U.S. Department of Transportation
Federal Highway Administration

Federal Highway Administration (FHWA) Research and Technology Agenda

Meeting the Challenge: Exploratory Advanced Research

Unique among FHWA's research programs, the Exploratory Advanced Research Program is producing research today that will address tomorrow's transportation challenges and will make the Nation's highways and intermodal systems more durable, efficient, environmentally sound, productive, and safe. Unlike many other areas within FHWA that focus on more established technologies, the Exploratory Advanced Research Program supports early-stage research that is crosscutting, high risk, and long term that has high potential for revolutionary breakthroughs.

Collaboration with stakeholders from multiple disciplines inside and outside transportation fosters opportunities for innovative research solutions. The Exploratory Advanced Research Program encourages the transition of innovations from early-stage research to applied research, such as facilitating handoff activities to ensure eventual commercialization. The program also demonstrates and communicates the value of research through targeted efforts.

Many of FHWA's research programs focus on technologies that have existing market potential and can be easily transferred to industry for commercialization. These market-ready technologies are a key part of the research life cycle, which describes movement over time from basic to applied research, field testing, implementation, deployment, and, finally, assessment of impacts.

Producing market-ready technologies is important because a key measure of success depends on stakeholders' ability to access and accept new technologies on a national scale. However, there is also a need for FHWA to conduct research in cutting-edge or emerging technologies that are far from being market ready, but have the potential to make transformational improvements to the Nation's transportation system. Because it defines and anticipates future transportation needs while exploring potential solutions, the Exploratory Advanced Research Program is a critical piece of the research life cycle.

The Exploratory Advanced Research Program supports FHWA's priorities and assists policy makers, the research community, and transportation agencies with addressing critical knowledge gaps and accelerating innovation and technology deployment.

Objective: 1: Collaborate with stakeholders from multiple disciplines (both inside and outside transportation) to promote and foster creative, innovative thinking.

Strategies

- Seek crosscutting research on topics that go beyond those typically associated with transportation to identify possible linkages or insights that would improve surface transportation systems or users of these systems.
- Identify and investigate research on topics that anticipates questions and future needs in the transportation sector.
- Identify potential researchers who are capable of conducting exploratory advanced research and with whom the Exploratory Advanced Research Program can build partnerships.

Showcase Activities

- Nanoscale Research Workshop
- Assistive Technology Workshop
- Behavioral Economics Approach to Highway Pricing

Nanoscale Research Workshop

The Nanoscale Research Workshop explored the question, "Why spotlight nanoscale opportunities in highway research?" The workshop informed the highway research community about nanoscale studies relevant to highway research, informed nanoscale researchers about highway research needs, and identified possible opportunities for investing Exploratory Advanced Research Program funds within the nanoscale focus areas. Nanoscale highway research could lead to faster construction, increased durability, and improved performance.

Activity Contact

David Kuehn
FHWA Office of Corporate Research, Technology, and Innovation Management, Exploratory Advanced Research Program
Tel: 202-493-3414
Email: david.kuehn@dot.gov

Additional Resources

- FHWA: Nanoscale Approaches for Highway Research

Assistive Technology Workshop

Convened by FHWA, the Assistive Technology Workshop asked the question, "How can government, academia, and the private sector cooperate to advance the state of the practice in the automated analysis of data from naturalistic driving studies?" Because of smaller, less invasive technology, researchers are better able to monitor driving behavior using invehicle devices during naturalistic driving studies. For example, the Future Strategic Highway Research Program's (SHRP2) naturalistic driving studies, the largest ever conducted, will result in a large quantity of usable data. The SHRP2's naturalistic driving studies present challenges such as privacy issues and data accessibility. The Assistive Technology Workshop explored solutions to these challenges to ensure that the beneficial aspects of data resulting from naturalistic driving studies may be used by government and industry alike.

Activity Contact

Lincoln Cobb
FHWA Office of Safety Research and Development
Tel: 202-493-3313
Email: lincoln.cobb@dot.gov

Additional Resources

- FHWA: Automated Video Feature Extraction Workshop Summary Report

Behavioral Economics Approach to Highway Pricing

As part of a 3-year study, FHWA, in partnership with the University of Central Florida and Georgia State University, is examining when and why drivers choose a priced or tolled facility over an untolled but congested parallel route. The study involves participants in the metropolitan areas of Miami, Orlando, and Atlanta, with 200 to 300 drivers per area. The research team will outfit each participant's private vehicle with a global positioning system device to observe the daily driving choices. The findings will result in a guide that explores the application of experimental economics in the area of congestion pricing.

Activity Contact

Karen White
FHWA Office of Transportation Policy Studies
Tel: 202-366-9474
Email: karen.white@dot.gov

Additional Resources

- FHWA: Investigating Congestion and Solutions: Experiments on Congestion Conditions and Pricing Initiatives

Objective: 2: Promote, fund, and enable high-risk research that has high potential for revolutionary breakthroughs over the long term.

Strategies

- Identify and fund promising Exploratory Advanced Research proposals through a merit review, collaboration with outside experts, and coordination with internal leadership.
- Collaborate with outside experts at each stage of the research process to ensure the quality of research.

Showcase Activities

- Freeway Merge Assistance
- Real-Time Bridge Monitoring Nanosensor Technology
- Demonstrating the Benefits of High-Volume Fly Ash in New Concrete Mixtures
- Evaluating the Potential of Nanomaterials to Reduce Concrete Cracking

Freeway Merge Assistance

This project will develop and evaluate three algorithms designed to improve freeway merging: dynamic lane control, gap-responsive metering, and merge control. These algorithms will be developed specifically to take advantage of the capabilities provided by vehicle-infrastructure research, an initiative formed by the U.S. Department of Transportation that involves communication between vehicles, infrastructure, and the wireless devices of passengers. The research then will use an enhanced simulation environment to evaluate the safety and efficiency impacts of these algorithms under different scenarios of equipped and nonequipped vehicles.

Activity Contact

Robert Ferlis
FHWA Office of Operations
Research and Development
Tel: 202-493-3268
Email: robert.ferlis@dot.gov

Additional Resources

- Efficient and Safe Merging Solutions

Real-Time Bridge Monitoring Nanosensor Technology

Steel bridges represent approximately 34 percent of the nearly 600,000 highway bridges in the United States. Continual monitoring and early detection of deterioration in these structures are vital to prevent costly repairs or severe failures. It is estimated that eliminating all bridge deficiencies within the next 50 years would cost more than $17 billion per year. FHWA, in partnership with the Georgia Institute of Technology, is studying Real-Time Bridge Monitoring Nanosensor Technology. This project aims to overcome the technical and financial obstacles in measuring in situ bridge conditions and deliver a product more efficiently and faster than currently available.

Activity Contact

Hamid Ghasemi
FHWA Office of Infrastructure
Research and Development
Tel: 202-493-3042
Email: hamid.ghasemi@dot.gov

Additional Resources

- FHWA: Real-Time Bridge Monitoring - Developing Wireless Nanosensors to Monitor Structural Integrity

Demonstrating the Benefits of High-Volume Fly Ash in New Concrete Mixtures

High-volume fly ash (HVFA) concrete mixtures offer many benefits, including reduced cost, reduced energy content, enhanced environmental sustainability, and improved long-term performance. Although beneficial, several barriers exist to implementing new concrete mixtures. For example, it is difficult to predict strength gain in full-scale structures. Part of an FHWA initiative, a 24-month research project is exploring ways to overcome these difficulties. The project team, comprised of Purdue University in partnership with Auburn University, the National Institute of Standards and Technology, and the National Ready Mixed Concrete Association, is using temperature management software and developing a database with analytical prediction tools along with screening procedures to identify and influence the properties of residual carbon on the rate of admixture absorption.

Activity Contact

Richard Meininger
FHWA Office of Infrastructure
Research and Development
Tel: 202-493-3191
Email: richard.meininger@dot.gov

Additional Resources

- FHWA: Benefits of High Volume Fly Ash: New Concrete Mixtures Provide Financial, Environmental, and Performance Gains

Evaluating the Potential of Nanomaterials to Reduce Concrete Cracking

Concrete transportation structures and pavements are subject to cracking that leads to further deterioration, significantly shortening service lives and degrading their levels of performance. Crack-free concrete has been a challenge for materials engineers, highway officials, and researchers for decades. FHWA is supporting cutting-edge research to evaluate the potential for new materials, such as carbon nanofibers, to address concrete cracking. In response to an Exploratory Advanced Research Program broad agency announcement in 2007, Texas A&M

Activity Contact

Richard Meininger
FHWA Office of Infrastructure
Research and Development
Tel: 202-493-3191
Email: richard.meininger@dot.gov

University's Texas Transportation Institute proposed new methods for preventing cracking in concrete and enhancing the mechanical properties of concrete pavements and structures. The research resulted in the development of a novel method for enhancing and quantifying dispersion of carbon nanofibers in cement paste. The new method can be applied to many types of structures and pavements and is also applicable for use in other fields of study ranging from ecology to materials science. Most directly, this early-stage research identifies next steps for testing how the dispersion of carbon nanofibers in cement paste improves concrete strength, shrinkage, and other properties.

Additional Resources

- FHWA: Crack-Resistant Concrete Maximizing the Service Life of Transportation Infrastructure
- Texas Transportation Institute: Nanotechnology-Based System for Damage Resistant Concrete Pavements
- Journal of Nanomaterials: Challenges and Benefits of Utilizing Carbon Nanofilaments in Cementitious Materials

Objective: 3: Demonstrate and communicate the value and impact of exploratory advanced research and promote opportunities to move from advanced to applied research.

Strategies

- Identify promising Exploratory Advanced Research Program-sponsored projects that lead to continued, high-impact applied research.
- Fund and support handoff activities when needed to ensure successful continuation of high-impact applied research, product development, and adoption by industry.
- Identify, promote, and encourage funding opportunities available from other sources (e.g., Federal, State, or private sector) that will support applied research based on results from the projects sponsored by the Exploratory Advanced Research Program.
- Explore and promote how secondary research products resulting from projects funded by the Exploratory Advanced Research Program could improve the outcomes of ongoing and future projects.

Showcase Activities

- Building on Exploratory Advanced Research Results
- Facilitating the Use of New Methods for Modeling and Simulating Traffic and Driver Behavior
- Lane-Level Positioning and Navigation Workshop

Building on Exploratory Advanced Research Results

FHWA is an active investor in exploratory advanced research. As sponsored research projects progress, the Exploratory Advanced Research Program, along with technical experts internal and external to FHWA, assess the potential of the research for further development. For those projects with the highest potential, the Exploratory Advanced Research Program works to identify funders and researchers who are the most likely to continue the research in the next stage. The Exploratory Advanced Research Program develops focused implementation and marketing plans for selected projects and hosts hand-off workshops or demonstrations to connect research teams with organizations that are interested in advancing projects in future stages of research, development, and deployment.

Activity Contact

David Kuehn
FHWA Office of Corporate Research, Technology, and Innovation Management, Exploratory Advanced Research Program
Tel: 202-493-3414
Email: david.kuehn@dot.gov

Additional Resources

- FHWA: Program Hand-Off Workshops Report
- FHWA: Exploratory Advanced Research Program Results

Facilitating the Use of New Methods for Modeling and Simulating Traffic and Driver Behavior

Technological advancements continue to be applied to vehicles and to the operation and management of the transportation network. To keep pace with these innovations and to aid in the evaluation of their safety and efficiency, new methods are needed to more precisely model the behaviors of drivers and to address connected vehicle and autonomous vehicle systems in traffic models and simulations. To facilitate collaboration, FHWA convened a workshop that brought together research representatives from five projects that had examined new approaches and applications for modeling and simulation in the critical areas of human behavior and connected vehicle systems. The researchers shared information about their individual projects. Certain projects covered a range of near-future advances and long-term breakthroughs; some explored the application of simulation methods to analyze specific transportation problems, while others looked for breakthroughs in modeling techniques. FHWA will use information and ideas gathered in the workshop to guide future investments in modeling and simulation research.

Activity Contact

David Kuehn
FHWA Office of Corporate Research, Technology, and Innovation Management, Exploratory Advanced Research Program
Tel: 202-493-3414
Email: david.kuehn@dot.gov

Additional Resources

- FHWA: Trends of Transportation Simulation and Modeling Workshop Summary Report

Lane-Level Positioning and Navigation Workshop

FHWA's Exploratory Advanced Research Program assembled a panel of experts comprised of Government program managers and positioning and navigation researchers to explore dependable, precise, and commercially affordable solutions for roadways. The panel shared information about the results of Exploratory Advanced Research Program-sponsored research on vehicle positioning and navigation for increased safety, mobility, and efficiency in transportation systems. This research aims to help State agencies, academia, industry, and others increase mobility on our Nation's highways.

Activity Contact

David Kuehn
FHWA Office of Corporate Research, Technology, and Innovation Management, Exploratory Advanced Research Program
Tel: 202-493-3414
Email: david.kuehn@dot.gov