effort to protect the increasingly vulnerable and interconnected U.S. computer and communications infrastructure. Executive Order 13010 identifies aviation transportation among the key protection areas. To this end, extraordinarily difficult and challenging technical problems must be addressed as a part of protecting the National Airspace System (NAS). The FAA is seeking resources to develop R&D in this area.

The FAA's Advanced Technology Development and Prototyping program develops and validates technology and systems that support air traffic services and the development of airport standards.

FAA is also conducting research leading to the development and implementation of an integrated *Space and Air Traffic Management System* (SATMS). SATMS will accommodate travel through airspace of vehicles en route to or from space.

Airports

The Airport Technology program's mission is to provide technology solutions that will allow the Nation's airports to accommodate the projected traffic growth and establish an operational environment that is free of accidents and fatalities. This is accomplished by fulfilling the FAA's regulatory obligation to develop standards, criteria, and guidelines for planning, designing, constructing, operating, and maintaining the massive airport system. This includes: airport pavement design; airfield design; wildlife hazard mitigation; visual guidance systems; surface traction; post-crash rescue and firefighting; and wildlife control.

Aircraft Safety

The mission of the Aircraft Safety program is to provide a safe global air transportation system by establishing safety standards and acceptable practices through development of technical information, tools, and technology to ensure safe operation of the civil aircraft fleet. This program addresses the many hazards that face all aircraft in flight, as well as special hazards that apply to select portions of the civil aircraft fleet. For example, older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft — with digital flight control and avionics systems, associated imbedded software, and construction of new non-metallic materials — present significant challenges in certification, continued airworthiness, and operation. However, all aircraft, old or new, must deal with the hazards of adverse weather.

Specific project address fire-resistant materials, aircraft fire safety research, structural safety and advanced materials/structures, propulsion and fuel systems, flight safety/atmospheric hazards research, aging aircraft, aircraft catastrophic failure prevention research, and aviation safety risk analysis.

System Security

The FAA's Aviation Security Research and Development (R&D) Division has the lead responsibility within the FAA for R&D programs related to civil aviation security. The division performs R&D to eliminate civil aviation security incidents and provides assistance in anticipating future risks to civil aviation. Division programs accelerate and expand R&D and implement advanced technologies. Division products provide equipment and methods to counteract terrorist efforts against civil aviation.

The FAA conducts extensive R&D to detect explosives, weapons, and other more sophisticated devices, to prevent their placement onboard aircraft. The Aviation Security R&D program focuses on automated aviation security systems and screening protocols that are the least intrusive and enable the highest throughput, thus minimizing passenger delays and inconvenience. The FAA conducts R&D to identify methods of hardening aircraft fuselages to mitigate damage from explosives, weapons, surface-to-air missiles, and electromagnetic interference.

Specific projects address explosives and weapons detection, security of civil aviation airports and air carriers, human systems integration/human factors, and explosives/advanced threat vulnerability mitigation).

Human Factors and Aviation Medicine

The FAA Human Factors and Aviation Medicine program conducts applied research, to identify methods that will help reduce the fatal accident rates. It ensures that human factors issues are addressed in acquiring and integrating all new and modified FAA aviation systems. The division also reviews medical patterns in civilian flight, and develops recommendations for protective equipment and procedures. Some specific project areas include human factors relating to flight deck, maintenance, system integration, and ATS. It also sponsors and conducts aeromedical research.

Environment and Energy

Mitigating the impacts of aircraft noise and emissions are important to protect the environment and to sustain the growth of aviation. The FAA sponsors research that aims to produce reductions in aircraft energy consumption and emissions while supporting the environment and maintaining the efficiency of the air system. Some planned activities for FY 2001 include: a report on subsonic jet noise reduction; an assessment of the FAA/NASA light propeller-driven airplane noise reduction technology; development of a harmonized, simplified engine exhaust emissions certification test procedure; a new emissions and dispersion modeling system; and the development of a global emissions model.

Longer-term Outlook for FAA R&D

Air Traffic Services

The essence of the ATS R&D program is to maintain a long-term view of the research requirements for continued safe and efficient operation, maintenance, and use of the air transportation system today and in increasing system safety, capacity, and productivity.

The ATS R&D program is a continuing effort that will have continuing funding expectations at or beyond the current level. Although the composition of the R&D program portfolio will change over time as some efforts come to fruition and transition to a relevant implementation or operational environment, continued investment in ATS R&D will ensure that the FAA stays current with the ever-increasing demands on the air

traffic system. Further, continued investment in the ATS R&D will ensure that the FAA has an effective risk-identification/mitigation strategy for the high-risk areas of the future NAS architecture.

Airports

Support for friction testing of new products to eliminate slipperiness as a cause of accidents will continue beyond 2005. Operation of FAA's national pavement test facility began in June 1999 and will continue for 10 years. The data collected from the test machine will allow smooth introduction of new heavy aircraft expected to join the fleet well into the next century. The pavement design standards based on these data will:

- Provide assurance to manufacturers about the compatibility of their aircraft with airports throughout the world
- Provide airport operators precise costs estimates to permit new aircraft operations at their facilities
- Allow airlines to plan for new equipment and routes
- Give airport designers confidence in their designs

This long-range commitment to improving airport technology gives the FAA the tools required to assure the public that Federal funds are being judiciously spent and that public investment in infrastructure is prudently managed.

Aircraft Safety

The need for safety and safety-related research will continue indefinitely. With the emergence of new and advanced technologies, there will be an ongoing need to improve air transportation system safety. There will always be a need to understand the impact of new technology on operator performance. As air traffic continues to increase, and as aircraft continue to age, there will always be a need to address issues related to aging aircraft.

With new technology, new damage mechanisms may occur, introducing hazards that must be understood and addressed. Research in aircraft safety must be continued to understand the impact of changes in technology on current regulatory safety standards, certification procedures, and acceptable practices for demonstration of compliance mandates.

Security

The FAA envisions an integrated aviation security system for the 21st century that incorporates the strengths of a variety of technologies that are continuously being monitored and upgraded to respond to changes in the threat environment. This integrated system will enable aviation security professionals to perform most effectively.

Automated detection technologies will enhance screener performance by providing detection that is constantly vigilant and impervious to distraction or fatigue, as in the case

of human or canine screeners. This understanding of the aviation security system of the future guides and directs future Aviation Security R&D efforts and supports decisions for FAA investments.

Terrorist capabilities and techniques will continue to increase and evolve. This ever-changing threat necessitates continued funding of R&D for the foreseeable future. Aviation Security R&D efforts will continue to focus on modifications and other technical improvements to deployed explosives detection equipment.

Identification and evaluation of explosives mitigation techniques will also continue. Efforts will continue, expanding to include the entire aviation spectrum, including airports, airplanes, and other areas of the National Airspace System, as needed.

Human Factors and Aviation Medicine

The FAA is responsible for initiating and maintaining research and development programs that support modernization, regulation, certification, and NAS issues. The FAA is also responsible for initiating proactive research for identifying emerging safety trends. The Human Factors investment strategy will directly support these research efforts to identify and reduce targeted safety issues.

Baseline data will be established to show direct causal relationships between research outputs, and accidents and incidents. Research programs will focus on targets that will have the greatest impact on aviation safety. The programs will be multiyear efforts and will require stabilized resources to plan, execute, and complete. Successful implementation of research outputs will require full partnerships and close cooperation within FAA organizations and the aviation community.

Research strategies will focus on technology, partnerships, and measurements. Methods will be developed to identify interventions to address human performance issues in flight maintenance and air traffic operations. In addition, methods will be developed to reduce operational hazards. Regarding partnership strategies, a five-year, integrated safety research plan will be developed with NASA, addressing long-range, high-payoff priorities. Measurement strategies will be developed to accurately monitor trends and identify opportunities for risk mitigation research.

There is strong public and congressional interest in maintaining a healthy and comfortable environment for each civil aviation category. A five-year interagency agreement between FAA and NIOSH began in FY 1997, addressing infectious disease and other health considerations in the aircraft cabin environment.

FAA goals related to minimizing injury, associated pain, necessary rehabilitation, and death as a consequence of aviation accidents make the work of the Aviation Medicine program a critical component of coordinated steps that will increase survivability, which is one of the accepted corporate strategies for decreasing fatal accidents. The Aviation Medicine program will emphasize reducing the severity of injuries encountered in aviation accidents and in such precautionary events as evacuation of passengers from an

aircraft after the flight crew recognizes a safety concern. This approach will cut rehabilitation time, decrease medical costs, and improve the quality of life for people who suffer injuries.

In concert with the targets expressed in Challenge 2000 and with FAA's broad commitments to harmonize safety regulations on a global scale, the Aviation Medicine program--collaborating with domestic and international laboratories--will generate research data for use in developing internationally harmonized aviation standards and regulations. Aeromedical Research will be increasingly required to interpret data derived from around the world, and to determine if the data should be accepted or re-collected before being integrated into regulatory considerations and outputs.

Environment and Energy

Planning for environmental research needs beyond 2000 requires a look at key indicators. These are generally described as driving forces for change, targets of opportunities, or future (environmental) threats. Some key indicators that may influence aviation environmental research include:

- Scientific findings
- Air transportation growth
- New aviation technologies
- Increased globalization of aviation
- Reduced Federal resources

FAA predicts steady growth of the demand for aviation services into the first decade of the next millennium. The growth in aircraft operations to meet this demand will produce increased environmental impacts and create barriers to further growth.

The key to successful environmental planning is to identify operational mitigation options for those sectors of the growing aviation markets that are most likely to reach environmental critical mass. FAA will need to continue to assess the situation to determine whether research to support mitigation should be directed, for example, toward tour operations over national parks, urban vertiports, resurgent general aviation activity, the old standby large jet transport operations, or a new threat.

Major NASA aeronautics research programs are coming to an end; most notably, the AST program. Several technologies will come out of these NASA research programs that U.S. industry will be utilized in the next generations of aircraft, entering the marketplace within 10-15 years. With the end of the AST program, FAA will close its companion research program on subsonic noise reduction. The agency will use its research findings to consider new environmental certification standards and procedures for the next generation of transport aircraft. FAA will shift future environmental research in the field of new aircraft technology toward other research programs, with emphasis on rotorcraft and general aviation.

The solution to controlling the environmental consequences of new aircraft technologies is through a coordinated regulatory and R&D approach involving the FAA with other Federal agencies, such as EPA, NASA and DoD, from the early stages of the technology research.

Technologies, such as the Global Positioning System (GPS), are already beginning to have a profound effect on the aviation system. As these technologies are introduced to improve system efficiency and flexibility, a new FAA paradigm is emerging under the general term, "Free Flight." As the FAA builds more user flexibility into the NAS, what are the environmental consequences (impacts and improvements)? FAA must expand the current suite of environmental analysis tools to address the consequences of alternative actions as the agency moves towards free flight in all domains.

While human (animal) behavioral research is generally not the responsibility of the FAA, the agency must devote research resources to apply pertinent scientific findings on environmental impacts into Federal guidance and policy. And the findings of earlier FAA and NASA scientific studies have now been incorporated in the Intergovernmental Panel on Climate Change Special Report on Aviation and the Global Atmosphere, requiring consideration of national and international actions to mitigate global climate change.

As stated in FAA's 1998 Strategic Plan, "The globalization of aerospace, U.S. business, and travel is another factor driving change." What is the potential effect of expanding international and multinational manufacturing centers on the harmonization of international aircraft noise and engine emissions certification procedures and recommended practices? The FAA must plan research efforts to support continued international harmonization and standardization of the aviation environmental certification standards and procedures.

National Highway Traffic Safety Administration (NHTSA)

Mission

Established by the Highway Safety Act of 1970, the National Highway Traffic Safety Administration (NHTSA) has five missions: establish and enforce safety standards for new motor vehicles and equipment; provide highway safety grants to state and local governments; promote use of safety belts, child safety seats, and airbags; provide information to consumers; and set and enforce standards for fuel economy, odometers, and theft prevention. NHTSA is responsible for reducing deaths, injuries and economic losses resulting from motor vehicle crashes.

Current R&D Profile and Funding Levels

Research on driver behavior and traffic safety is conducted by NHTSA to develop the most efficient and effective means of bringing about safety improvements. To carry out its missions, NHTSA conducts a supporting program of research, development, and technology demonstration. For FY 2001, the budget request is $130.6 million (see Table C-5). This program addresses several areas:

Table C-5. Comparative Summary of NHTSA R&D Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
R&D	$50,350	$50,569	$95,258
Technology Investment	$22,041	$21,871	$35,388
Total	$72,391	$72,440	$130,646

Highway safety research aims to alter the unsafe behavior and attitudes of drivers, passengers, pedestrians, bicyclists, and others who share the road. A major effort is devoted to the reduction of drivers' drug and alcohol use and the development of improved methods of detecting impaired drivers.

Safety systems research in this area seeks to reduce crash-related deaths and injuries through improvements in vehicle structure, occupant compartment design, and restraint systems. Biomechanics research evaluates the extent and severity of potential crash injuries through the use of dummies and detailed computer models. Crashworthiness research covers air bags and occupant protection. Crash avoidance research seeks to help drivers avoid crashes, or decrease crash severity, through improvements in driver and vehicle performance. ITS research assesses the potential benefits of ITS-based collision-avoidance systems and the safety impacts of new ITS products. Databases and data collection includes the Fatality Analysis Reporting System, the National Automotive Sampling System, the State Data Program, and the Occupant Protection Survey. NHTSA's specific research, development, and technology programs are summarized below.

Data Analysis Program

Each year, approximately 42,000 people die from injuries received in traffic crashes. The success of NHTSA's mission to reduce fatalities and injuries depends on reliable crash data analysis. The Data Analysis Program meets this need by (1) providing analytic support to internal and external customers; (2) identifying injury mechanisms and associated outcomes in motor vehicle crashes; (3) providing accurate and timely traffic safety and related information to customers; and (4) obtaining in-depth information on air-bag-related injuries via an interagency agreement with the Consumer Product Safety Commission. An important goal is to analyze motor vehicle crash and related data to support NHTSA's research, safety performance, safety assurance, traffic safety, and injury control efforts. The results of these analyses not only form the basis for agency decisions affecting motor vehicle and traffic safety, but are used by the entire highway safety community to quantify emerging traffic safety issues and problems, to order priorities, and to target resources where they will be most effective. Specific projects include:

- Evaluating the effectiveness of air bags and safety belts, as well as the effectiveness of daytime running lights and continuing analyses of other motor vehicle safety improvements.

- Supporting the Office of Defects Investigation to quantify crash occurrence and crashworthiness related to vehicle defects.

- Examining the impact of increased speed limits at the state and national levels, where possible.

New efforts proposed in FY 2001 will:

- Review new technology and upgrade the current customer-service response system.

- Improve timeliness of responding to customers' requests for the latest traffic safety data and information.

Driver/Vehicle Performance

Nearly 90 percent of motor vehicle crashes are the result of driver error. Many of these errors could be reduced if the vehicles' collision avoidance systems were improved to be more compatible with the capabilities and behaviors of the driving population. This program supports NHTSA's rulemaking and consumer information efforts by developing the scientific basis for improving the collision avoidance capabilities of the driver/vehicle combination. Research areas include vehicle braking, handling, stability, direct and indirect visibility, vehicle lighting/signaling, and controls and displays, as well as human factors issues associated with the interaction between the driver and vehicle. Specific efforts include:

- Enhancing the effectiveness of light vehicle antilock braking systems (ABS).

- Reducing light vehicle rollover, especially light trucks and sport utility vehicles, through the development of a procedure for on-road, untripped rollovers and the examination of the effects of vehicle loading conditions on rollover propensity.

- Identifying and evaluating possible rear lighting and signaling designs that could better alert drivers of stopped or slow-moving vehicles.

- Reducing driver distraction from in-vehicle devices, such as cellular telephones, navigation systems, and computers.

- Examining the relative impact of headlight glare on driver discomfort and visibility and identifying countermeasures for glare reduction.

- Quantifying the effects of age-related impairments on driver performance, risk compensation, and the use of new technologies.

In FY 2001, a new initiative will be to:

Conduct research in support of a new, globally harmonized safety standard for light vehicle tires.

Fatality Analysis Reporting System (FARS)

FARS is a data collection system that provides a census of all fatal highway crashes in the United States. Information is collected through cooperative agreements between NHTSA and each of the 50 states, the District of Columbia, and Puerto Rico. The overall goal of the program is to provide data to evaluate the effectiveness of NHTSA's crashworthiness, crash avoidance, and traffic safety efforts, as well as relating human, vehicle, roadway, and environmental factors to the approximately 42,000 traffic-related fatalities each year. Ongoing activities are:

- Collecting and coding FARS data in the 50 states; Washington, D.C.; and Puerto Rico.
- Creating 2,000 FARS electronic data files on approximately 42,000 fatalities.
- Creating and delivering FARS training to all analysts, including a remedial course for selected analysts.

New initiative are proposed in FY 2001 to:

- Broaden the availability of FARS information through electronic media (i.e., World Wide Web, CD-ROM).
- Improve the quality of drug and alcohol information by establishing direct electronic links between FARS analysts and medical examiners, coroners, hospitals, and police.
- Link the FARS database with other national databases and with state data files.

Heavy Vehicles

Approximately one out of eight people who die in traffic crashes every year is killed in a collision involving a heavy truck; 80 percent of those fatalities are occupants of other vehicles that collide with trucks. This program supports NHTSA's rulemaking and consumer information efforts by developing the scientific basis for improving the safety of heavy vehicles. It aims to make these vehicle less prone to crashes by (1) improving their braking, handling, and visibility characteristics and (2) mitigating the consequences of collisions that do occur between heavy trucks and other vehicles. The program is focused on the following critical safety needs:

- Improving heavy-truck stopping capabilities, through new test procedures and performance requirements.

National Automotive Sampling System (NASS)

Nationally representative data on crashes is vitally important to NHTSA and other users. NASS General Estimates System (GES) data assist in assessing the trend and magnitude of the crash situation, and the NASS Crashworthiness Data System (CDS) provides more in-depth and descriptive data to understand real-world crashes. Ongoing activities include:

- Collecting CDS data at 24 sites in 17 states.
- Collecting GES data at 60 sites (including the 24 CDS sites) in 26 states.
- Creating annual NASS CDS databases, with approximately 5,000 detailed crash investigations for CDS and 54,000 crash reports for GES.
- Minimizing the time from case investigation to public availability of data.
- Training state and local crash investigators in field investigation procedures at the Transportation Safety Institute in Oklahoma City, Oklahoma.
- Providing in-depth injury information from NASS CDS cases to support research and regulatory initiatives on occupant protection systems.
- Researching, developing, and testing new technologies for field data collection.

New initiatives are proposed in FY 2001 to:

Conduct detailed investigations of medium/heavy truck crashes at the 24 NASS CDS sites with funds provided through the FMCSA.

National Transportation Biomechanics Research Center

"Biomechanics" uses the principles and practices of engineering to study human injury mechanisms in vehicle crashes; develops criteria to predict injury risk in automobile crashes; and provides test devices, such as dummies, that mimic human impact responses to allow, using the injury criteria, a prediction of injury risk for a particular impact situation. This work supports the development of intervention and prevention strategies by correctly modifying or limiting the appropriate mechanical components of the impact processes that cause injury. Current efforts encompass the following:

- Identifying and analyzing critical safety issues through multi-disciplinary teams at seven hospital-based Crash Injury Research and Engineering Network (CIREN) centers.
- Continuing experimental research at university-based impact trauma laboratories with multi-disciplinary teams of physicians, engineers, and anatomists.

- Identifying design approaches that would improve the compatibility of trucks and passenger vehicles and preventing crashes through other countermeasures.

- Reducing lane-change crashes caused by "blind spots."

- Providing data on the relative performance of original rubber versus retreaded tires, which could be used to assess the need for a safety standard for retreaded truck tires.

New research projects in FY 2001 will:

- Evaluate the feasibility of using aerodynamics to create a drag on heavy-duty vehicles when one is wanted to slow these vehicles down, similar to devices used by race cars.

- Evaluate the benefits of adding traction control to heavy vehicle ABS.

Highway Safety Research

NHTSA's highway safety research program determines the causes of crashes, identifies target populations, acquires the research for developing countermeasures, and evaluates the effectiveness of programs that will reduce traffic deaths, injuries, and associated monetary costs. The program provides the scientific basis for NHTSA's national leadership in highway safety through studies of (1) driver, passenger, and pedestrian attitudes and behaviors; (2) the circumstances and situations of crashes; and (3) the most effective ways to reduce crashes. Specific research activities are:

- Developing improved methods to identify impaired drivers, keep repeat offenders from drinking and driving, and improve the enforcement process.

- Developing strategies and technologies to increase the use of seat belts.

- Developing strategies to improve safe mobility for older drivers, including the testing of driver evaluation tools and evaluation of rehabilitation options.

- Reducing the incidence of aggressive driving.

- Improving safety for pedestrians, bicyclists, and motorcyclists by developing and testing countermeasures, evaluating methods to reduce speeding, and assessing motorcycle crash risks.

For FY 2001, new activities will:

- Develop and test programs that address driver fatigue and inattention among shift workers and students.

- Determine changes in differential enforcement practices.

- Simulating in detail the human in the automotive crash environment to mathematically predict (1) the occupant's interaction with typical automotive restraints and structures and (2) the extent and severity of expected injuries.

- Developing enhanced test devices, from sub-component devices representing particular body segments to complete dummies representing the total human, to evaluate and regulate safety.

- Developing tools to assess the safety of current and emerging air-bag deployment systems.

Work in FY 2001 will build on the activities in the five preceding areas.

Partnership for a New Generation of Vehicles (PNGV)

Projections indicate that a 40 percent reduction in vehicle mass will be needed to meet the fuel economy requirements of the PNGV program. Coupled with the potential use of materials other than steel and of entirely new power trains, this reduction requires that NHTSA determine the overall crash safety of the new vehicles. Beyond the testing required by Federal motor vehicle safety standards, the safety analysis must evaluate the vehicles' performance in crash modes that are representative of the real-world crash environment. NHTSA's PNGV program thus includes the following research activities:

- Developing vehicle/occupant system models to evaluate the crashworthiness performance of PNGV conceptual designs.

- Developing an analytical model of the U.S. traffic environment, including vehicles, crash modes, and crash frequencies.

- Determining how lightweight materials, such as aluminum and advanced composites, affect vehicles' crash safety performance.

In FY 2001, the program will:

- Apply the developed models to evaluate the baseline platforms upon which the PNGV vehicles are based.

- Analyze the crashworthiness of specific PNGV technologies, such as hydrogen storage systems, advanced flywheels, and other systems, as appropriate.

Safety Systems (Crashworthiness)

This program will enhance occupant protection by providing improvements in vehicle structure and interior compartment design, in combination with improvements in occupant restraint systems. Achieving these improvements requires analysis of real-

world crash experience, development of test procedures that reproduce the crash environment, evaluation of injury likelihood from crash test measurements, development and evaluation of vehicle countermeasures, and estimates of safety benefits. The program also fosters international harmonization in the areas of pedestrian, frontal offset, side impact, and vehicle compatibility research. Specific activities include:

- Mitigating safety problems associated with frontal crashes through (1) countermeasures that improve occupant protection; (2) development of harmonized injury criteria and an associated crash test dummy; and (3) development of harmonized test procedures.

- Improving rollover-crash protection by (1) reducing occupant ejection injuries; (2) analyzing roof structural performance; and (3) evaluating design concepts for reducing roof crush and inflatable devices that provide head protection.

- Improving occupant protection in side crashes, especially those involving light trucks and vans, and in vehicle-to-narrow object crashes, such as utility poles and trees.

- Developing advanced occupant protection systems, such as upgraded air-bag systems, inflatable automatic belt systems, pre-crash sensing, side-inflatable cushions, and improved energy-absorbing interior surfaces and seat designs.

- Developing and evaluating air-bag systems that incorporate solutions to safety problems identified in the field, including injuries to children resulting from aggressive air-bag deployments.

Work in FY 2001 will:

- Reduce pedestrian injuries by developing procedures for child head protection and establishing injury-reduction levels that might be attained through countermeasures.

- Augment the direct collection and evaluation of crash data from in-vehicle sensing and recording devices with systems that record pre-crash data.

Special Crash Investigations

This program identifies and documents the effects of rapidly changing vehicle technologies to assess their impacts on motor vehicle crashes. Among other tasks, the program is charged with investigating air-bag-related fatalities and has been instrumental in confirming issues related to children and adults injured or killed by air-bag deployments. The program also will assess the real-world crash performance of new air-bag systems as they emerge. Specific activities include:

- Investigating crashes nationwide involving air bags, school buses, alternative fuel vehicles, and adaptive devices for the physically challenged.

- Providing in-depth vehicle-trauma information on air-bag-related crashes to support research and regulatory initiatives on occupant protection systems in passenger cars.

- Increasing the quality and completeness of data provided in motor vehicle crash investigations.

- Facilitating the collection and use of collision-avoidance and crashworthiness data from on-board event data recorders.

- Developing and testing new technologies for improving reports of special crash investigations.

Work in FY 2001 will build on these research activities.

State Data Program

This program provides the state crash data that NHTSA analysts use in research aimed at reducing deaths, injuries, crashes, and associated health care costs. For example, NHTSA is currently using state crash data in analyses of the rollover propensity of light-duty vehicles, crashes involving large trucks and buses, injury risks to front-seat passengers in minivans equipped with dual air bags, and the effect of ABS on single- and multi-vehicle crashes. Overall efforts focus on the following:

- Obtaining, documenting, and making available to NHTSA analysts electronic data files based on motor vehicle crash reports collected from police departments across 17 states.

- Providing technical assistance to NHTSA staff in the use of state data for agency programs.

- Providing technical assistance to states to improve their highway-safety-related databases.

- Promoting the linkage of crash and medical outcome databases to improve states' abilities to analyze crashes in terms of injuries, the severity of injuries, and treatment costs.

In FY 2001, the program will:

- Work with national and state organizations to encourage states to adopt standardized elements for motor vehicle crash data.

- Provide technical assistance, sponsor research and meetings, and award grants to states to promote the use of linked crash and medical outcome data files.

Technology Transfer

The public demands fast, current, and accurate reporting of NHTSA's safety research results. This program provides timely information on NHTSA safety research and development to a concerned motor vehicle and traffic safety community. Technology transfer efforts include:

- Contributing to the continued expansion and success of the Seventeenth International Enhanced Safety of Vehicles Conference, International Harmonization Research Activities, and other important safety programs.

- Continuously updating NHTSA's Research and Development website to better fulfill requests for information worldwide on motor vehicle and highway safety research results and programs.

Work in FY 2001 will continue and build on these activities.

Vehicle Research and Test Center (VRTC)

The VRTC is NHTSA's research, development, test, and evaluation facility in East Liberty, Ohio. Assisting all NHTSA program offices, the Center uses in-house researchers to address safety issues and support new or revised rulemaking.

The VRTC's three divisions support NHTSA crashworthiness and defects investigations, assisting with advanced air-bag studies, school bus safety assessments, child safety initiatives, and evaluations of possible motor vehicle defects. In the area of applied biomechanics, the VRTC manages, refurbishes, and supplies anthropomorphic dummies to facilitate compliance testing, rulemaking, and research and development. It also addresses vehicle stability and control, completing an assessment of anti-lock brake technology. The three VRTC divisions will continue to support these and other priority programs in FY 2001.

Longer-term Outlook for NHTSA R&D

NHTSA has no long-range R&D plan, per se, but it did publish in 1997 a document that provides a vision statement out to the year 2020 (DOT NHTSA 1997). The report depicts a surface transportation system still struggling with many of the same safety issues that confront us today. Shaping that future environment are demographic, economic and social changes such a growing but aging U.S. population growth, a large number of younger drivers, continued migration to sunbelt states, roadway congestion, managed health care, and increased use of information technology. The new generation of motor vehicles will be more fuel efficient, more spacious, and constructed of lighter weight materials.

NHTSA will develop, promote and implement effective educational, engineering, and enforcement programs toward ending preventable tragedies and reducing economic costs associated with vehicle use and highway travel. Many of NHTSA's strategic goals are addressable through its R&D programs:

- Lead the effort to make traffic and motor vehicle safety a priority on the Nation's health care agenda.
- Lead a national effort to address the most significant traffic and motor vehicle safety issues.
- Deliver the highest quality technical and program assistance to states and communities, and promote international cooperation.
- Support research and apply the results to education, engineering, and enforcement to reduce road casualties and costs.
- Improve the internal processes, management, and structure to create a more effective and efficient agency.

NHTSA views the trend toward greater state roles in transportation decision-making, established in the 1990s, to continue as MPOs and state DOTs assume broader powers and more local control of transportation. In such an environment, the Federal government would conduct research to define effective programs and local agencies would determine how to best use the resources.

Since fatalities, injuries, and property damage will continue as unintended by products of motor vehicle usage, NHTSA envisions four major roles for itself:

- Be catalyst for improving the human element.
- Facilitate the design and deployment of the most effective vehicle and road technology.
- Drive the costs associated with traffic crashes to an absolute minimum.
- Exploit information technology to create a foundation for safety research, policy decision-making and safety impact evaluation.

Partnerships, in NHTSA's estimation, are essential ingredients of the future surface transportation R&D world. These include new and traditional multipurpose partnerships with states and communities, medical and allied public healthcare organizations, vehicle manufacturers and equipment suppliers, and the transportation provider industry.

Research programs to analyze and understand the effects of human behavior on traffic safety are critical to achieving these goals and partnerships. R&D resources must also support the use of advanced technology to enhance traffic safety, and develop simulations and models of human behavior and vehicular operations.

Federal Railroad Administration (FRA)

Mission

The FRA promulgates and enforces railroad safety regulations, administers railroad financial assistance programs, conducts research and development in support of improved railroad safety and to foster the deployment of high-speed rail passenger service, provides

for the rehabilitation of Northeast Corridor rail passenger service and consolidates government support of rail transportation activities.

Current R&D Profile and Funding Levels

The FRA has a comprehensive research and development program that addresses all areas of safety for freight, intercity passenger, and commuter railroads: human factors, rolling stock and components, track and structures, track-train interaction, train control, highway–railroad grade crossings, hazardous materials transportation, safety of train occupants, railroad system safety and security, and R&D facilities and equipment. FRA also has the Next Generation High-Speed Rail program, which demonstrates technologies in four areas – train control, non-electric locomotives, grade crossings, and track and structures – aimed at fostering the deployment of high-speed rail passenger service in corridors around the country. In FY 2001 the total research and technology request is just over $52 million (see Table C-6). Descriptions of the Safety R&D and Next Generation High-Speed Rail programs follow.

Table C-6. Comparative Summary of FRA R&D Activity ($ 000)

Item	FY1999 Actual	FY 2000 Enacted	FY 2001 Request
Safety R&D	$21,864	$24,507	$28,816
Technology	$20,494	$27,771	$22,705
Facilities*	$500	$500	$1,350
Total	$42,858	$52,778	$52,171

*Facilities funds are included in Safety R&D

Safety Research and Development

The budget for the Safety R&D program is organized in four sub-program categories that are conducted with the cooperation of, and some cost-sharing by, private sector organizations. The Equipment, Operations, and Hazardous Materials Research promotes research on safety and performance improvements in train occupant protection, rolling stock safety assurance and performance, human factors, transportation of hazardous materials, and grade crossing safety. The Track and Vehicle Track Interaction Program focuses research on safety and performance improvements to track structure, track components, railroad bridge and tunnel structures, signal and train control, and track-train interaction. The Railroad Systems Safety Program continues research in the development of safety performance standards, high-speed rail safety (equipment performance, track performance, train control, systems operations, test equipment), and environmental issues related to new high-speed ground transportation systems. The Research & Development Facilities and Equipment Program provides capital to support the Transportation Technology Center (TTC) at Pueblo, Colorado, as well as to acquire equipment used in other R&D activities.

Equipment, Operations and Hazardous Materials Research

- Conduct research on structural crashworthiness and interior safety of inter-city and commuter rail equipment and freight and passenger locomotive through dynamic modeling, simulations, component testing, and full scale crash testing.

- Conduct research on rolling stock safety assurance and performance through projects that identify, analyze, demonstrate, and disseminate information about on-board and wayside systems for monitoring railroad equipment defects by monitoring the condition of wheels, bearings, truck suspension system and brakes.

- Conduct human factors research to focus on identifying root causes for repetitive human errors and developing effective counter measures by targeting human factors in yards, terminals, and mainline train operation for freight, conventional passenger, and highly automated high-speed passenger operations.

- Conduct research in hazardous materials transportation safety, damage assessment and inspection, and tank car integrity through evaluation and models.

- Conduct research for both conventional and high-speed grade crossings through analyses of accident statistics and driver behavior, and through demonstrations and evaluations of new techniques and processes for improving crossings.

Track and Vehicle Track Interaction Program

- Conduct track and component research on automated track safety inspection technologies and technical support for regulatory actions and inspection strategies, through studies on failure mechanisms found in rails, bridges, and signal systems, and the deployment of existing technologies.

- Conduct research in track train interaction safety to reduce risk of derailments and other accidents and identify causes through tests, evaluations, and development of a computer simulation tool.

- Complete installation of the vehicle tracking systems at TTC with digital radio.

- Provide for grade crossing research, including ITS integration, through operational tests, reviews, demonstrations, and a feasibility study of a truck scanning system.

Railroad Systems Safety and Security Program

- Conduct research and evaluations to enhance high-speed equipment, to support rulemaking, to enhance high-speed rail safety, and to address noise impacts and electromagnetic field effects through dynamic modeling, simulations, and full-scale testing.

- Evaluate methods for developing performance-based regulations for applicability to FRA's safety regulatory process through an analysis of standards and regulations already established by similar government entities.

R&D Facilities and Equipment Program

- Conduct research and test activities at the TTC on high-speed test track, acquire a tamper/liner machine, and upgrade and maintain site facilities.

- Continue upgrades and component replacement of FRA's track research instrumentation platform to conduct investigations that support development of automated equipment for track inspection.

Next Generation High-Speed Rail

The funding for the four programs in the Next Generation High-Speed Rail Program allows technology enhancements to achieve cost-effective, reliable inter-city passenger rail service on corridors where rail travel times can be made competitive. The High-Speed Train Control Systems Program will continue to develop and demonstrate communications-based train control systems. The High Speed Non-Electric Locomotive program will continue to facilitate the development and deployment of domestically-produced high-speed, high- acceleration locomotives, which do not require electric power from wayside supplies via costly catenary systems. The Grade Crossing & Innovative Technologies Program will continue to demonstrate a comprehensive methodology by which states and their partners can address the implementation of high-speed rail service on existing infrastructure. The Track/Structure Technology Program will continue to seek out and demonstrate advanced, more economical track and structure technologies to resolve corridor capacity constraints and bottlenecks.

High-Speed Train Control Systems

- Continue development, installation, and safety validation of a flexible block high-speed train control system on the Chicago-St. Louis Corridor in a joint Federal, state, Amtrak, and railroad industry effort.

- Complete demonstration of the Incremental Train Control System on a segment of the Detroit-Chicago corridor in a joint Federal, state, and Amtrak effort.

High-Speed Non-Electric Locomotives

- Continue to support the rolling demonstration of a prototype lightweight, fossil-fueled, high-speed locomotive capable of 150-mph meeting all applicable FRA safety standards and to support the adaptation of a locomotive to demonstrate the flywheel energy storage system in a Federal and private effort.

- Begin mobile testing and demonstration on the hybrid flywheel-turbine Advanced Locomotive Propulsion system with academia and industry partner funding.

Grade Crossing & Innovative Technologies

- Continue to approach grade crossing safety by promoting a comprehensive approach to crossing hazards on a total corridor basis through a demonstration program that evaluates multiple solutions and the exploration of more opportunities for interlinking railroad signal systems, grade crossing protection, automatic train control systems, and highway applications.

- Continue to solicit a wide range of technology projects from the entire spectrum of American industry, academia, and individuals to facilitate the implementation of high-speed rail.

- Continue to support the Sealed Corridor Project being conducted by the North Carolina Department of Transportation.

Track/Structure Technology

- Continue to seek out and demonstrate advanced, more economical technologies to resolve corridor capacity constraints and bottlenecks through lower cost design and installation methods for high-speed switches and crossovers, improved methods for upgrading track structures, and more cost- effective methods of track construction.

Longer-term Outlook for FRA R&D

The changes that have occurred in the U.S. freight railroad industry in the past three years have been as dramatic as any that have taken place during the 175-year history of the industry. There are now only four major freight railroads, each representing about 20 percent of the industry's business. In addition, there are seven mid-sized railroads that serve regional markets, and a large and growing number of short-line railroads throughout the country that have emerged as the large railroads have sold off unprofitable branch lines to private operators with the ability to provide better service at lower cost.

These structural changes in the railroad industry have been occurring as the market for railroad freight transportation has continued to reach record levels. Profitability of the industry reached an all-time high in 1997, but has fallen off since as the major railroads have had difficulties in implementing mergers and acquisitions. As a result, the market capitalization of the major railroads has fallen significantly, seriously affecting their ability to raise capital for further improvements and to fund research and development programs.

The nature of freight railroad operations has also evolved. The freight railroad companies have responded to the growing demand for their services by running more, heavier, and faster trains. The railroad industry's share of the intercity freight market has grown from less than 38 percent in 1990 to more than 40 percent today. For the first time since World War II, some railroads face capacity constraints on certain lines. Trucking companies, long viewed as competitors of the railroads, are now among the railroads' largest customers, as they contract for the long-haul transport of containers and trailers.

Passenger operations have been evolving rapidly as well. Congestion on highways in and between major urban areas has also led to renewed interest in intercity and commuter rail passenger services. A number of states are planning high-speed passenger corridors on existing rail lines. The most rapidly growing segment of the railroad industry (and the transit industry) is the commuter rail market; the number of commuter trips has grown by 27 percent over the past decade. Finally, states are increasingly pursuing the use of new high-speed corridor services to reduce the pressures on highways and airports. The result is a greater commingling of freight and passenger trains on common tracks, which raises new safety concerns.

United States Coast Guard (USCG)

The Coast Guard is the primary Federal agency with maritime authority for the United States. It is a complex organization of people, ships, aircraft, boats and shore stations, the service responds to tasks in several mission and program areas. The multi-mission approach permits a relatively small organization to respond to public needs in a wide variety of maritime activities and to shift emphasis on short notice when the need arises. The Coast Guard's four main missions are Maritime Law Enforcement, Maritime Safety, Marine Environmental Protection and National Security.

The USCG conducts most of the research and development on waterborne transportation safety in the Department, and plays a leading role in research and development that addresses other aspects of waterborne transportation, such as mobility and environmental impact.

Coast Guard research is focused on technologies, materials and human factors research directly related to improvement of mission performance. The USCG is partnering with the Navy, DOC, and other DOT modes to design, develop and test a standard fuel cell propulsion system for marine and other heavy-duty vehicular applications.

Current R&D Profile and Funding Levels

USCG conducts most of the research and development on waterborne transportation safety in the Department, and plays a leading role in research and development that addresses other aspects of waterborne transportation, such as mobility and environmental impact. About $22.5 million in total R&D is planned for FY 2001 (see Table C-7).

Waterways Safety Management and Aids to Navigation

This program has the objectives of developing decision tools for safe and effective waterway management, promoting use of electronic navigation tools, and developing collision warning systems for recreational boaters.

Table C-7. Comparative Summary of USCG R,D,T&E Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
R&D	17,969	$19,890	$22,206
Facilities	$260	$303	$314
Total	$18,229	$20,193	$22,520

Comprehensive Law Enforcement

This program seeks to develop more effective sensors for law enforcement applications, including sensors for non-invasively detecting concealed contraband and hidden compartments aboard vessels.

Marine Safety Research

The goals of this program are to make our waterways safer through R&D such as: use of risk management principles to enhance marine safety, performing research on human factors to prevent marine incidents as well as to improve Coast Guard search and rescue operations, and developing national standard protocols for distress signals.

Marine Environmental Protection

This program has the aim of reducing the impact of maritime transportation on the environment through researching better methods of mitigating spills of pollutants, and improving USCG spill response capabilities through development of automated decision tools.

Improved Search and Rescue Capability

This program has the goals of improving USCG search and rescue capabilities through R&D activities. These R&D activities have included developing computerized decision-making tools to assist search planners in the optimal allocation of search resources.

Technology Investment

This program is very wide in its scope: it encompasses diverse R&D activities which enhance the technical capabilities of USCG and incorporate advanced technologies into USCG operations. These R&D projects include reducing communication costs through combining satellite and high frequency systems, and increasing use of satellite communication technology.

Longer-term Outlook for Coast Guard R&D

According to the USCG *Research and Technology Plan*, the Coast Guard will address the following R&D program areas.

Waterways Safety Management and Aids to Navigation

Planned work under this program includes working with the maritime industry to develop international standards for maritime navigation and communication systems and equipment, and evaluating these systems.

Comprehensive Law Enforcement

Future work under this program area includes working with other defense and law enforcement agencies to test and evaluate the effectiveness of acoustic systems for detecting and tracking suspect vessels.

Marine Safety Research

This program will continue its human factors R&D, and also work towards developing risk-based decision making and resource allocation tools for regulation as well as operational missions.

Marine Environmental Protection

Some areas for future work under this program include developing technologies and procedures for controlling aquatic nuisance species on waterways, and implementing procedures for in-situ burning of oil spills.

Improved Search and Rescue Capability

This program has the following future goals: improving USCG search and rescue capabilities through R&D activities such as developing models of the interaction of wind, currents, and other environmental factors with survivor location; and developing detection equipment for locating survivors more effectively.

Technology Investment

Some future work under the Technology Investment area are: development of a marine fuel cell for USCG vessels, and upgrading USCG databases, models, and custom software.

Federal Transit Administration (FTA)

The FTA mission is to ensure personal mobility and America's economic and community vitality by supporting high quality public transportation through leadership, technical assistance and financial resources. To carry forward this mission, FTA has charted a vision of leading America with high-quality public transportation that ensures mobility and livable communities.

FTA research aims at stimulating application of technological innovation in transit system operations, including programs such as development and testing of hybrid-electric

buses and fuel cell and battery-powered propulsion systems. The FTA takes a leadership role in coordinating transit research and technology activities for public transit agencies and the private sector, promoting global competitiveness, international information exchange, and mainstreaming innovation.

Current R&D Profile and Funding Levels

FTA performs most of the departmental R&D on mass transit vehicles, infrastructure, and operations. The FY 2001 budget request for R&D is around $60 million (see Table C-8). Transit is modally eclectic in nature, with a great degree of variation between sub-modes in their vehicular and operational characteristics. There is also sharing of infrastructure with other modes (such as sharing of highways between the highway mode and transit buses or of waterways between the maritime mode and transit ferries). Many transit R&D areas thus cut across modes in their applicability.

Table C-8. Comparative Summary of FTA R&T Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
R&D	$16,685	$17,107	$14,214
Technology Investment	41.550	43,218	46,230
Total	58,235	60,325	60,444

There are four distinct types of R&D programs under FTA.

FTA-Funded Programs with a Defined Set of Technical and Operational Objectives on a National Scale

Safety and Security

This has as the goals of improving transit safety and security through diverse projects. These include developing grade crossings for improved compliance (a clear cross-cut with the rail mode), improving the detection and prevention of drug and alcohol use by transit operators, studying operator fatigue, and researching the structural and fire safety of transit vehicle materials.

Fleet Operations

R&D enhances the operational efficiency of transit fleet operations through integration of advanced technologies such as Intelligent Transportation Systems (ITS) concepts into fleet dispatching, control and management. The Bus Rapid Transit (BRT) demonstration program is moving forward. The BRT will focus on technical assistance, and workshops on such topical issues as ITS applications, vehicles and vehicle procurement, traffic engineering and infrastructure, land use and development and innovative financing. More emphasis and resources will be placed on data collection and evaluation of actual operating projects during FY 2001 and FY 2002. Technology transfer and professional development are planned for later years.

Specialized Customer Services

Seeks to improve transit access for elderly persons, low income persons, and persons with disabilities. The challenge is to develop operationally feasible flexible route and flexible schedule transit systems for serving small, often geographically dispersed populations, through design of software and information systems and vehicle location systems for demand-responsive transit, and real-time information systems for customers.

International Mass Transportation

This research is an internationally focused program, with significant technology transfer activities. It monitors advances in transit technologies and operating concepts internationally and disseminates the information to U.S. transit equipment manufacturers and transit agencies.

Equipment and Infrastructure

R&D develops advanced technologies for vehicles (such as fuel cells and battery storage systems), and for infrastructure and control systems (such as Positive train Control (PTC) systems).

Programs Providing Support to all FTA R&D

Research and Technology Program Support

This consists of basic support activity for all FTA R&D programs, including report writing, web page creation, production of a Transit Research and Technology Journal, organizing transit research and technology conferences and workshops for researchers to exchange information, and other means of communicating R&D results and sharing knowledge and expertise.

Performance and Review/Evaluation

A key component of all R&D, and all programs in general, is performance measurement, i.e., the evaluation of the success of the program by comparing its output to desired outcome goals based on established benchmarks. The purpose of the Performance and Review/Evaluation program is to collect and analyze transit system financial, operational, and performance data through the National Transit Database to provide the informational basis for such an evaluation of the U.S. transit system, and to develop Geographic Information System (GIS) based tools for performance evaluation.

Human Resources

A successful R&D program needs effective human resource management, including staffing of programs with appropriately skilled and experienced personnel, and training of personnel to enable them to acquire these skills. This is the R&D role of the FTA Human Resources program.

Programs that are Local in Scope

Metropolitan/Rural Policy Development

Conducts research into social and economic issues which impact local and national transit policy, including: the demographic and economic bases of demand for transit to improve determination of infrastructure and service needs; quantification of the benefits of transit; and, the relationship of transit and land use.

Planning and Project Development

Assists state and local transit planners in their planning process for creation and expansion of transit infrastructure and services. Activities include research on job access planning, performance of environmental and social impact studies, and financial planning.

Rural Transportation Assistance Program (RTAP)

Provides technical assistance to transit agencies operating in low-density suburban and rural areas, which often have limited staff and resources. Areas of technical assistance include innovative applications of ITS for rural transit.

Sponsored R&D Programs

Transit Cooperative Research Program (TCRP)

A cooperative research program under the management of FTA, the National Academy of Sciences (NAS) acting through the Transportation Research Board (TRB), and the American Public Transit Association (APTA) acting through the Transit Development Corporation (TDC). FTA funds the TCRP, TRB provides program management, and APTA, as the trade association of transit agencies, provides the user perspective on transit R&D. Diverse R&D projects are funded through TCRP, including: development of standards and best practices in various areas such as Transit Capacity and Quality of Service Principles (TCQSP), and system and subsystem interfaces in electric rail transit vehicles; development of transit bus driver training simulators to enhance safety; and rail track research, a joint program with the Association of American Railroads (AAR) and its affiliated Transportation Technology Center (TTC).

University Transportation Research

Provides funding to universities selected as University Transportation Centers (UTCs) to perform cutting-edge R&D in the transit area; in addition to obtaining research results, the program has the benefit of training graduate students as the next generation of transit research professionals. The four universities designated as additional UTCs in FY 2001 are: Morgan State University, North Carolina State University, Northwestern University, and the University of Minnesota.

A training institute for advanced transit technology and operating practices, but aspects of its work are R&D-related. The NTI is FTA-funded, and affiliated with Rutgers University. The connection of the NTI with R&D stems primarily from the need to design and develop flexible training curricula which reflect the dynamic nature of transit technologies, including ITS and PTC.

Longer-term Outlook for FTA R&D

The Research and Technology program areas in the FTA *R&T Five-year Plan* are discussed in detail below. The five major program areas are:

Safety and Security

The four elements of the Safety and Security five-year plan are:

1) Railroad Safety. This in turn consists of the following sub-elements: a) Grade Crossing Safety: planned activities under this heading include development of technologies for providing a constant warning time to motorists and pedestrians at electrified rail transit grade crossings; development of traffic signal for rail transit grade crossings; and, development of train-activated power swing gates at grade crossings. b) Train Control Centers Safety: planned activities for this sub-element consist of research on human and technological factors influencing signal control failure leading to incidents. Major human factors issues are fatigue, distraction, and training. c) Rail Vehicle Materials Safety: in response to NTSB recommendations, FTA plans to conduct R&D on fire-resistant materials for train interiors.

2) Information Systems Security. Planned R&D activities under this program include enhancing the security of electronic fare payment systems to prevent abuse, and protecting transit communication systems from electronic attack.

3) Crime Prevention and Anti-Terrorism. This activity consists of the following sub-elements: a) Development of an Advanced Multisensor System Incorporating Full Data Fusion: this entails development of an interlinked system of Urban Chemical Release Detector (UCRD) instruments which are effective at detection of actual releases but minimize false alarms. They are also planned to be modular in their design to enable inclusion of other detector types such as meteorological, fire, smoke, and biological agent detectors. b) Development and Validation of the Subway Environmental Simulation Chemical and Biological (SESCB) Model: a numerical model will be developed and validated, for both detection and dispersion prediction, and post-incident automated consequence assessment and crisis management. c) Incorporation of Environmental Sensors to Improve Performance of Multisensor System and Model: incorporation of sensors to measure temperature, relative humidity, and wind speed and direction into the multisensor system will facilitate both the collection of data and the development of models for accounting for the influence of these external factors on the dispersion of released agents. d) Expansion of Background/Interferant Measurements: this entails

acquisition and analysis of background concentration data for agents, and incorporation of these background levels into detection algorithms, to prevent false alarms.
e) Security Survey and Public Perception Research: surveys will be conducted to assess the public perception of transit security and "no tolerance" policies, and the effects of these perceptions on ridership.

4) Bus Vehicle Safety. This planned research project is linked to the Intelligent Vehicle Initiative (IVI). It includes R&D on collision warning and avoidance systems for buses, and the integration of improved understanding of human factors into these systems.

Equipment and Infrastructure

The five elements of planned Equipment and Infrastructure R&D are:

1) Bus Equipment. This consists of the following sub-elements: a) Advanced Technology Buses: this includes R&D on structural performance of small buses to improve their longevity, and R&D on lightweight, high-strength, low cost materials for bus construction. b) Hybrid Electric and Electric Vehicle Technology: this entails R&D on the propulsion system, drivetrain, battery storage system, and charging infrastructure for hybrid electric and electric buses. c) Bus Testing: this includes development of testing procedures for the safety testing of buses.

2) Rail Equipment and Systems. This consists of the following sub-elements: a) Communication-Based Train Control Systems: this project seeks to develop Positive Train Control (PTC) systems for rail transit applications. b) Lightweight Rail Transit Vehicles: this project envisions the development of rail transit vehicles using advanced lightweight, high-strength, low cost materials which reduce vehicle weight (and consequently save energy and make higher speeds possible) without compromising structural integrity and safety. c) Specialty Guideway Technologies: these technologies include modification of magnetic levitation (MAGLEV) technologies for transit applications.

3) Civil Infrastructure. This element consists of R&D on improved infrastructure design and construction technologies, as well as improved project management techniques for construction projects.

4) Advanced Simulation. This element consists of development of better computer-aided design codes, testing codes which simulate realistic operating conditions, and training codes which simulate realistic operating environments.

5) Innovative Financing. This element consists of research on effective innovative financing methods.

Fleet Operations

This planned R&D area consists of the following four elements:

1) Transit Capacity and Quality of Service. This element entails development and documentation of a standard set of definitions, principles, and practices concerned with transit capacity and service quality.

2) Transit Intelligent Transportation Systems. This element consists of integrating Intelligent Transportation Systems (ITS) technologies and concepts into transit system operations to enhance mobility and efficiency.

3) Bus Rapid Transit Systems. Drawing upon a prototype system already in operation in Curitiba, Brazil, FTA plans to develop technologies and operating procedures for more efficient bus transit, incorporating features such as electronic fare collection, adaptive signal timing, and exclusive right-of-way.

4) Mixed Rail Corridor Operations. This project is intended to take advantage of existing freight railroad infrastructure for operating commuter rail service, thus maximizing use of infrastructure and avoiding costly right-of-way acquisition and construction. Such mixed use of track, however, poses considerable challenges to the signal and control systems, since freight and commuter rail traffic have very different operational characteristics.

Specialized Customer Services

This research area consists of developing the required technologies and operating procedures to provide transit access to populations which have been historically hard to serve: low income people, especially welfare recipients, trying to reverse-commute from their homes in the city to jobs in suburban areas not served by transit; people with disabilities; elderly people; and, travelers in low density suburban areas in which traditional fixed-route, fixed-schedule transit service is not feasible. Required innovations range from technology for information interfaces accessible to vision or hearing impaired persons, to operating procedures, communication technologies, and vehicle location technologies to use in conjunction with flexible route and schedule demand-responsive transit systems.

Policy and Planning

This is an area of quantitative social science and policy research. Major proposed projects include advances in travel demand modeling, land use modeling, transportation environmental impact modeling, Geographic Information System (GIS) development, and so on. Products include the Transit Economic Requirements Model (TERM) and the Transit Performance Monitoring System (TPMS). It requires cooperative R&D with such diverse agencies as FHWA, the Department of Energy (DOE), the Census Bureau, and the Environmental Protection Agency (EPA).

Professional Capacity Building

This program has the goal of building the required future base of professional capacity for transit research and technology, and enhancing the quality of professional expertise in transit R&D. It consists of four elements:

Attracting a Quality Workforce.

Through participation in the Garrett A. Morgan Technology and Transportation Futures program, FTA plans to promote an interest in transit at the high school level. Through participation in the University Transportation Centers (UTC) program, FTA plans to assist in the formation of advanced technical skills by students who do opt for transit as a career.

Training a Quality Workforce.

By working cooperatively with the National Transit Institute (NTI), FTA aims to provide continuous training to transit professionals to enable them to function with a high degree of competence in an environment of rapidly changing technology and operating procedures.

Retaining a Quality Workforce.

FTA plans to do research on effective human resource management methods that enhance employee satisfaction and help to retain the best, most skilled workers.

Technology Sharing

To promote the use of its research results, FTA plans to share technology and expertise with transit agencies, and with small businesses through the Small Business Innovation Research (SBIR) program.

Research and Special Programs Administration (RSPA)

Mission

The RSPA is the Department's research, safety and transportation systems administration, responsible for addressing transmodal issues relative to the safe, effective and efficient transportation of people and goods throughout the world. In contrast to the other DOT operating administrations that focus on specific sectors of the US transportation system, RSPA's mission concentrates on the system as a whole. Its mission is to make America's transportation systems more integrated, effective and secure by conducting and fostering cross-cutting research and special programs to enhance the quality of life, safety, the environment and the economic well-being of all Americans. The objectives of RSPA are: to protect the Nation from the risks inherent in the transportation of hazardous materials by all modes, including pipelines; to provide expertise in transportation and logistics research, analysis, strategic planning, systems engineering, and training; to serve as the principal advisor to the Secretary with respect to transmodal scientific and technical matters; to serve as the principal advisor to the Secretary in planning and implementing the civil sector response to emergencies impacting the Nation's transportation systems ; and to support the Secretary in promoting utilization of new approaches and technologies with intermodal or transmodal impacts.

The RSPA agenda emphasizes transportation strategic planning and system assessment in support of DOT and NSTC. In addition, RSPA conducts continuing R&D in support of its responsibilities in pipeline safety and transport of hazardous materials. RSPA conducts all of the research and development on pipelines in the Department, and plays a leading role in research and development that addresses all modes.

Current R&D Profile and Funding Levels

RSPA conducts R&D in several program areas. These include hazardous materials transportation, emergency transportation, research and technology, and pipeline safety. RSPA is unique for the extent of R&D initiatives that cut across modes. These comprise R&D planning and management, human factors research programs, advanced vehicle technologies, and transportation infrastructure assurance.

For FY 2001, RSPA is also requesting an increase of $13.4 million in Research and Technology (see Table C-9). The RSPA Office of Pipeline Safety (OPS) is the lead agency within the Department for pipeline regulation and research. The pipeline safety R&D program enhances the safety and reduces the potential environmental impacts of transporting hazardous materials by pipeline, through such R&D activities as developing a GIS-based national mapping system for pipelines, and developing internal inspection ("smart pig") technologies for early, non-intrusive detection of corrosion and failure of pipelines.

Table C-9. Comparative Summary of RSPA R&D Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
R&D	$6,991	$7,075	$13,397

RSPA Multimodal Research and Development

In addition, RSPA conducts R&D on various other areas which cut across modes. The multimodal R&D programs and projects of RSPA are:

Human Factors Research Program.

This program studies the interaction of humans with technology in challenging scenarios, as operators, traffic controllers, and emergency responders. It studies such issues as fatigue and distraction, with the aim of developing systems for monitoring human performance real-time as well as systems for training people through simulation of real-life conditions from a transportation environment.

Advanced Vehicle Technologies

The goals of the Advanced Vehicle Technologies Program are to develop advanced trucks, buses, locomotives, and ships which: have lower emissions than the 2004 standards; have 50 percent better fuel efficiency as compared to today; enhance global competitiveness of U.S. industry; have greater public acceptance.

Transportation Infrastructure Assurance R&D

This is an inter-agency R&D program with RSPA and the Office of Intelligence and Security in the Office of the Secretary (OST S-60) as the lead agencies. In addition, FAA, FTA, and other modes are involved. The three major objectives of this program are: to improve the physical security of transportation terminals, such as airports and subway stations; to improve the security of communication, navigation, and information systems on which the transportation system is increasingly reliant; to improve dissemination of warnings about threats to security.

Research and Technology

This program involves strategic planning, coordination, and definition of goals for Department-wide R&D.

Hazardous Materials programs

The hazardous materials R&D programs of RSPA address issues in a number of modes, since hazardous materials are transported by truck, rail, waterways, and pipeline. The two R&D programs in the area of hazardous materials are the Research and Analysis program which provides analytical support to the regulatory and standard-setting functions of the RSPA office of Hazardous Materials, and the Research and Development program which advances technical knowledge to assist response to hazardous materials emergencies, and to assist enforcement of regulations.

Longer-term Outlook for RSPA R&D

RSPA Pipeline Research and Development

An example of the kinds of activities planned under this program is the development of technologies, databases, models, and procedures for incorporation of risk-based approaches in regulation and enforcement of pipeline safety.

RSPA Multimodal Research and Development

In addition, RSPA conducts R&D on various other areas that cut across modes. The multimodal R&D programs and projects of RSPA are:

Human Factors Research Program

This is a relatively new program, with no concrete results having emerged yet. The plans are identical with the ongoing work identified in the previous section on current activity.

Advanced Vehicle Technologies

Specific areas for future R&D include the development of: a) hybrid electric transmissions; b) auxiliary power units and motors; c) advanced batteries and charge control systems; d) flywheels; e) advanced lightweight materials.

Transportation Infrastructure Assurance R&D

Future work includes: R&D on security of DOT computer systems, such as developing tools for real-time detection of intrusion by hackers; and developing technologies for detection of chemical and biological agents.

Research and Technology

Selected areas for future activity include assessment of international transportation R&D, performing independent assessments of transportation science and technology programs, and implementation of a University Research and Education Plan.

Hazardous Materials programs

Planned work under the Hazardous Materials Research and Analysis program includes performing cost-benefit analyses and regulatory impact analyses as required.

Office of the Secretary of Transportation (OST)

Mission

The Office of the Secretary (OST) oversees the formulation of national transportation policy and promotes intermodal transportation. Other responsibilities range from negotiation and implementation of international transportation agreements, assuring the fitness of US airlines, enforcing airline consumer protection regulations, issuance of regulations to prevent alcohol and illegal drug misuse in transportation systems and preparing transportation legislation

Current R&D Profile and Funding Levels

The Office of the Secretary of Transportation has traditionally conducted research that focuses on policy and planning issues involving economics, aviation, the environment (including climate change), radionavigation, and intermodalism. These projects are often high-visibility but comparatively low in funding. The total FY 2001 request is about $4.7 million (see Table C-10).

Table C-10. Comparative Summary of OST R&D Activity ($ 000)

Item	FY 1999 Actual	FY 2000 Enacted	FY 2001 Request
Total R&D Funding	$8,559	$3,142	$4,658

In the program area of transportation policy and planning, the office plans three studies in FY 2001. The first involves services to persons with disabilities. Research and data collection aim to support rulemaking activities to fulfill the Department's rulemaking obligation to improve access to various modes of travel by persons with disabilities under various statutes, primarily the Air Carrier Access Act (ACAA) and the Americans With Disabilities Act (ADA). A second study will look at the possible interrelationships among freight flow patterns, motor carrier demographics, and accident patterns. A series

of crosscutting environmental projects are also proposed, the prospect being improved information on the relationship between land use and transportation.

A second program area will sponsor research efforts in transportation economic policy. Included in this group are 1) economic and international trade trends and their implications for freight transportation, 2) improving ground access to transportation, and 3) the DOT transportation Livability Initiative. The last project seeks to improve the Department's ability to provide better customer service to cities, counties, and regions grappling with the need to ease traffic congestion, reduce air pollution, and use transportation more effectively in serving economic growth. DOT headquarters and field staff from all modes will be collaborating to ensure the success of this effort.

The OST also conducts R&D in radionavigation and positioning. In FY 2001, proposed studies include the preparation of the Federal Radionavigation Plan (FRP). The FRP is the official U.S. policy and planning document on Federally-provided radionaviagation systems such as the Global Positioning System (GPS) that is updated and published every two years. A number of other GPS-related studies are planned dealing with issues of modernization, vulnerability assessments, and spectrum coordination.

Maritime Administration (MARAD)

The overall mission of MARAD is to promote the development and maintenance of an adequate, well-balanced, United States merchant marine, sufficient to carry the Nation's domestic waterborne commerce and a substantial portion of its waterborne foreign commerce, and capable of serving as a naval and military auxiliary in time of war or national emergency.

MARAD also seeks to ensure that the United States enjoys adequate shipbuilding and repair service, efficient ports, effective intermodal water and land transportation systems, and reserve shipping capacity in time of national emergency

MARAD does not currently have an explicit research budget, but it does participate actively in several important cooperative programs to advance innovation in shipbuilding and marine operations.

Bureau of Transportation Statistics (BTS)

Mission

BTS started operations in December 1992. Its mission is to lead in developing transportation data and information of high quality, and to advance their use in public and private transportation decision making. BTS compiles, analyzes, and makes accessible information on the Nation's transportation systems; collects information on intermodal transportation and other areas as needed; and works to enhance the quality and effectiveness of government statistics.

Current R&D Profile and Funding Levels

The BTS is not formally included within the DOT Research and Technology Budget Submission. However, its funding is authorized in the Research section of the Transportation Equity Act for the 21st Century. BTS provides the critical knowledge and understanding of our transportation system that is needed in the assessment of research needs and opportunities, as well as in formulation of policy. Under TEA-21, the BTS has an annual authorized budget of $31 million, much of which goes to support two large surveys – the Commodity Flow Survey (CFS) and the American Travel Survey (ATS). The agency does not currently have specific R&D programs, but many of its projects do have R&D components or support R&D. Due the breadth of its programs, activities in BTS support all five of the DOT strategic goals.

Longer-term Outlook for BTS R&D

Although the BTS programs are not currently classified as R&D, the agency expects to begin engaging in R&D once it implements its TEA-21 authority to award grants to universities, state DOTs, metropolitan planning organizations (MPOs) and other entities.

One of BTS' goals is to create an information infrastructure, and tools to use that information, in order to ensure that the U.S. transportation system is safe and efficient. It seeks to sponsor R&D that increases its ability to assess the transportation system and thus achieve those goals. Major R&D objectives over the next five years include: information technology (IT) for better data collection; improved data quality; and using IT for better data analysis and dissemination.

Appendix D
AASHTO Research Advisory Committee 1999 Questionnaire

Organization

Name of Person Completing this Questionnaire			
Title			
Member Department			
Name of Office Responsible for Managing RD&T			
Address			
City, State		**Zip Code**	
Phone	( )	**Fax**	( )
Email			

How long have you been in your current position? _____ years

How long have you been performing in some research, development, or technology capacity? _____ years

Including yourself, what is the size of your research staff (numbers)? _____ technical _____ administrative

Please return the completed questionnaire and materials by October 22, 1999

Acronyms Used in this Questionnaire

AASHTO -- American Association of State Highway and Transportation Officials
FHWA – Federal Highway Administration
ITS -- Intelligent Transportation Systems
LTAP – Local Technical Assistance Program
NCHRP – National Cooperative Highway Research Program
NHTSA – National Highway Traffic Safety Administration
RD&T – Research, Development and Technology
TEA-21 – Transportation Equity Act for the 21st Century
SP&R – State Planning and Research
USDOT – United States Department of Transportation
UTC – University Transportation Centers

Research, Development and Technology (RD&T) Priorities

- What current importance do the following **RD&T programs** have in your state? (Please rate 3-high importance; 2-medium importance; 1-low importance; 0-no interest.)
- Future importance -- do you expect them to have more, less, or the same importance 3 to 5 years from now? (Please circle one.)

RD&T Program		Current Importance (3-0)	Future Importance, Circle one
RD&T Performed by Your State	SP&R		More Less Same
	State-Funded RD&T		More Less Same
	Other (please specify):		More Less Same
Cooperative Research Activities	National Cooperative Highway Research Program		More Less Same
	Transit Cooperative Highway Research Program		More Less Same
	National Pooled Fund Studies		More Less Same
	Regional Pooled Fund Studies		More Less Same
	Other (please specify):		More Less Same
Federal RD&T Activities	FHWA Contract Research		More Less Same
	FHWA Staff Research		More Less Same
	FHWA Demonstration Projects		More Less Same
	FHWA Experimental Projects		More Less Same
	Long Term Pavement Performance		More Less Same
	NHTSA Research		More Less Same
	Local Technical Assistance Program (LTAP)		More Less Same
	National Highway Institute Training		More Less Same
	Other (please specify):		More Less Same
Other RD&T Activities	Superpave® Implementation		More Less Same
	Other SHRP Implementation		More Less Same
	University Transportation Centers (UTC)		More Less Same
	Intelligent Transportation Systems (ITS)		More Less Same
	Aviation Research		More Less Same
	Transit Research		More Less Same
	Rail Research		More Less Same
	Marine Research		More Less Same
	Intermodal Research		More Less Same
	Other (please specify):		More Less Same

- What current importance do the following **RD&T activities** have in your state? (Please rate 3-high importance; 2-medium importance; 1-low importance; 0-no interest.)
- Future importance -- do you expect them to have more, less, or the same importance 3 to 5 years from now? (Please circle one.)

RD&T Activity	Current Importance (3-0)	Future Importance Circle One
Fundamental research		More Less Same
Applied research on state or regional problems		More Less Same
Applied research on national problems related to state mission		More Less Same
Applied research on national problems related to federal mission		More Less Same
Long range, large scale strategic research		More Less Same
Research for setting standards, specifications, or design guides		More Less Same
Development of equipment, materials, or methods		More Less Same
Development, distribution, and maintenance of software		More Less Same
Research to develop policy		More Less Same
Synthesis of current practice and research results		More Less Same
Transfer of technology from researcher to user		More Less Same
Implementation of research results through pilot tests or field demonstration		More Less Same
Training in use of new methods, processes, or technology		More Less Same
Coordination of research programs		More Less Same
Testing and evaluation of new products and materials		More Less Same
Breakthrough research		More Less Same
Research on regulatory compliance issues		More Less Same
Research on transportation as a system		More Less Same
General (not project-specific) support for university of research facilities, faculties, and graduate students		More Less Same
Other (please specify):		More Less Same

- What current importance do the following **RD&T activities** have in your state? (Please rate 3-high importance; 2-medium importance; 1-low importance; 0-no interest.)
- Future importance -- do you expect them to have more, less, or the same importance 3 to 5 years from now? (Please circle one.)

RD&T Area (all transportation modes)		Current Importance (3-0)	Future Importance Circle one
Infrastructure Renewal	Pavements		More Less Same
	Structures		More Less Same
	Other Transportation Facilities		More Less Same
	Asset Management		More Less Same
Safety			More Less Same
Operations & Mobility	Transportation Operations & Management		More Less Same
	Freight Operations & Management		More Less Same
Planning & Environment	Planning		More Less Same
	Environment/Real Estate		More Less Same
Policy Analysis & System Monitoring	Policy Analysis		More Less Same
	System Monitoring		More Less Same

- What current importance do the following **RD&T activities** have in your state? (Please rate 3-high importance; 2-medium importance; 1-low importance; 0-no interest.)
- Future importance -- do you expect them to have more, less, or the same importance 3 to 5 years from now? (Please circle one.)

Mode	Current Importance (3-0)	Future Importance Circle One
Highways		More Less Same
Motor Carrier		More Less Same
Aviation		More Less Same
Transit		More Less Same
Rail		More Less Same
Marine		More Less Same
Intermodal		More Less Same

- Here is a more detailed list of **RD&T areas**. Please estimate based on the funds invested for each of the areas, what percentage they comprise of your current year's RD&T activities. Please do not double count projects. The total of the list should be 100 percent.

- For all RD&T areas listed: Tell us what importance they have in your state? (Please rate 3-high importance; 2-medium importance; 1-low importance; 0-no interest.) Future importance -- do you expect them to have more, less, or the same importance 3 to 5 years from now? (Please circle one.) Even if you do not now invest funds in an area, please indicate the current and future importance.

RD&T Area (all transportation modes)	Percentage of Current Activities Based on $	Current Importance (3-0)	Future Importance Circle One
Congestion Mitigation	%		More Less Same
Highway Safety	%		More Less Same
Highway Infrastructure Repair, Restoration, & Expansion	%		More Less Same
Intelligent Transportation Systems	%		More Less Same
Environmental Issues	%		More Less Same
Application of Emerging Technologies	%		More Less Same
Finance	%		More Less Same
Administration	%		More Less Same
Regulatory Issues	%		More Less Same
Human Resources	%		More Less Same
Computer Technology	%		More Less Same
New Materials	%		More Less Same
Information Technology	%		More Less Same
Economic Analysis	%		More Less Same
Intermodal Coordination	%		More Less Same
Goods Movement (domestic and international)	%		More Less Same
Mobility and Safety for Older Persons	%		More Less Same
Pedestrian and Bicycle Issues	%		More Less Same
Other (please specify):	%		More Less Same
Other (please specify):	%		More Less Same
Other (please specify):	%		More Less Same
Total	**100 %**		

RD&T Program Funding

- What is the total amount of funding your Department invested in RD&T activities in FY1999 or the most recent year for which you have a total? (Please specify year _____)

$_____ (all RD&T activities, including state match moneys, all modes – everything).

- What amounts of funding did your Department invest in the following **RD&T programs** in FY1999 (or the year specified in question 6 above)?

RD&T Programs		SP&R (Federal)	State Match to SP&R	Other Federal Funds	Other State Funds	Other Funds
State RD&T Projects	In-house staff	$	$	$	$	$
	University researchers	$	$	$	$	$
	Consultants	$	$	$	$	$
	Other	$	$	$	$	$
NCHRP Support		$	$	$	$	$
National Pooled Fund Studies		$	$	$	$	$
Regional Pooled Funds Studies		$	$	$	$	$
University Transportation Centers Support		$	$	$	$	$
LTAP Support		$	$	$	$	$
Other (please specify):		$	$	$	$	$
Other (please specify):		$	$	$	$	$
Other (please specify):		$	$	$	$	$
(Please Don't Double Count Items) Total		**$**	**$**	**$**	**$**	**$**

- What amounts of funding did your department invest in RD&T in each of the following transportation modes in FY1999 (or the year specified in question 6 above)?

Transportation Mode	SP&R (Federal)	State Match to SP&R	Other Federal Funds	Other State Funds	Other Funds
Highways	$	$	$	$	$
Motor Carrier	$	$	$	$	$
Transit	$	$	$	$	$
Rail	$	$	$	$	$
Aviation	$	$	$	$	$
Marine	$	$	$	$	$
Intermodal	$	$	$	$	$
Policy & Administration (non-modal)	$	$	$	$	$
Other (please specify):	$	$	$	$	$
(Please Don't Double Count Items) Total	**$**	**$**	**$**	**$**	**$**

- We know this question may ask about areas for which you have little prepared information, however it is important to get an **estimate** of future RD&T expenditures. Please provide your state's actual or estimated spending for transportation RD&T activities for the years listed below. The figures you provide will be used only for broad-based national estimates.

Fiscal Year	SP&R (Federal)	State Match to SP&R	Other Federal Funds	Other State Funds	Other Funds
FY1998 (actual)	$	$	$	$	$
FY1999 (actual)	$	$	$	$	$
FY2000 (planned)	$	$	$	$	$
FY2001 (estimated)	$	$	$	$	$
FY2002 (estimated)	$	$	$	$	$
FY2003 (estimated)	$	$	$	$	$
FY2004 (estimated)	$	$	$	$	$
FY2005 (estimated)	$	$	$	$	$

- For your DOT FY1999, what percentage of the federal-aid SP&R funds apportioned to your state went to RD&T and related activities? _____ % (e.g., 25% minimum mandated or some other percentage.)

- One consequence of TEA-21 is that the research portion of SP&R funds increased by some $45 million (55%) nationally between 1997 and 1999. Please indicate how this increase affected your state program of RD&T. Please check the one choice that most closely matches your program's response.

Please Check One	Effect of SP&R Increase
	All parts of our program increased approximately in proportion to the SP&R increase
	State funding for research was decreased, roughly canceling out _____ % (please fill in) of the SP&R increase
	The SP&R increase was used primarily to increase the following parts of our program. Please specify: _____ _____ _____
	Other, please explain: _____ _____ _____

- If federal-aid funds that are now specifically reserved for SP&R were no longer reserved for such purposes, but could be spent for other purposes instead, how would the overall RD&T program in your state be affected? In your estimation, what percentage change (+, - , or no change) would occur in your total RD&T budget? _____ %

- To ideally support a vigorous and effective RD&T program in your state, by what percentage would you change (+, -, or no change) your total current funding? _____ %

- In your ideal program, by what percentage would you change (+, -, or no change) the funding allocated to each of the following RD&T activities?

RD&T Activity	Percent Change	Research Activity	Percent Change
Perform staff research	%	Sponsor research cooperatively with other states	%
Perform contract research	%	Implementation of research results	%
Hire research staff	%	Implementation of SHRP results	%
Purchase computers, instrumentation, or equipment	%	Intelligent Transportation Systems activities	%
Provide training and technology transfer	%	Other (please specify):	%
Support university research	%	Other (please specify):	%

RD&T Program Trends

- Please indicate the approximate percentage of change (+, -, or no change) that has occurred in your Department's RD&T unit over the last three years, and the percentage of change (+, -, or no change) you expect to occur in the next three years. Use dollars invested as your basis for determining change.

Category		Change in Past Three Years	Anticipated Change in Next Three Years
Total RD&T budget		%	%
State RD&T funding		%	%
Department research staff size		%	%
Intelligent Transportation Systems activities		%	%
Testing and evaluation activities		%	%
University research activities		%	%
Contract research activities		%	%
Partnerships/alliances (cooperative research)		%	%
Modal areas	Highways	%	%
	Rail	%	%
	Motor Carrier	%	%
	Aviation	%	%
	Marine	%	%
	Intermodal	%	%
	Transit	%	%
Other (please specify):		%	%

What trends do you see developing within your state over the next three years? Circle one choice for each trend.

Trend	Change
Emphasis on research	More Less Same
Emphasis on technical assistance	More Less Same
Emphasis on technology transfer and implementation	More Less Same
Emphasis on experimental, demonstration or pilot projects	More Less Same
State research funding for modes other than highway	More Less Same
Federal-aid research for modes other than highway	More Less Same
Other (please specify):	More Less Same

Coordination of Transportation Research

How important is it to your state that AASHTO adopt a National Research Agenda, which would identify common research needs, priorities, and goals, and would list specific research projects that state, federal, academic, and industry groups could sponsor or perform to achieve the goals?

__ vitally important
__ important
__ desirable
__ doesn't matter
__ undesirable

How important is RAC's involvement in the development of a National Research Agenda?

__ vitally important
__ important
__ desirable
__ doesn't matter
__ undesirable

- If AASHTO were to adopt a National Research Agenda, to what extent would your state target its research activities to address nationally identified research needs? (Check the one that most describes your Department's response.)
  - ____ we would perform no research unless it was part of the National Research Agenda
  - ____ we would specifically dedicate part of our program to National Research Agenda items
  - ____ we would sponsor research on National Research Agenda items that align with our state's needs
  - ____ we would limit our involvement in the National Research Agenda to NCHRP and national and regional pooled fund studies
  - ____ other (please describe): _____

- If AASHTO were to adopt a National Research Agenda, are you aware of major gaps in transportation RD&T or significant duplication of effort that should be addressed? Please describe them:

Major Gaps:
Significant Duplication of Effort:

- The U.S. Department of Transportation has established five strategic goals. Please estimate the percentages of your state's transportation RD&T activities for FY1999 (or the most recent year for which you have a total) that address these USDOT goals (total does not have to be 100%):

USDOT Goal All Modes	**% of Your State's Program That Fits Goal (measured in terms of funding allocation)**
Safety	%
Mobility	%
Economic Growth & Trade	%
Human & Natural Environment	%
National Security	%

Evaluation & Peer Exchange

Is your state's transportation RD&T program tied to stated or published strategic goals or performance measures? _____
yes _____ no

If yes, please specify these goals or measures (attach extra sheets if necessary or include printed copy, e.g., brochure, if available):

. _____
. _____
. _____

How are the results your department's transportation RD&T activities evaluated? (check all that apply)

____ Peer exchange

____ Other (please specify) _____

____ In-house officials
___ User (customer) groups
____ No formal evaluation process

- Please rate how effectively your first research peer exchange accomplished the following: (3 - very well; 2 - adequately; 1 - to a limited extent; 0 - not at all)

Accomplishment	Rating (3-0)
Developed more or closer peer contacts	
Gained greater understanding of research program management concepts	
Discovered strategies to better manage my state's research program	
Provided opportunity to think strategically about my state's research program	
Created enhanced visibility for the research program with senior management	
Created enhanced visibility for the research program with middle managers and other technical and professional staff	
Fostered stronger relationships with external organizations	
Other (please specify):	

What date (month/year) did you conduct your state's first research peer exchange? ____/____

How many years will you allow between your first and second research peer exchange?____ years

RAC Web Site

What additional information would you like to see on the RAC Web Site?

. _____
. _____
. _____

- Please enclose a copy of your full FY1999 (or the most recent year for which you have material) RD&T program description. This may be your SP&R Work Plan and/or the documentation that you use to show what activities your unit will be doing during the fiscal year.

Checklist for response:

_ Completed questionnaire
_ Enclosed strategic goals or performance measures if not included on questionnaire – #22?
_ Enclosed a copy of your unit's program description from FY 1999 (or most recent year for which you have materials) -- #28?

Thank you for your answers to this questionnaire. Please return the completed questionnaire and materials by October 22 to:

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Cooperative Research Programs (Div.D)
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Washington, DC 20418
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