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Research and Development
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ECONOMIC DEVELOPMENT THROUGH ADVANCING TRANSPORTATION TECHNOLOGY

Since the early years of our nation’s history, the link between transportation and economic development has been recognized. Secretary of the Treasury Albert Gallatin wrote in an 1807 report that, in effect, when transportation improvements were made, it provided added revenue to the nation. It also is fitting that we recognize that here in Lexington, Kentucky, we are on the site of the first federally aided road—the Zane Trace—approved by Congress in 1796 and extended initially from Wheeling to Maysville and on to Lexington. Its purpose was to increase the efficiency and reduce the cost of mail service. It also increased expansion of the settlement along the Ohio River Valley.

For the last 100 years, the Federal Highway Administration (and its predecessor agencies) has worked to bring highway technology and roads to the nation to advance the economy. As early as World War I, a major network of highways was planned to aid the nation in its economic growth and in its defense. Since 1956, the Interstate Highway System has served as the centerpiece of our national highway program. The nearly complete Interstate Highway System has had a tremendous economic effect on the nation.

After housing, transportation is the largest single household expenditure (18.9 percent in 1987). That’s higher than food (15 percent), clothing (5.9 percent), and health care (4.6 percent). Since the 1930s, growth in the GNP and vehicle-miles of travel have had very similar patterns, including the energy disruptions in the 1970s.
NATIONAL TRANSPORTATION POLICY

An investment in transportation is an investment in America's future. American’s spend nearly $800 billion for transportation products and services every year. --Secretary Samuel K. Skinner, National Transportation Policy.

The economy of the United States and its role internationally are key elements in the President’s National Transportation Policy. Over the last years of the 1980s, the transportation community has evaluated where it has been and where it is going. The Department of Transportation set about the task of establishing a national transportation policy to evaluate the status of the national transportation network and to develop a plan for meeting the transportation needs of the country. There is a clear consensus that the transportation network is critical to the economy of the country and our competitiveness abroad. While quantitative data linking the two has been obscured in the past, recent correlation work by such economists as Dr. David Aschauer has demonstrated a significant corollary.

The National Transportation Policy reflects the importance of transportation to the national goals and international competitiveness. It will help define the federal role in relation to state and local governments and to the private sector. And, it provides significant support for major legislative re-authorization proposals.

The National Transportation Policy includes the following six themes that encompass the full scope of the direction of the policy:

- Maintain and expand the nation's transportation system.
- Foster a sound financial base for transportation.
- Keep the transportation industry strong and competitive.
- Support public safety and national security.
- Protect the environment and the quality of life.
- Advance U.S. transportation technology and expertise.

SUPPORT FOR AN EXPANDED HIGHWAY RESEARCH PROGRAM

Over recent years, the national highway community--federal, state, and local governments; highway organizations; the private sector; and universities--have joined in a consensus for an expanded R&D Program. The American Association of State Highway and Transportation Officials (AASHTO) has worked independently and in cooperation with the FHWA and other highway community organizations to propose an approach for the national highway research program and for the use of the FHWA's Turner-Fairbanks Highway Research Center. Their 1989 report Innovation: A Strategy for Research Development and Technology Transfer defines the organization's perception of the direction that the program should be taking. Organizations such as the Highway Users Federation for Safety and Mobility and the American Road and Transportation Builders Association have endorsed the expansion of the national highway research program. In the recent budget negotiations, the U.S. Congress has endorsed the expansion by providing increased funding for the program.
The FHWA's research and technology program consists of four parts: safety, intelligent vehicle highway systems (IVHS), preservation and productivity, and technology transfer.

Safety

The highways in the United States are the safest in the world, but they are not without problems. The fatality rate is 2.4 per 100 million vehicle miles of travel; on an annual basis the total loss of lives is about 47,000. Total annual travel is increasing about 4 percent for passenger cars and nearly 9 percent for trucks. By the year 2000 the projected number of highway fatalities in the United States will be 80,000 if the current fatality rate is not reduced. It can be reduced if we seriously seek, test, and implement new and improved ways for preventing highway accidents. New safety solutions will be coordinated and developed in parallel with the goals of the Intelligent Vehicle Highway Systems program. Together these programs will spawn the level of highway safety needed for the United States in the first two decades of the twenty-first century. The key elements of the highway safety program are:

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This area of the program includes Highway Safety Research and Development and Motor Carrier Safety Research. We hope to be able to improve the safety and operational efficiency of the highway system for motorists, commercial vehicle operators, and pedestrians through advanced technology and behavioral research.

Highway Safety Research and Development has five key elements:

- Highway Safety Information Management.
- Human Factors Research for Highway Safety.
- Pedestrian and Bicycle Safety.
- New Traffic Control Methods and Devices.

Highway Safety Information Management--The objective of this research is to improve the safety of the highway system by developing a systematic approach for identifying and eliminating highway safety hazards. This approach includes the effective utilization of existing state highway safety data, the development of advanced technologies for data collection, and the creation of improved analysis techniques.

Human Factors Research for Highway Safety--The objective of this research is to improve highway safety by systematically focusing on the problems associated with the driver component of the highway-vehicle-driver system. The aim is to reduce the number and severity of automobile accidents by improving the compatibility between highway elements and the capabilities and limitations of vehicle drivers.

Pedestrian Safety--The objective of this research is to reduce pedestrian fatalities and injuries by developing improved engineering and planning techniques that are applicable to both motorists and pedestrians.

Highway Safety Design Practices and Criteria--The objective of this research is to reduce the number and severity of single- and multi-vehicle accidents through improved design practices and criteria.
accidents on the nation’s highways by designing the appropriate level of safety into the highway.

*New Traffic Control Methods and Devices*—The objective is to improve operational safety and efficiency of major highways through the application of advanced technology for providing conspicuous and timely roadside control and warning assistance to drivers based on current roadway, traffic and environmental conditions.

The objectives for Motor Carrier Safety Research are to reduce the rate of accidents (especially fatalities), involving commercial motor vehicles and to develop and refine the tools necessary to significantly improve the safety of commercial motor vehicle drivers and vehicles and their operating environment.

**Intelligent Vehicle-Highway Systems**

Many in the highway community believe that future highway program emphasis should focus on operational issues including reducing congestion, and improving safety and air quality. The application of advanced technology systems along with a balanced program of traffic management, new construction, and demand management is seen as the most promising way to improve system operation. A significant element of this overall thrust is a proposed national program in intelligent vehicle-highway systems (IVHS). Also referred to as "smart cars" and "smart highways," a program of IVHS technology represents the marriage of the vehicle, the driver, and the highway into a much more effective and efficient integrated system. Presently, IVHS is broadly described as comprising four basic system areas consisting of:

- Advanced traffic management systems.
- Advanced traveler information systems.
- Commercial vehicle control operations.
- Advanced vehicle control systems.

**Advanced Traffic Management Systems (ATMS)**—The development of advanced real-time traffic management and control strategies is aimed at achieving maximum traffic movement efficiency in high demand metropolitan and rural corridors.

**Advanced Traveler Information Systems (ATIS)**—These systems will incorporate advanced in-vehicle capabilities and communication with the roadside to enhance the efficiency and safety of individual motorist travel.

**Commercial Vehicle Control Operations (CVCO)**—Operational efficiency and safety will be increased through the application of advanced technology to commercial operations.

**Advanced Vehicle Control Systems (AVCS)**—The objective of this research is to further enhance safety and reduce congestion by developing technologies to help the driver perform vehicle control functions.

The potential market for the automobile was not fully realized until the roads were paved. The potential market for intelligent vehicles will not be realized until there is a commitment to deployment of the infrastructure required to provide intelligent highways.
Preservation and Productivity

The American public needs an efficient transportation system. The effects of an aging and deteriorating highway system are becoming more frequent—increased delay, incidents of catastrophic failure, congestion, reductions in safety and service. Therefore, this program places an emphasis on developing the tools and materials to rebuild, strengthen, and preserve the U.S. highway system. Five research areas have been identified to address the needs of this system:

- Research and Development: Pavements and Structures.
- Long-Term Pavement Performance.
- Motor Carrier Productivity Research.
- Right-of-Way and Environment Research.
- Policy and Planning Research.

Pavements and Structures Research and Development is subdivided further into four elements: materials to strengthen and enhance performance; construction, repair, and rehabilitation of the highway infrastructure; system management to increase service-life; and commercial vehicles.

Materials to Strengthen and Enhance Performance—Under this element, we will identify new materials including waste and hazardous materials for twenty-first century highway applications, enhance applications of existing materials for use in highway construction, and increase the understanding of the properties and performance of these materials. The research includes material identification, selection, laboratory testing and evaluation in conjunction with extensive field experimental construction and performance monitoring and evaluation.

Construction, Repair, and Rehabilitation of the Highway Infrastructure—We will pursue the development and foster the implementation of new techniques, procedures, equipment, specifications, and contract administration to improve the quality, cost-effectiveness, efficiency, and safety associated with the repair, rehabilitation, and restoration of existing facilities and the construction of new facilities for the highway system.

System Management to Increase Service-Life—We will develop improved management techniques that will allow strategic planning to extend the service life, ensure structural and operational safety, and minimize failures caused by natural disasters.

Commercial Vehicles—We will provide the technology needed to maintain the capability of the nation’s highways to support American industry and public needs. This research is designed to optimize transportation service and costs to accommodate truck traffic, addressing the interaction between the design of the highway system and heavy vehicles.

The Long-Term Pavement Performance Program (LTPP) is a 20-year project initiated under the Strategic Highway Research Program (SHRP). The first 5 years of the program were funded under the SHRP. The objective of the research is to support state highway agencies and Canadian plans to establish a pavement performance data base for North America.

The effort will include periodic data collection and condition monitoring of approximately 1500 in-service pavement sections across the United States and Canada. Once a sufficient number of data points has been...
collected, the analysis to establish the relationship between pavement performance and design, materials, construction maintenance, traffic, environment, and geographic location will begin.

The LTPP program has already provided new test and evaluation methods and pavement condition monitoring equipment that is being implemented by highway agencies. As sufficient data becomes available for analysis, this program will provide an evaluation of existing design methods, improved rehabilitation strategies, improved design procedures for new and reconstructed pavements, and the cost effectiveness of numerous pavement design features and maintenance strategies.

The Motor Carrier Research Program is a comprehensive, long-range program designed to provide the data bases, analytical tools, demonstrations, and market capabilities necessary to significantly improve our nation's competitiveness in the world markets. The FHWA will continue its coordination with industry on key research issues that can improve productivity. Our objective is to improve industry productivity and international competitiveness without compromising commercial motor vehicle safety.

It is essential to the U.S. economy that the motor carrier industry continue to improve productivity and compete effectively both domestically and internationally. This research promises to increase the industry’s ability to operate more efficiently and compete more effectively in a global market.

The right-of-way and environment research program will contribute to a more efficient right-of-way program and an enhanced environment through the development of corridor preservation criteria, improved tools for assessing highway impacts and mitigation strategies, and identification and development of innovative mitigation techniques.

Our objectives for the right-of-way and environment research program are to improve the efficiency and effectiveness of the right-of-way program, and to provide the states with practical guidance and up-to-date technologies to enable them to more effectively comply with environmental laws and regulations.

The policy and planning research program will develop efficient ways to evaluate the appropriate level of future federal involvement in the highway program, provide information and methods to evaluate policy and program alternatives, and develop and disseminate improved planning methods to enhance land use and transportation system development and system performance.

The objectives for the policy and planning research program are to evaluate the appropriate level of future federal involvement in the highway program, to maximize the return on funds invested in the federal-aid highway program, to enhance highway transportation contribution to the national economic development and competitiveness, to provide the information needed to evaluate policy alternatives, and to develop and disseminate improved planning methods to assist state and local transportation agencies to enhance transportation system performance.
Technology Transfer

Both nationally and internationally, the highway community faces unparalleled challenges and demands. The future highway program will require innovation and both the public and private sector research efforts are being increased to provide technologies that address these ever-growing challenges. Research results must be put into practice quickly and widely to benefit the nation’s transportation system and to improve the U.S. technical presence abroad. The technology transfer program will foster innovation, evaluate and establish the validity of new technologies, and communicate new highway products and programs to transportation professionals through the highway system. The major elements of the technology transfer program are technology applications, education and training, and international programs.

With representatives of the national and international highway community, the technology applications program will plan, develop, and coordinate a technology transfer program to promote and provide technical assistance for the purpose of enhancing the timely adoption of innovative technology as it relates to the highway system and the vehicle. The technology applications program includes:

- Technology assessment.
- Technology refinement and packaging.
- Technology delivery.

Technology assessment--We will identify and evaluate products emerging from research efforts of the highway community that are ready for deployment; analyze elements of the highway system to determine additional opportunities for application of technologies, and perform market and product analysis.

Technology refinement and packaging--We will refine and package innovative technology and products to ensure timely adoption.

Technology delivery--We will ensure the timely delivery and widespread use and adoption of innovative technology through effective delivery systems.

The education and training program will develop and administer in cooperation with state highway agencies, training programs of instruction for FHWA and state and local highway department employees and other national, international, and private individuals engaged or to be engaged in highway work of interest to the United States. The education and training program includes:

- Local Transportation Assistance Programs.
- National Highway Institute.
- University Transportation Centers Program.

Local Transportation Assistance Programs--The objectives of this program are to identify, package, and deliver modern highway technology to rural and urban local transportation agencies; to assist local transportation agencies in developing and expanding their ability to deal effectively with road-related problems; and establish and operate, in cooperation with state highway departments and universities, technology transfer centers for local transportation agencies.
National Highway Institute--Through the National Highway Institute (NHI), we will provide specific high technology training courses at locations throughout the United States; identify, create, enhance, and implement programs required to qualify key highway personnel for leadership roles; and conduct unique programs with national and world experts.

University Transportation Centers Program--Under the University Transportation Centers Program (UTCP), the Department helps to fund 10 regional centers established to attract the nation's best talent to the study of transportation as a discipline. We also will develop new strategies and concepts to effectively address existing and future transportation issues.

The international programs are designed to enhance U.S. highway technology, to improve the U.S. technical presence in developed and developing countries, and to provide better support for U.S. private sector firms in the international market place. The international programs includes:

- Import Foreign Technology.
- Technology Transfer to Foreign Countries.
- Promote U.S. Expertise.

Import Foreign Technology--The objective of this portion of the international program is to keep the U.S. highway community informed of technological innovations abroad that could significantly improve transportation in the United States.

Technology Transfer to Foreign Countries--Through this effort, we will increase transfers of U.S. technology to developing regions of the world.

Promote U.S. Expertise--We will demonstrate the United States' highway transportation expertise with the aim of helping U.S. firms compete for business in foreign markets.

Program Delivery

Major changes in an organization's program require the organization to examine its strategic plan for delivering the program and the end products to the user. The challenge facing the FHWA is implementing an expanded research and technology program while minimizing any increase in personnel and other resources. We must determine how to supplement the experience and technical knowledge of the existing FHWA research and program offices staff in delivering an expanded research and technology program. To do this, we must use a combination of existing partners and opening up avenues of technical innovation with new partners.

We are reviewing a number of options for delivering the program: direct contracting, cooperative agreements, centers approach--consortia, federal-aid, grants, and lead-state approach. We are still performing our review and so have not assessed which approach or combination of approaches would serve the program best. We do believe that it is important for the FHWA to have administrative oversight of the program considering the FHWA's stewardship of federal funds that are used in our nation's highway program.

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It is clear that there is a strong need for a firm partnership among the members of the highway community. We will make decisions on program delivery mechanisms in cooperation with our partners in the highway community. Decisions will be based on valuable insight on the strengths and weaknesses of each of these approaches and the capabilities of those who may be doing some of the work.

Resource Needs
To meet the needs of the expanded research and technology program, the proposed funding levels for the program have been significantly increased over the proposed fiscal year 1991 budget levels. In addition, to deliver the proposed programs, the FHWA cannot continue to operate under "business as usual." Some of the programs will need changes in the program delivery mechanisms, and nearly all of the programs will need additional personnel at some time during fiscal years 1992 through 1996. At this point, indications are that the Administration and the U.S. Congress will support the expanded research and technology program. However, while projections and proposals have been for funding and personnel increases, it is too early to know at what levels the increases will come to fruition.

OUTREACH
A big part of our expanded highway research and technology program will be the outreach or communication and coordination mechanism. Along with a consensus for an expanded program was agreement that input from the states, universities, industry associations, the Transportation Research Board, and others in the highway community would be necessary to make the program work at its best. The mechanism will help us to know better what research problems the highway community has, who should perform the research, and, when technology has solved the problem, getting that technology to the users that can make the most of it. We are moving ahead on this effort and expect it to become an integral part of the research and technology program process.

I will abbreviate these remarks about our outreach effort since Deputy Federal Highway Administrator Gene McCormick will elaborate on the effort during his talk tomorrow.

SUMMARY
We are entering a new age for the national highway research and technology program. After a decade of programs that have seen diminishing resources that resulted in a deteriorating infrastructure, traffic congestion, a growing disparity between the sizes of automobiles and commercial motor vehicles, increased negative environmental effects from highways, decreased international competitive edge, etc., the nation is prepared to respond with a program that produces innovation and increased national expertise in highway technology. Both will have a revitalizing effect on the national transportation system, the nation's economy, and in preserving the lifestyle of citizens of the United States in the 1990s and well into the twenty-first century.
The expanded research and technology program will result in new materials to build better pavements, protective coatings and scour preventative methods for highway structures, improved traffic operation hardware and software, more efficient and competitive motor carriers (including electronics and computer controls to greatly improve the vehicle-highway interaction), technology that will support the human element in driving and result in smoother operation of the highways, better materials in the construction and maintenance of the highways to reduce environmental effects, improved safety hardware and technology to reduce the number of accidents and the effects of accidents that do occur, and other technology.

As the technology emerges from these programs, we will train the individuals who will build and operate the highway on the federal, state, and local levels. Courses and educational programs will be developed to disseminate the new technology from the local labor level to the most sophisticated and specialized highway official.

Public and private sector cooperation will increase as highway and vehicle industry participants research, develop, market, and deploy the new technology.

We are approaching the end of a major highway undertaking, the planning, design, and construction of the Interstate Highway System. The Interstate System is an historical monument of engineering inventiveness, incorporating the best highway technology of the last 30 years.

The next era will begin with new innovations and new technology leading to engineering techniques and processes yet undiscovered. Attracting people nationally from among the best and the brightest to a program that encourages and inspires innovation will help us ensure the safety of tens of thousands more people and move those people and the nation’s commercial goods with little or no delay on an infrastructure that is unrivaled internationally.