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I welcome the opportunity to testify on the Department's technology, research and education activities and its surface transportation research and development, in particular. Transportation is undergoing a technology revolution, and the Department has taken on the challenge of "riding" this technology wave. This is a key hearing for the Department in two ways.

First, it acknowledges the Department's important and growing role in Federal research and technology (R&T). The Department received approximately $930 million in fiscal year 1997 for all modes of transportation--highway, rail, transit, aviation, and maritime.

Second, it recognizes that both the President and Congress see transportation technology, research and education as important to the long-term economic, security, ecological and social well-being of the Nation. This has been reflected by an average increase of 31 percent over the last four years in funding for research and development (R&D) compared to the average of the previous four years. The bulk of this R&D increase was in the surface modes.

Opportunities in Surface Transportation Research and Development

The transportation enterprise faces an enormous challenge in meeting the Nation's mobility needs in a world characterized by financial constraints, growing demand, changing demographics, environmental concerns, and decentralization and devolution of transportation responsibilities. Transportation research and

education, and the innovation that they enable, will be a critical component in the national response to these challenges.

Secretary Slater recently noted, "we can look to information and communication technologies, intelligent transportation systems, and other new or improved technologies " to transform the safety, efficiency and environmental soundness of travel in the future. The stimulation and fostering of innovative transportation technologies will thus be central to meeting national needs in the next century.

Research and development enables and stimulates these needed innovations in three ways: accelerated introduction of existing technologies into transportation, development of new transportation technologies, and increased knowledge on which to base major decisions, investments and other actions.

The priorities we have in the technology area support the Secretary's three major priorities for the Department as a whole:

1. Safety

Secretary Slater has established safety as his number one priority for the Department. The physical presence and operation of our large and varied transportation system carries with it the potential for loss of life, property, and significant adverse societal impacts that pose a continuing challenge to the entire transportation community. The U.S. transportation system remains the safest in the world, and has shown steady improvement in this regard during the last several decades. Even with our efforts, transportation still accounts for almost half of all deaths in this country not resulting from homicide or natural causes--more than 43,000 last year, about 95 percent of which arise in motor vehicle crashes. The societal cost of motor vehicle deaths, injuries and property damage has been estimated at $150 billion per year. To be sure, we have made strides in this area. We still have an unacceptable number of fatalities and injuries. We will continue to back programs which have proven track records for improving safety, but advancements in research and technology (R&T) hold the key to dramatically reducing highway injuries and fatalities.

R&T is vital to understanding the factors contributing to such incidents, to reducing the number of incidents, and to decreasing the number of deaths and serious injuries resulting from incidents. DOT's R&T initiatives focus on a wide range of issues: vehicle design, crashworthiness, improved protective technologies such as air bags, controlled crashes of instrumented vehicles, biomechanics, and improved driver training. We have an extensive set of activities to gather and analyze data on situations causing motor vehicle deaths and injuries, and to indicate needed areas for research. The National Advanced Driver Simulator will contribute substantially to our understanding of driver behavior under extreme conditions, and help us evolve better strategies for crash avoidance and driver training. We have also worked through the National Science and Technology Council's Human-Centered Transportation Safety Team to apply knowledge about human behavior gained from the military and aerospace programs to transportation safety improvements. One area already highlighted is integration and streamlining of vehicle control panels. I have emphasized our R&T work with highway-oriented systems, but this philosophy holds true throughout our entire program.

2. A Transportation System for the 21st Century

Secretary Slater's second priority for the Department is to "ensure that America's transportation system meets the needs and desires of the American people in the 21st century." These needs and desires include unparalleled mobility, access, and security. Over the next several decades, a variety of stresses will be placed on our transportation systems, threatening to compromise mobility, security, and sustainability. R&T programs provide the key to dealing with these challenges.

Mobility - Two parallel demographic trends will complicate the process of ensuring mobility to every citizen. First, population worldwide is anticipated to grow from 5.5 billion people today to 8 billion over the next 25 years. Much of this growth will occur in major cities of the developing world, creating additional congestion and placing heavy strains on highway and transit infrastructures everywhere. Second, in the United States, this population growth trend is complicated by a substantial increase in the proportion of older Americans in the population as the "baby boom" matures. An estimated 65 million people will be over 65 in the U.S. by the year 2020. The Americans With Disabilities Act sets specific standards for levels of accessibility that must be met for this large

population group. Taken together, these two trends will necessitate new approaches to developing transportation services, infrastructure, and vehicles.

New information and related technologies now entering application provide this new approach. They are transforming transportation from a system that requires people to adapt to a system that adapts to people. For years we have had a vision of a user-friendly, reliable, easy to use system that brings mobility to all our citizens, and moves freight swiftly and reliably on a global basis. That vision comes closer to reality every day, and is nowhere more apparent than with Intelligent Transportation Systems (ITS). Because of their high potential, research on these systems now comprises about one-quarter of the DOT R&T budget request for FY-1998.

Without action, congestion will extract an increasing cost in delay, irritation, safety, energy use, and adverse environmental impacts. The days when we could respond by simply building more physical infrastructure are clearly gone. The spectrum of concepts included in ITS permit us to use the existing system more effectively, efficiently, and with greater seamlessness among the existing systems and organizations.

Security --Now and in the coming century, the public must have confidence in the security of the global transportation system. In the last few decades the threat of aircraft hijacking and deliberate sabotage has become real and highly visible worldwide. Similarly, attacks have been planned or actually made against rail, subway, bus, and highway targets, both domestically and internationally. As the transportation system becomes more integrated and dependent on information technologies for improved efficiency, it also becomes more susceptible to intentional or unintentional disruption.

Again, R&T will provide many of our future solutions to these problems. To better understand security problems, we are conducting assessments of the potential vulnerability of our transportation systems to attack or disruption. This work includes detailed analyses of previous incidents. We have become particularly sensitive in the last year to the potential impacts from introduction of spurious data into transportation management systems, or damage to the hardware or software of these systems.

To address security problems, we are working across all modes to develop security solutions. Improved metal and explosive detection systems will reduce the threat of harmful objects or materials being taken onto transportation vehicles. Our work on vehicle technologies, particularly in the aviation area, but ultimately applicable to all modes, will help minimize damage to vehicles when incidents do occur. And, our work on information technologies will help keep system electronics functioning even if extraneous data or commands are input to the system.

Sustainability - Transportation is responsible for about one-quarter of U.S. energy consumption today, including two-thirds of our petroleum use. It is the only sector in which petroleum consumption is increasing, due to a leveling off of fuel efficiency in most modes and steadily rising travel and goods shipment. Energy use is of particular relevance to surface transportation: 78 percent of total transportation energy is consumed by highway vehicles, with 62 percent associated with passenger cars and light trucks. Transportation is thus at the heart of national concerns over U.S. dependence on imported oil, and is especially vulnerable to any future price shocks or constraints on availability. Petroleum use is also closely related to release of greenhouse gases, with approximately 20 pounds of carbon dioxide produced for every gallon of fuel burned. Technology development can and should provide additional ways to address energy usage.

In the past, transportation, economic, energy and environmental issues were too often viewed separately. Today we understand that these issues are inextricably linked and need to be assessed together, if the Nation and the world are to have a transportation system that works effectively in the 21st century. We call the capability of the Nation to support a system, considering all its resource needs and impacts, its sustainability. Work goes on throughout DOT to assure the sustainability of future transportation systems, including factors influencing transportation demand and land use, the planning context in which decisions are made, and the potential contributions of various strategies to sustainability.

To assure needed options are available, DOT has sponsored or participated in work to develop or refine fuel efficient personal vehicles, electric and hybrid vehicles, and advanced transit buses. This includes work not only on the technology of the vehicles themselves, but also on assuring their safety over time. For example, through FTA, DOT has helped develop and deploy electric bus technology in a

number of cities. RSPA, in partnership with DOE, auto manufacturers, and electric utilities, has been working to educate cities on electric vehicle technologies.

To deal with the great changes occurring in all parts of transportation today, and assure development of a skilled workforce of transportation professionals in the future, the Department is emphasizing education and training program development. The University Transportation Centers Program, the Eisenhower Transportation Fellowship Program, the Aviation Education Program, and the National Highway, Transit and Maritime Institutes reflect the Department's historical commitment to this area. Future initiatives will build the capacity of industry and State/local government transportation staffs; improve the general public's understanding of transportation's benefits; ensure a globally-competitive workforce; and prepare the next generation of transportation professionals with a multi-disciplinary education.

3. Commonsense Government

Secretary Slater's third priority is to continue the progress already made in bringing common sense government to the Department: using technology to "work smarter;" forging better, more effective partnerships with the transportation community and other stakeholders; and bringing additional flexibility to the Department's programs. This issue is much broader than DOT programs themselves. Proposals for welfare reform, improved health care, job training and placement, rural development, and elder services all assume that there are adequate transportation alternatives to enable personal access to employment, education, health care, and other activity centers. Supporting such initiatives requires a vigorous program of public and private R&D activities to address needs and challenges emerging with them, and the necessary resources to exploit and deploy new technological and operational opportunities.

The increasing complexity and constraints under which we will operate over the next decades require that we in government work together and take a more sophisticated approach to doing business. In other words, we have to "work smarter." Technology is an essential tool in helping us achieve that goal. Advances in modeling, simulation, and related technologies, combined with a much broader availability of more and better data on transportation problems,

enable us to assess the nature of transportation problems facing us all. These same techniques can help us evaluate the relative benefits and impacts of potential solutions, and thereby support better, more informed decision-making at all levels. Once systems are operational, these same technologies can help us improve the effectiveness and efficiency of the deployed services.

If there is one theme for our activities in the R&T area to assure "commonsense government," it is that government works better if we build partnerships with other government agencies, the private sector, and academia, to stimulate innovation across the transportation enterprise. Development of advanced transportation technology and improved operations is largely the responsibility of the private sector, individual states, and local governments. Focused federal investment in research, development, test, evaluation, and technology dissemination can have great impact in the many areas in which those entities do not have sufficient economic incentive to invest due to market, institutional, technological, or other barriers. We have therefore adopted an increasingly strategic perspective within the Department as we have broadened and reinvigorated our R&T activities.

DOT Surface Transportation R&D Successes

Over the last four years, the Department has made major strides in bringing technological innovation to the transportation enterprise. The Department's funding for research and development and, in particular, for surface research and development, have increased considerably. This is due to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the President's commitment to transportation research and development, and his confidence in the Department's ability to manage the resources in an efficient and effective manner. DOT has taken a leadership role in identifying, promoting, sponsoring, and developing partnerships to perform research and development.

The Department has also played an expanded role in technology policy formulation at the highest levels within the Executive Branch. A key element in implementation of the President's Technology Policy was formation of the cabinet-level National Science and Technology Council (NSTC) under the White House Office of Science and Technology Policy. The NSTC Transportation R&D

Committee (TRDC), which I chair, includes NASA, EPA and the Departments of Defense, Commerce, and Energy, among others.

Over the last three years, the TRDC has been effective in shaping the direction of transportation research and development as well as forging partnerships among the Department, federal agencies, academia and private sector. At the present time, the TRDC is cooperatively finalizing the first comprehensive Transportation Science and Technology Strategy. We are proud of this evolving document, and we will forward it to you once it is published. One of the major partnership initiatives that the Strategy highlights is the recent joint FAA and NASA initiative on the next generation global air transportation system. Recently announced by the Vice President, this application of new information and communications technologies to over-ocean flight will revolutionize global air transportation.

DOT has also been a full partner in other high-technology multi-agency research and development programs, such as the Technology Reinvestment Project led by the Defense Advanced Research Projects Agency. This collaboration has proved highly productive for DOD and DOT, with approximately one-third of the winning TRP proposals in FY 1993 being transportation-related. The net result was an infusion of $400 million of public and private funding into dual-use transportation research, with the Department serving as project manager on nine of those initial TRP activities. Topics investigated included automatic train control systems, portable ship building robotics, and advanced composites for bridge infrastructure renewal.

Intelligent Transportation Systems (ITS)

ISTEA launched a program of ITS research, testing, and technology transfer aimed at solving congestion and safety problems, eliminating operating inefficiencies in transit and commercial vehicles, and reducing the environmental impact of growing travel demand. Since 1991, the accomplishments of the ITS Program have included a long-term basic research program, tests of numerous technology applications, definition of costs and benefits, development of a national architecture and initiation of an unprecedented standards development program. Today we are poised to begin deployment of a national intelligent transportation infrastructure, and the development of a fully integrated intelligent vehicle.

Last year Secretary Peña, accompanied by then-FHWA Administrator Slater and FTA Administrator Linton, established a national goal to deploy this intelligent transportation infrastructure across the United States within the decade. It is a challenging goal. We have already taken the first steps with model deployments of integrated travel management systems in four metropolitan areas, and commercial vehicle intelligent systems in 8 states. We have established a baseline of deployment to date and will report progress in reaching this goal on an annual basis. We believe ITS infrastructure will provide for our surface modes, in many respects, what air traffic control has provided for aviation -- an ability to manage operations -- for greater efficiency within the same infrastructure, less environmental impact, and greater predictability for the customer.

Highway Research

Given the predominance of highway transportation in the U.S., advancing the technologies that underlie the *safety*, operation, maintenance and construction of our road system is of great importance. The Federal Highway Administration has achieved considerable success in this area, often working in partnership with the states and relevant industries.

Safety initiatives are aimed at designing safe roads for all users while meeting the special needs of vulnerable users such as pedestrians, bicyclists, and the elderly. Computer-based tools are being developed to assist highway designers and planners assess the impacts of alternative highway designs. A recent application of one of these new technologies resulted in an interchange design that saved $14 million, while producing safety and traffic operations that are superior to the original design.

High performance concrete (HPC) technologies have the potential to produce significant savings in the initial construction and long-term maintenance of the nation's bridges. The first high performance concrete bridge--the Louetta Road Overpass--is currently under construction in the Houston, Texas area and serves as a showcase for the technology. Ten additional State DOT's are currently implementing use of HPC in bridge construction technology. Another innovation, high performance steel, offers improved corrosion resistance, easier repair, and

eliminates the need for repainting. Two State DOT's are in the process of implementing this new technology.

High-tech composite materials offer physical properties that may change the way bridges are built. Ongoing efforts to develop and put these composite materials into use offer great promise, and include carbon-fiber column wrappings used to strengthen existing bridges against earthquakes and composite fabrics used to repair damaged bridges. Seven deployment projects using composite materials were funded by the FHWA last year. Similarly, recent breakthroughs in the Department's "Superpave" asphalt materials research are expected to yield overlays and new pavements with significantly longer service lives. More than 90 percent of paved roads and streets in the United States have asphalt concrete surfaces, requiring the placement of approximately 500 million tons of asphalt concrete mixtures annually. Thus, the potential exists for hundreds of millions of dollars in cost savings annually by Federal, State and local governments.

Traffic Safety Research

The National Highway Traffic Safety Administration's (NHTSA) research and analysis programs provide the scientific basis for the agency's vehicular and behavioral programs, and contribute directly to the Department's goals of providing secure transportation and international leadership in motor vehicle safety. The reductions in deaths and injuries resulting from these programs contribute directly to improving public health and lowering health care costs.

NHTSA's research programs include data collection and crash investigations to ascertain the magnitude and the source of driver and motor vehicle-related problems; research in the biomechanics of injuries that helps provide an understanding of how injuries occur in crashes; research to identify hardware countermeasures having the potential to advance the crashworthiness of vehicles; and, behavioral research and investigations of new ITS technologies that have the potential to help operators avoid crashes.

Rail Research

The Department's rail research has focused on railroad safety and technology to advance high-speed rail. Human factors and track hazards account for a majority of railroad accidents and are a focus of the program to improve intercity and commuter passenger protection. To address these problems, the Federal Railroad Administration is using a modern locomotive simulator to gain a better understanding of the safety issues associated with locomotive operator stress and fatigue, and is pointing to effective mitigation methods to enhance safety of operations. They have instrumented an Amtrak test car with force-measuring sensors to provide critical data necessary to revise track safety standards for both conventional and high speed trains.

FRA is also testing the application of the Global Positioning System, digital data radios, and onboard supervisory computers to control train movements. This will enhance the safety of operations, and permit States and their partners to implement incremental high-speed passenger rail upgrades, as well as improve the efficiency and productivity of freight, intercity passenger, and commuter rail operations.

Transit Research

The Department's Advanced Public Transportation Systems program managed by the Federal Transit Administration is yielding greatly improved customer information, seamless multi-modal service and increased transit management within metropolitan areas. Using modern computers and communications technologies, the program is providing automatic vehicle location, on-board and wayside passenger information, electronic fare collection systems, traffic signal pre-emption for emergency services, and automated demand-response dispatch systems.

The Federal Transit Administration is also actively involved in developing and testing alternative fuel vehicle technologies, including electric-hybrid drive systems, advanced suspension components and advanced vehicle control networks for transit bus applications. These technologies offer ultra-low emissions along with improved vehicle handling and interfaces with intelligent transportation

systems. Many improvements, including aerospace construction, accessible design, and hybrid-electric propulsion, have been integrated in the prototype Advanced Technology Transit Bus (ATTB) which was rolled out in October 1996. The Department is also partnering with the Department of Energy and the Defense Advanced Research Projects Agency on highly efficient and environmentally acceptable fuel cell propulsion systems for transit buses.

Intermodal Terminals and Connections

The terminals that serve as the intermodal link between the oceangoing ships or air systems and the inland surface modes must operate with increased efficiency to handle the growing volumes of passengers and cargo in both our domestic and international trades. Advanced technology will play a significant role in improving the movement of people, resources and cargo through domestic and international gateways.

Highway and rail access to these airports and marine intermodal terminals is crucial to the performance of the freight transportation system of the Nation, particularly for the high-valued container movements which have become part of our just-in-time manufacturing and distribution networks. Improvements in both physical and information infrastructure are urgently needed in this regard. Improvements of the type developed for the surface modes, such as improved pavements and inspection machines, and applied at interfaces will contribute significantly to these improvements.

A variety of aviation and space research programs have strong relevance to surface transportation issues and innovation, such as work involving security, human factors, and non-destructive inspection of vehicle structures. For example, to handle the pavement thickness and durability requirements for the next generation of aircraft, which will weigh more than one million pounds, new pavement standards are needed. The Federal Aviation Administration and Boeing Company have combined resources to build a National Airport Pavement Test Facility that will provide the needed full-scale testing information and will help to validate new design technologies. The resulting design and criteria will have wide applicability to the surface transportation modes.

Future Directions

As noted earlier, the NSTC Transportation R&D Committee has just developed the first comprehensive Transportation Science and Technology Strategy. It will be a key guide to assist Congress, the White House, and Federal agency heads in establishing national transportation R&D priorities and coordinated research activities. The Strategy has four components: (1) strategic planning and assessment; (2) strategic partnership initiatives on topics offering particularly attractive opportunities; (3) enabling research in areas of long-term continuing importance to transportation; and (4) transportation education and training. These elements all include an emphasis on partnering in collaborative efforts with other Federal agencies, state and local governments, academia and industry. Another theme common to each is explicit attention to deployment--working to foster and facilitate the integration of promising concepts and prototypes into operating transportation systems.

We have been working each year to increase the degree to which a strategic perspective is incorporated in our research and technology planning. To that end, this year's edition of the Surface Transportation R&D Plan, now nearly complete, will draw substantially on the work of the NSTC Transportation Committee process and the Transportation Science and Technology Strategy that has resulted from it. We would welcome the opportunity to brief you on both the Strategy and the fourth edition of the Surface Transportation R&D Plan when they are completed.

We have some exciting times ahead as we continue to explore the possibilities resulting from tomorrow's surface transportation technologies. We look forward to working with you to shape and advance the performance of the Nation's transportation system through prudent government investments in technology, research and education. I would be pleased to answer any questions you may have.