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Inside SAFETEA-LU
Innovative Financing
GIS Successes

U.S. Department
of Transportation

Federal Highway
Administration

Public Roads

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—featuring developments in Federal highway policies, programs, and research and technology—

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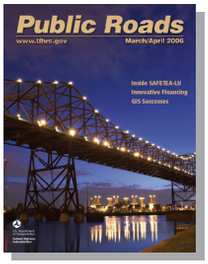

Front cover—In January 2005, the city of Chicago entered into a lease agreement with a private consortium to operate the Chicago Skyway and bridge (shown here at dusk) for the next 99 years. In return, Chicago taxpayers received a single payment of $1.83 billion at the time of the closing. The Skyway concession is an example of an emerging trend in privatization of roadways in the United States as transportation agencies explore innovative financing strategies. *Photo: Fritz Geiger, Hot Shots Imaging.*

Back cover—The Otay River Bridge, shown here under construction, is part of the 16-kilometer (10-mile) South Bay Expressway, which connects the growing southeastern cities of Chula Vista and Otay Mesa to a Mexico border crossing and the rest of San Diego County. The project is being funded through a public-private partnership between the California Department of Transportation and California Transportation Ventures, Inc. When complete, the bridge will be 1.2 kilometers (0.75 mile) long and reach a height of 55 meters (180 feet). *Photo: South Bay Expressway.*

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Federal Highway Administration

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Guest Editorial

SAFETEA-LU for Meeting Today's Challenges

This year, the United States celebrates the 50th anniversary of the Dwight D. Eisenhower National System of Interstate and Defense Highways, which connects communities across the Nation, serves as the backbone for economic prosperity, and supports a way of life that Americans have grown to enjoy and expect. As the success of the interstate system grows, however, so do the challenges facing transportation officials. The burden of maintaining and rebuilding the network of highways and bridges continues to increase—and more cars and freight mean more congestion, safety concerns, and wear on the system. The ability of the transportation community to learn from the past, apply these lessons, and recognize and address new challenges will affect the success of the entire system.

In this issue of PUBLIC ROADS, the article "The Straight Scoop on SAFETEA-LU" describes the major features of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—the largest highway program authorization in U.S. history. The hefty infusion of funding reflects the high priority given to transportation and carries with it a tremendous responsibility for the transportation community. As with past legislation, SAFETEA-LU contains provisions that offer States more flexibility in using resources to meet the most critical national and State goals.

For example, of all the challenges, none is more important than saving lives and reducing injuries resulting from highway crashes. SAFETEA-LU elevates safety to a stand-alone core program. The legislation provides more than $5 billion in Highway Safety Improvement Program funds to help States advance highway safety in a comprehensive, strategic manner. In addition, SAFETEA-LU provides targeted funding for specific safety issues such as work zone safety and programs such as Safe Routes to Schools and the High Risk Rural Road Safety Improvement Program.

SAFETEA-LU also contains the first substantive revision in almost 40 years to Section 4(f) (of Section 138 of Title 23 and Section 303 of Title 49, United States Code) to simplify the processing and approval of projects that have only *de minimis* impacts on lands protected by Section 4(f). Other provisions aim to streamline the environmental review process while preserving environmental quality. These provisions will help cut red tape, reduce delays, and enable officials to make timely decisions during environmental reviews. Since the signing of SAFETEA-LU on August 10, 2005, the Federal Highway Administration (FHWA) has issued guidance calling for increased collaboration between Federal and State officials involved in environmental actions. This is just the beginning. FHWA is committed to fully implementing SAFETEA-LU in a way that will accelerate the review process without diminishing environmental protections.

Although the level of funding provided by SAFETEA-LU is at an all-time high, needs exceed the resources available. To address this shortfall, SAFETEA-LU makes more opportunities available for States to explore innovative financing solutions such as private activity bonds, tolling and other road pricing, and loans under TIFIA (Transportation Infrastructure Finance and Innovation Act). SAFETEA-LU also continues and expands the State Infrastructure Bank program. The array of tools in SAFETEA-LU furnishes additional opportunities for States and strengthens their ability to attract private investment and participation.

By building on the firm foundations of the Intermodal Surface Transportation Efficiency Act of 1991 and the Transportation Equity Act for the 21st Century (1998), SAFETEA-LU furthers equity in the distribution of funds, including increasing minimum rates of return on States' Highway Trust Fund contributions and delivering increased flexibility to explore creative solutions to the growing challenges.

SAFETEA-LU is not the end to the means but rather the means to the end. As the transportation community implements SAFETEA-LU, the key question is: What will the transportation community need to meet tomorrow's challenges? FHWA is committed to working with State departments of transportation and other partners to find the answers.

Frederick G. "Bud" Wright
Executive Director
Federal Highway Administration

The Straight Scoop on SAFETEA-LU

by Susan J. Binder

Building on the ISTEA and TEA-21 foundations, the new Federal surface transportation legislation introduces new programs and policies.

President George W. Bush signs SAFETEA-LU at a Caterpillar® facility in Montgomery, IL, on August 10, 2005. Joining the President in the front row, from left, are Congressman Ray LaHood, R–IL; Congresswoman Melissa L. Bean, D–IL; Congressman Jim Oberstar, D–MN; Congressman Tom Petri, R–WI; Senator Kit Bond, R–MO; U.S. Transportation Secretary Norman Y. Mineta; Speaker of the House Dennis Hastert, R–IL; Congressman Bill Thomas, R–CA; and Congressman Bobby L. Rush, D–IL. (Inset) In front of a backdrop of earth-moving equipment, Bush waves to the crowd gathered for the signing ceremony. *White House photos by Eric Draper.*

Passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005 marked the culmination of 4 years of work to achieve a new surface transportation authorization law. It also signified the beginning of a new challenge as the transportation community absorbs the law's changes and requirements.

With overall funding authorization totaling $244.1 billion, SAFETEA-LU enacts the largest highway program in the history of the Nation. At the same time, it changes the structure and requirements of longstanding programs, introduces new initiatives, adds oversight responsibilities, and alters transportation policies.

SAFETEA-LU addresses many of the challenges facing the transportation system today, such as enhancing safety, reducing traffic congestion, improving efficiency in freight movement, increasing intermodal connectivity, and protecting the environment. Through its provisions of enhancing research and planning activities, it also lays the groundwork for meeting future challenges.

"This law funds vital new transportation projects, holds the line on gas taxes, and avoids adding to the deficit," says U.S. Transportation Secretary Norman Y. Mineta. "More importantly for America's drivers, it contains significant new safety provisions. State and local officials now have the resources, flexibility, and support they need to make driving safer, fight congestion, and ensure that the Nation's transportation system keeps pace with the rapidly expanding economy."

SAFETEA-LU, signed into law on August 10, 2005, was enacted 22 months after its precursor, the Transportation Equity Act for the 21st Century (TEA-21), expired. In the interim, a series of 12 stopgap extension acts provided the authority for

continuance of the Federal-Aid Highway Program, which provides financial assistance to the States for transportation projects and programs.

"It's been a long time coming, but the law will accelerate needed transportation projects, increase safety, improve people's quality of life, and create jobs," says Jack Lettiere, commissioner of the New Jersey Department of Transportation and former president of the American Association of State Highway and Transportation Officials.

Senator Johnny Isakson, R–GA, adds, "This legislation is critical to Georgia because it will provide our State with the tools necessary to improve and expand its surface transportation infrastructure to meet the demands of a growing population."

Analyzing and Implementing the New Law

Since SAFETEA-LU's passage, the U.S. Department of Transportation (USDOT) has been analyzing the changes outlined in the 800-plus-page law and implementing them as efficiently as possible. Actions run the gamut from changing business practices to providing guidance to the Federal Highway Administration's (FHWA) State and local partners on developing regulations.

"Our State and local partners are understandably anxious for us to make SAFETEA-LU funds available as soon as possible, but we must take care that we do so within the law and within the stated preferences of Congress," says FHWA Acting Administrator J. Richard Capka. "We must implement the law quickly, but without sacrificing the high quality of service FHWA has been providing the traveling public for 38 years."

Typically, surface transportation authorizations are multiyear acts that set the amounts that can be spent on federally assisted highways, highway safety, and other transportation programs. They also set the Nation's transportation policy and alter those aspects of the United States Code and regulations that affect surface transportation.

Some surface transportation laws have been described as "revolutionary," as was the case with the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). ISTEA gave more decisionmaking authority to States, created new statewide planning processes, focused on linkages among transportation modes, brought new players into the transportation process, and set the groundwork for establishing the National Highway System, a network of interstate and other roadways important to the Nation's economy, defense, and mobility.

Other surface transportation laws have been described as "evolutionary," such as TEA-21, which preserved the basic framework of ISTEA with a few important changes. Healthy economic conditions led to increased Highway Trust Fund balances, which enabled greater overall funding and the creation of financial features such as guaranteed funding, firewalls (a budgetary device establishing separate budget categories for discretionary programs such as mass transit spending), and Revenue-Aligned Budget Authority (RABA), an adjustment that ensures transportation funding follows actual revenues from vehicle and gas taxes. TEA-21 was heralded for providing a dramatic increase in investments in Federal surface transportation—40 percent more than the total funding provided for highways, highway safety, and public transportation programs under ISTEA.

SAFETEA-LU—while closer to the evolutionary side of the spectrum—contains several significant changes in areas such as funding, safety, program structure, transportation planning, highway finance, environmental streamlining, and research.

Funding Under SAFETEA-LU

SAFETEA-LU is commonly referred to as a "6-year bill," but it is actually a *law* that covers the 5 fiscal years (FY) 2005–2009. To compare SAFETEA-LU with the two previous acts—which covered 6-year timeframes—analysts frequently add 2004, the year authorized completely by short-term extension acts. SAFETEA-LU's total funding thus includes the 5-year period and, for comparison purposes, the 6 years starting with FY 2004.

SAFETEA-LU authorizes $201.6 billion for Federal-aid highways, but also rescinds $8.5 billion, bringing net authorizations to $193.1 billion. A permanent Emergency Relief (ER) program authorization of $100 million per year to repair Federal-aid highways damaged by disasters brings the total to $193.6 billion.

SAFETEA-LU retains the Federal-Aid Highway Program's core programs—the Surface Transportation Program (STP), National Highway System (NHS), Interstate Maintenance Program, Bridge Program, and Congestion Mitigation and Air Quality Improvement Program—and adds a new one, the Highway Safety Improvement Program (HSIP). Funding for core programs is about 63 percent of SAFETEA-LU's total highway and highway safety funding.

Funding issues were a major reason SAFETEA-LU was enacted so long after TEA-21 expired. Formulas—which determine how the transportation pie is sliced—are often a contentious issue in reauthorization debates.

SAFETEA-LU contains changes in funding and other areas to meet the challenges of maintaining and growing transportation infrastructure such as the highway shown here.

SAFETEA-LU Funding

	FY 2005–2009 (All numbers in billions)	FY 2004*–2009
Federal-Aid Highways	$193.1	$227.4
Public Transportation	$45.2	$52.6
Highway and Motor Vehicle Safety	$5.8	$6.5
Totals	**$244.1**	**$286.5**

**FY 2004 funding provided through Extension Acts.*

Source: USDOT.

During this cycle of reauthorization, the transportation committee leadership in both houses of Congress stressed the importance of greater overall highway spending and their desire for greater equity in the highway program (that is, lessening the "donor/donee" issue between the Federal Government and its State and local partners). These factors, coupled with a desire not to pass a law that would increase taxes, led to much debate on the overall size of the program and how it should be structured.

Specific Projects And Programs

SAFETEA-LU authorizes spending on an unprecedented number of specific projects. The largest category of these congressionally designated earmarks is High-Priority Projects, totaling $14.8 billion over 5 years for 5,091 projects throughout the country. The next largest category is Transportation Improvements with 466 projects funded at $2.6 billion.

Lesser amounts are earmarked under other new programs: Projects of National and Regional Significance ($1.8 billion), National Corridor Infrastructure Improvement ($1.9 billion), Freight Intermodal Distribution Pilot ($30 million), designated bridge projects ($400 million), and Nonmotorized Transportation Pilot ($100 million).

A new Equity Bonus Program has three features, one tied to Highway Trust Fund contributions and two that are independent. First, building on TEA-21's Minimum Guarantee concept, the Equity Bonus Program ensures that each State's return on its share of contributions to the Highway Trust Fund (in the form of gas and other highway taxes) ranges from at least 90.5 percent in 2005 to 92 percent in 2009.

In addition, each State is guaranteed a specified rate of growth over its average annual TEA-21 funding level, regardless of Highway Trust Fund contributions. Finally, States meeting certain conditions set in SAFETEA-LU (for example, a median household income of less than $35,000) are guaranteed a share of apportionments and High-Priority Projects not less than the State's average share under TEA-21.

RABA is continued in SAFETEA-LU, but with some changes to avoid the dramatic swings seen under TEA-21. Early in TEA-21's existence, actual revenues accruing to the Highway Trust Fund exceeded projections, resulting in large distributions of additional program funds being made to the States.

Reduced travel by U.S. motorists and a drop in Highway Trust Fund revenues would have required a reduction of the funds available to States if Congress had not acted to prevent it. To even out the swings when calculating RABA, SAFETEA-LU "looks back" at the average of the past 2 years of revenue. Also, SAFETEA-LU allows a negative adjustment only when the balance of the Highway Trust Fund highway account is less than $6 billion.

Raising the Bar on Safety

SAFETEA-LU raises the stature of highway safety by making it a core program tied to strategic safety planning and performance. In the past, highway safety was funded through a 10-percent set-aside from STP, but SAFETEA-LU establishes a separately funded HSIP. Under HSIP, States have flexibility on how to spend the funds, enabling them to target money to their most critical safety needs.

Of the $5.1 billion in HSIP funds available for FY 2006 to 2009, $220 million per year is set aside for the Railway-Highway Crossings Program, with the remainder distributed by formula to the States. Of that amount, $90 million is to be set aside for construction and operational improvements on high-risk rural roads.

HSIP money comes with a condition: States must develop and implement a Strategic Highway Safety Plan (SHSP), a comprehensive plan with specific goals and objectives for reducing highway fatalities and serious injuries. If they complete such a plan by October 1, 2007, States may use HSIP funds for new, eligible safety activities, such as safety-conscious planning, collection and analysis of crash data, integration of emergency communications equipment, and work zone safety projects.

States with SHSPs also can use up to 10 percent of their HSIP funds for behavioral and other safety projects if they meet rail grade crossing and safety needs as defined in their SHSPs. States without SHSPs in place

SAFETEA-LU Core Program Authorizations

	FY 2005–2009 (All numbers in billions)
Surface Transportation Program	$32.5
National Highway System	$30.5
Interstate Maintenance Program	$25.2
Bridge Program	$21.6
Congestion Mitigation and Air Quality Improvement Program	$8.6
Highway Safety Improvement Program (4 years)	$5.1
Core Program Total	**$123.5**

Source: USDOT.

Center for Transportation Research, University of Texas, Austin

SAFETEA-LU makes safety a core program and provides States with funding for projects such as initiatives that promote safety in work zones such as this one.

by the deadline, however, will have their HSIP apportionments frozen at the 2007 level and may use those funds only for railway-highway crossing and hazard elimination projects.

In addition to the core HSIP, SAFETEA-LU creates several programs targeted at specific safety issues. The Safe Routes to School program provides $612 million over the life of SAFETEA-LU for projects to enable and encourage children to walk and bicycle to school. The Work Zone Safety program, funded at $5 million per year beginning in 2006, provides money for work zone safety training and a national information clearinghouse and requires traffic-control devices and high-visibility garments for workers in work zones.

SAFETEA-LU also funds bicycle and pedestrian safety, traffic sign and pavement improvements to benefit older drivers, a study on workplace safety at toll facilities, and a new FHWA Motorcyclist Advisory Council.

Updating Programs For Today's Needs

Other than adding safety as a core program, SAFETEA-LU does not alter the basic structure of the Federal-Aid Highway Program dramatically. Several program modifications, however, deserve highlighting.

Projects eligible for funding under both the NHS and STP programs have been expanded to include environmental restoration and pollution abatement to minimize the impact of transportation projects, control noxious weeds and aquatic noxious weeds, and establish native species. STP eligibility is further expanded to include advanced truckstop electrification systems and mitigation projects at high-crash, high-congestion intersections. Because of the new HSIP, the STP safety set-aside will be eliminated beginning in 2006.

The Bridge Program was broadened to include funds for systematic preventive maintenance, and the previous requirement that bridges must be considered "significantly important" to be eligible for funding was eliminated. The requirement that States spend at least 15 percent of their bridge apportionments on off-system bridges remains, although the upper limit of 35 percent was eliminated.

The Federal Lands Highway Program (FLHP) was modified with some additional eligibilities and flexibilities. New uses of FLHP funds include up to $20 million per year to maintain Forest Highways, $1 million per year to install signs identifying public hunting and fishing access, and $10 million to facilitate the passage of aquatic species beneath roads in the National Forest System.

The FLHP Indian Reservation Roads Program (IRR) was altered too. Tribes may use up to 25 percent of their IRR program funds for system maintenance. An authorization of $70 million is provided for projects to replace structurally deficient or functionally obsolete IRR bridges. IRR funding also may be provided, in accordance with the Indian Self-Determination and Education Assistance Act, directly to a tribal government that has demonstrated financial stability and financial management.

In addition to the $100 million annual authorization to the ER Program mentioned above, SAFETEA-LU authorizes that funds be made available from general fund appropriations in years when ER allocations exceed $100 million. Separate appropriations legislation is required to provide such sums. ER funds help State and local governments cover the expense of repairing serious damage to Federal-aid highways resulting from natural disasters or catastrophic failures.

Finally, SAFETEA-LU creates a number of new highway programs. Among them are the Coordinated Border Infrastructure Program, which is aimed at expediting safe and efficient vehicle and cargo movement at U.S. borders with Canada and Mexico, and the Freight Intermodal Distribution Pilot Program, which will provide grants for State and local initiatives to relieve congestion and improve safety at inland ports and intermodal freight facilities.

Enhancing Transportation Planning

SAFETEA-LU makes several changes in the metropolitan and statewide transportation planning processes established by ISTEA as the primary mechanisms for cooperative transportation decisionmaking in the States. Some changes add flexibility and efficiency, while others add new requirements. The new law identifies safety and security as separate items that should be considered in both the statewide and metropolitan planning processes.

Consultation provisions for States and metropolitan planning organizations (MPOs) are expanded under SAFETEA-LU. The statewide planning process must be coordinated with metropolitan and trade and economic development planning activities. Two or more States may enter

New freight-related programs in SAFETEA-LU include initiatives to expedite vehicle and cargo movement at U.S. borders for container trucks, such as these, and relieve congestion and enhance safety at inland ports and intermodal freight facilities.

into planning agreements to develop transportation projects that span State lines.

The metropolitan planning process must consider environmental mitigation, improved performance, multimodal capacity, and activities that enhance the environmental, cultural, and aesthetic aspects of the transportation system. In addition, tribal, bicycle, pedestrian, and disabled interests must be provided an opportunity to participate in the planning process. The set-aside for metropolitan planning is increased to 1.25 percent, and a new 30-day limit is established for States to reimburse MPOs for planning expenses.

Updates now are required every 4 years for transportation improvement programs (TIPs), documents prepared by MPOs listing transportation projects slated for Federal funding, and statewide transportation improvement programs (STIPs), statewide plans for federally funded highway and transit projects and other priority transportation projects. In the past, updates were required every 2 years.

Leveraging Innovative Financing

To help close the gap between transportation investment needs and funds available from traditional sources, SAFETEA-LU includes several features that can help States leverage innovative sources to fund transportation projects.

SAFETEA-LU provides States with more options to use tolling to finance infrastructure improvements and manage congestion. Over the 5-year period covered by the law, the new Express Lanes Demonstration Program will allow up to 15 demonstration projects across the Nation to use tolling to manage high congestion levels, reduce emissions, or finance additional interstate lanes to reduce congestion. The new Interstate System Construction Toll Pilot Program will allow up to three projects to collect tolls on interstate highways, bridges, or tunnels to fund interstate construction projects.

The law continues the Value Pricing Pilot Program to support the costs of implementing up to 15 variable-pricing pilot programs nationwide to manage congestion and benefit air quality, energy use, and efficiency. A new $12 million set-aside (that is, $3 million per year for each FY 2006 through 2009) must be used for projects not involving tolls.

In addition, SAFETEA-LU adds highway and surface freight transfer facilities to the list of activities eligible for tax-exempt private activity bonds. It modifies the Transportation Infrastructure Finance and Innovation Act (TIFIA), under which USDOT provides credit assistance for transportation projects, by lowering the project cost threshold to $50 million and adding freight rail facilities to the list of eligible uses. It also establishes a new State Infrastructure Bank program that allows all States and U.S. territories to establish investment funds to make loans or provide credit enhancement for transportation projects.

Streamlining the Environmental Process

To address longstanding concerns over the length and complexity of environmental reviews, SAFETEA-LU contains provisions designed to speed up the review process while preserving environmental quality. Although the changes are aimed at streamlining, they include additional steps and responsibilities for transportation agencies.

SAFETEA-LU establishes a new environmental review process for

Metropolitan Transit Development Board

SAFETEA-LU provides States with more options to use tolling to finance infrastructure improvements and manage congestion, as on the tollway shown here.

UDOT

SAFETEA-LU contains provisions to streamline the review process for construction projects while preserving environmental quality. An environmental review process helped the Utah Department of Transportation (UDOT) develop a design to avoid as many springs and peat bogs as possible when constructing an improved road, shown in this aerial photograph, between Mountain Green and Huntsville, UT.

transportation projects that incorporates much of the current state of the practice. This process will apply to new projects advanced with an environmental impact statement (EIS), required under the National Environmental Policy Act (NEPA) for projects that may have a significant impact on the environment, as well as to projects advanced with other environmental documents if USDOT chooses to do so.

To allow State, local, and tribal agencies a more formal role in the environmental process, a new category of "participating agencies" was added. After providing an opportunity for public and interagency involvement, USDOT will define a project's purpose and need and will establish a plan for coordinating public and agency participation. It also will provide, as early as practicable in the process, an opportunity to consider a range of alternatives.

USDOT is required to notify Congress of any issue that cannot be resolved in 30 days that might delay the process. SAFETEA-LU establishes a 180-day statute of limitations on lawsuits challenging Federal agency environmental approvals, but such approvals must be published in the *Federal Register.*

SAFETEA-LU establishes new ways for States to assume responsibility for environmental streamlining. The law allows States, after signing a memorandum of understanding, to assume responsibility for determining whether activities are categorical exclusions (CE) under NEPA. CEs are activities that do not involve significant environmental impacts, so they are excluded from requirements for environmental assessments.

The new law also establishes a project delivery pilot program that allows five States (Alaska, California, Ohio, Oklahoma, and Texas) to apply to USDOT to assume all USDOT environmental responsibilities under NEPA and other environmental laws. This delegated authority could apply to specific highway projects in a State or programwide. Another pilot program will allow up to five States to assume environmental responsibilities for projects to enhance recreational trails.

Among the FHWA staff who played key roles in developing SAFETEA-LU are (left to right) Susan Binder, deputy associate administrator of the Office of Policy and Governmental Affairs; Ross Crichton, leader of the Highway Needs and Investment Analysis Team; and Carolyn Edwards, leader of the Program Analysis Team.

SAFETEA-LU addresses challenges facing the transportation system today, including enhancing safety and reducing traffic congestion, such as on the highway pictured here, and lays the groundwork for meeting future challenges.

Research: A Mixed Message

SAFETEA-LU authorizes $2.3 billion for FY 2005 to 2009 for transportation research programs, which is less than the amount authorized in TEA-21. SAFETEA-LU's research title, Title V, discusses the critical nature of research and development to safety, mobility, economic vitality, efficiency, equity, and environmental protection. It also mentions the meager funding provided for research and how it is in the interest of the United States to increase Federal transportation research and development investment. However, in sharp contrast to TEA-21's programmatic flexibility for research, SAFETEA-LU's Surface Transportation Research, Development, and Deployment Program (STRDD) directs all research funds to designated projects and initiatives.

The surface transportation research program appears to address fundamental exploratory highway research aimed at significant research gaps, emerging issues with national implications, and research related to policy and planning. Exploratory advanced research is a newly authorized program under SAFETEA-LU that has not previously received direct funding authority. All research activities must include performance measurement and evaluation and be outcome based.

Specific features under the new law include strengthening and expanding the operations element in research, including provisions addressing transportation system management and operations, operational methodologies to reduce congestion, transportation security, and asset management.

Research funded under the law includes long-term bridge research, technology deployment, international highway transportation outreach, and transportation research and development strategic planning. Also included are the Surface Transportation-Environmental Cooperative Research Program (STEP), National Cooperative Freight Transportation Research Program, and Future Strategic Highway Research Program (F-SHRP).

SAFETEA-LU also provides funding for training and education through the National Highway Institute (NHI), Local Technical Assistance Program (LTAP), Garrett A. Morgan Technology and Transportation Futures Program, Dwight D. Eisenhower Transportation Fellowship Program, Transportation Education Development Pilot Program, and Transportation Scholarship Opportunities Program.

In addition to funding the STRDD and training and education, SAFETEA-LU provides funding for the Bureau of Transportation Statistics, University Transportation Research, and intelligent transportation systems research and deployment.

Moving Forward With SAFETEA-LU

Even with all of the hard work that went into developing SAFETEA-LU, the job does not stop there. USDOT and FHWA will continue to develop educational materials, courses, and other resources to help State and local agencies understand the complex new law and its many changes and requirements. The SAFETEA-LU Web site at www.fhwa.dot.gov/safetealu/index.htm provides summary information as well as full details on the law.

The largest surface transportation investment in U.S. history, SAFETEA-LU builds on the firm foundation laid by ISTEA and TEA-21. It supplies the funds and refines the programmatic framework for investments needed to maintain and grow the Nation's vital transportation infrastructure.

Furthermore, it promotes more efficient and effective Federal surface transportation programs by focusing on transportation issues of national importance, while giving State and local transportation decisionmakers more flexibility to solve transportation problems in their communities.

Susan J. Binder, deputy associate administrator of the FHWA Office of Policy and Governmental Affairs, provides executive direction and leadership for the agency's policy efforts. She also directs the Office of Legislative and Governmental Affairs, managing development of FHWA legislative proposals, national strategic planning initiatives, and congressional relations activities. She has served in a variety of posts since she joined USDOT in 1975, including administrator of the FHWA Maryland Division. She has a bachelor's degree in consumer economics from the University of Maryland and a master's degree in business administration from The George Washington University.

To learn more about SAFETEA-LU, visit www.fhwa.dot.gov/safetealu/index.htm.

Mileage-Based Road User Charges

As vehicles evolve and burn less fuel, fees assessed for the number of miles actually traveled may prove to be a stable, efficient, and equitable way to finance roads in the United States.

by David J. Forkenbrock and Paul F. Hanley

For almost a century, the motor fuel tax has been the mainstay of highway finance in the United States. This method has the advantage of being roughly proportional to the distance traveled and thus has the desirable attribute of being a pay-as-you-go form of user charge. In several important dimensions, however, motor fuel taxes may not be entirely satisfactory.

In future years, the revenue-generating capacity of the motor fuel tax will be at best problematic. The U.S. Department of Energy predicts that fuel efficiency will improve substantially through 2025, with automobiles achieving nearly 13 kilometers per liter (30 miles per gallon) on average in that year. The California Air Resources Board and the National Research Council also predict substantial improvements in fuel efficiency for the vehicle fleet by 2015 to 2020. Absent substantial increases in fuel tax rates per gallon, receipts are not likely to keep pace with costs.

Further, to help the United States become more energy independent and to improve the air quality in major cities, the auto industry and the Federal Government are working together to design a new generation of vehicles that are either hybrid—a combination of electric and conventional internal combustion power—or are powered by hydrogen fuel cells. Several auto manufacturers also are experimenting with internal combustion engines powered by hydrogen. Various prototype fuel cell vehicles have performed favorably, and hybrid vehicles already have entered the marketplace.

According to industry and trend analysts, Plunkett Research, Ltd., "2004 through 2005 will long be remembered as a pivotal period in the automobile industry. It was a period during which high gasoline prices started a sea change among U.S. consumers that will finally create significant demand for fuel-efficient vehicles."

Although it may be a few years before vehicles with these new propulsion systems become prevalent enough to severely impair motor fuel tax revenues, the day almost certainly will come. In the short run, it may be possible to raise the motor fuel tax sufficiently to offset increases in fuel efficiency of the vehicle fleet, but in the longer term, projections show that the gap will grow between highway needs and highway funding. Therefore, new solutions to road financing will be needed.

According to James March, team leader in the Federal Highway Administration's (FHWA) Office of Transportation Policy Studies, "This is a propitious time to explore a new approach to assessing road user charges—one that will accommodate vehicles with any of the possible propulsion technologies and also facilitate implementation of a variety of public policies related to more equitable and efficient charges for highway use."

Minnesota Lieutenant Governor Carol Molnau, who also serves as the State transportation commissioner,

Even electronic tolls, such as the FasTrak™ collection program in California's Bay area, shown here with traffic backed up at a toll plaza, are subject to congestion. A mileage-based user charge system could make tolls and long lines like this one a thing of the past. *Photo: AAA Foundation for Traffic Safety.*

says that while "the fuel tax has been a reasonable funding source over the years, it may grow less viable as we see extreme variations in vehicle efficiency. Although it may take years to implement a system to replace fuel taxes with a new kind of revenue source, it is our responsibility to take the long view."

Stuart Anderson, director of the systems planning office at the Iowa Department of Transportation, takes a similar view. "As more hybrid vehicles enter the fleet and additional work is underway on alternative fuel vehicles, it is important that new user fee methodologies are evaluated on a national basis," he says.

Indeed, transportation experts say that the broadest view will look beyond user fees to a range of potential revenue sources. "The mileage-based tax is just one of these that could possibly be viable in the future," says Molnau. "There is no simple solution, and there is no single solution."

State and local governments could consider several policy directions that would increase the role played by user charges, including the following:

- Increase the motor fuel tax
- Assess development impact fees
- Implement tolls more aggressively
- Develop an entirely new approach based on vehicle miles traveled

Fuel cell cars, such as the ones lined up here, are still in the development stage, but if they enter the mainstream in significant numbers, they could help make gas taxes obsolete.

DaimlerChrysler

In future years, policymakers will need to evaluate options such as these for characteristics including: fair distribution of cost burdens, ability to provide a long-term stable source of revenue, and capacity to support other social and economic initiatives that local governments may wish to pursue.

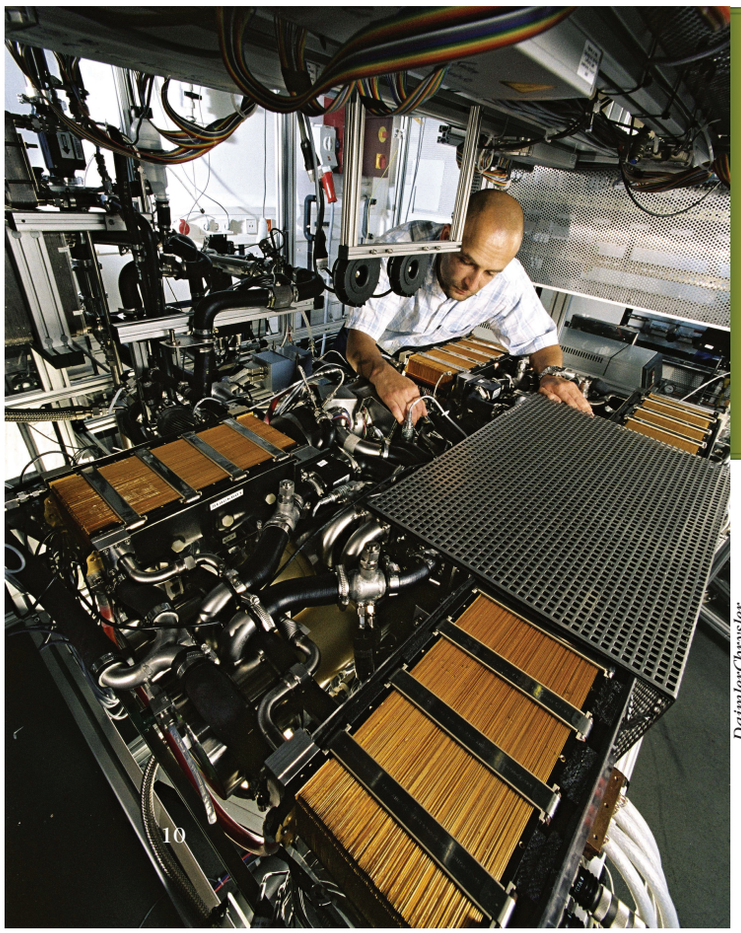
Motor Fuel Tax Increases

Until alternative propulsion systems become commonplace, and if the public-political will exists, one option to generate revenue to support the Nation's transportation systems is to increase Federal and State motor fuel tax rates. The motor fuel tax, however, has proven inequitable. In the *1997 Federal Highway Cost Allocation Study*, FHWA concluded that heavy vehicles underpay for their road use because the damage they do to roads is much greater than the amount paid in fuel taxes, especially when compared to the damage caused by lighter vehicles.

Likewise, *Road Work: A New Highway Pricing and Investment Policy* by Kenneth A. Small, Clifford M. Winston, and Carol A. Evans indicates that for each mile traveled, an 11,793-kilogram (26,000-pound), single-unit, two-axle delivery truck may impose pavement costs 1,000 times higher than caused by an automobile. Although the truck is likely to burn about three times as much fuel per mile, and therefore pay three times as much fuel tax per mile traveled, a substantial cross subsidy from auto drivers to truck operators results.

In a similar vein, an auto traveling in heavily congested traffic imposes delay and environmental costs that are far greater than a comparable vehicle traveling in free-flowing traffic. The former will burn more fuel, but the difference in fuel tax paid generally is far less than the difference in delay and environmental costs imposed. Because the fuel tax is unable to charge individual classes of vehicles or road users at a rate comparable to the costs imposed, various inequities among road users result. Another inequity, for example, is that the jurisdiction in which a vehicle travels and imposes costs may not be the same as where its fuel was purchased and the fuel tax paid.

In *A New Approach to Assessing Road User Charges*, a research team from the University of Iowa concluded that the motor fuel tax is a blunt instrument that is not sufficiently flexible to enable even a simplified form of road pricing. Given the equity problems it creates,



DaimlerChrysler

Any number of variations of alternative fuel vehicles could come online in the years ahead, all crimping the usefulness of the traditional gas tax. Here, a technician works on the engine of a car that uses a combination of hydrogen fuel cells and electric batteries for its propulsion.

Gasoline will continue to be the primary fuel for vehicles for some time, but the emergence of other fuel sources raises questions as to the viability of continuing to rely on the gas tax to fund highway projects.

this tax does not have a promising future from either a revenue generating or a pricing perspective.

Development Impact Fees

In recent decades, economists began to consider development impact fees as a means to finance a portion of the additional roadway capacity required to accommodate new development within a community. A common motivation for levying such fees is to reduce the burden on those who pay the local property tax. These one-time fees require that each new residential or commercial project pay its prorated share of the costs of new or widened arterial streets and roads that will serve the project. This approach has the advantage of placing part of the cost of transportation improvements on those who contributed to the need.

In one sense, development impact fees are equitable because those most likely to use the new facility pay a portion of its capital costs, while others do not. Some researchers, however, note that these fees can be inequitable because they usually do not vary with the value of homes in a development; they only vary with the number of units and therefore the probable amount of traffic to be generated. It is noteworthy that these fees can reduce the affordability of housing for people with limited incomes.

Development impact fees are not a direct user charge because the users of the road improvements do not pay directly on the basis of their actual amount of use. Once constructed, the operation and maintenance costs of the new facilities must be defrayed in the same way as other streets and roads. Because the additional road capacity imposes further operating costs, impact fees do not in themselves constitute a solution to the problem of how to finance the operation of local streets and roads.

Tolls

Tolls have been a part of transportation finance since the colonial period. They have the major advantage of being paid only by actual users of a road. In the United States, toll roads in Kansas, Massachusetts, New Jersey, New York, Ohio, and Pennsylvania, to name a few, have been operating for a half of a century or more. Other States including California and Florida also have added toll roads more recently. In urban areas, a growing number of tolling applications are designed as road pricing mechanisms. High-occupancy toll (HOT) lanes, for example, were implemented in San Diego on I–15; in Orange County, CA, on S.R. 91; in Houston on the I–10/Katy Freeway and U.S. 290; and in Minneapolis on I–394. A 274-kilometer (170-mile) HOT lane network is planned for the Washington, DC, metropolitan area as well.

HOT lane pricing enables vehicles with several occupants to drive free or pay a lower toll when traveling in a designated lane. If drivers of vehicles that do not meet occupancy requirements (such as solo drivers or two-person carpools in HOV-3 lanes, or single-occupant vehicles in HOV-2 lanes) wish to travel in this lane to avoid congestion, they must pay a toll that varies with prevailing traffic conditions (in San Diego, toll rates can change as frequently as every 6 minutes). Those traveling in other lanes do not pay a toll, but they must contend with congestion during peak travel periods.

Public response to HOT lanes on the aforementioned facilities generally has been favorable. In San Diego, for example, a telephone survey of 800 motorists who used the I–15 HOT lanes revealed an approval rating of about 90 percent. Early concern was that the tolled lanes would benefit mainly travelers who have comparatively high incomes, becoming so-called "Lexus lanes." In many cases, however, travelers with limited resources have benefited from HOT lanes by carpooling. Although tolling has significant potential, three problems may hamper the prospect of increasing the role of toll revenues in financing urban streets.

First, particularly in urban areas, the potential exists for traffic to divert from freeways and expressways with tolls to city streets without them, especially when these streets are parallel or would constitute shortcuts. Traffic diverting to routes through residential neighborhoods can endanger residents and perhaps increase traffic and congestion.

Second, double payment—tolls levied in addition to the motor fuel tax paid by all highway users—can constitute an inequity unless the facility on which they are paid offers superior service, in which case the toll becomes a form of surcharge. Equity also may be violated if tolls collected on only part of a road system are regarded as a means for financing the entire system.

Third, tolling has limitations as a pricing mechanism. Because only a small portion of the urban road system can support tolling, it cannot be used to price individual segments across a road system to encourage heavy vehicles to use appropriate facilities, discourage commuters from traveling through residential areas, or encourage use of fuel-efficient vehicles.

AAA Foundation for Traffic Safety

Like gas taxes, toll plazas like this one could become obsolete if mileage-based user charges were to come into widespread use.

Mileage-Based User Charge

With the advancement of global positioning system (GPS) and geographic information system (GIS) technology, a new approach to directly charge users has become more feasible. Now it is possible to accurately assess road user charges on the basis of the number of miles actually traveled. On behalf of the FHWA-sponsored Transportation Pooled Fund Program, which comprises representatives of FHWA and 15 State departments of transportation (DOTs), a research team at the University of Iowa developed a prototype mileage-based road user charge. The mileage-based approach is equally workable with any type of vehicle propulsion system, whether gasoline, electric, or fuel cell. (For more information, visit www.pooledfund.org.)

Functionally, mileage-based road user charges have attributes similar to electronic tolls, but assessing them on lower standard facilities such as city streets and lower volume rural roads is more feasible. Whereas electronic toll roads use "smart road" and "dumb vehicle" technology (roadside readers and passive identification labels on vehicle windshields), the opposite is true with mileage-based charging approaches. The process of determining user charges is independent of the roadway, with all the necessary equipment residing on board the vehicle. Therefore, it would be feasible to charge for travel on all roads within a jurisdiction without the need for any roadside devices, and tollbooths could be eliminated. Controlling agencies also could vary the charge by type of road or vehicle.

Installing the necessary equipment during production would not be costly. "Under a mass production scenario, the unit cost of installing the requisite onboard equipment could be quite low, under $50," says Professor Jon Kuhl of the University of Iowa, "given that in a few years most new vehicles are likely to feature GPS receivers and given that the other necessary equipment is fairly simple."

As determined by research for the FHWA-State DOT consortium, a basic receiver on board the vehicle uses GPS signals to determine its position, and the computer reconciles this position with a GIS file. The GIS file contains polygons that define State, county, and municipal political boundaries and enable the onboard computer to determine the jurisdictions within which travel has occurred. The computer, which contains a file with the charge rates per mile for participating jurisdictions, computes and stores the user charges based on the miles traveled within each polygon. When a vehicle crosses into another jurisdiction, it enters a different polygon, and travel within that polygon is charged accordingly.

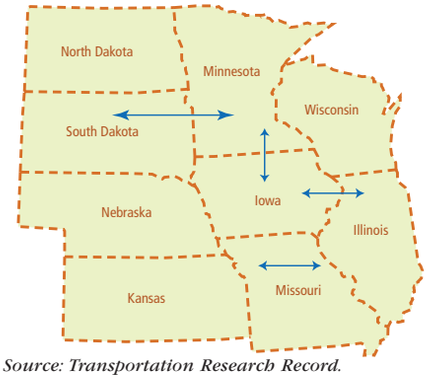
Protecting Privacy

Transportation officials need to consider three important issues and opportunities when considering implementing a mileage-based road user charge: (1) protection of the privacy of road users, (2) parallel operation of the motor fuel tax and the mileage-based road user charge as the vehicle fleet turns over, and (3) simultaneous pursuit of other policy initiatives.

If mileage-based road user charges have an Achilles' heel, it is the public's concern that the Government will track people's movements. That concern is not without merit: various services available from auto manufacturers involve transmission of cellular signals that enable the service provider to know the exact location of a participating vehicle at all times. If a similar type of technology were used, it indeed could be an affront to those who prefer that government agencies or their contractors not be able to determine their location and movements.

A mileage-based user charge system would rely on GPS technology, by which satellites, such as the one depicted here, would provide signals that onboard vehicle systems could use to measure travel, and fees would be assessed according to the roads traveled and the jurisdictions in which the roads are located.

Boeing



Source: Transportation Research Record.

This large-scale map shows data polygons for several Midwestern States. The boundary of each State would be defined in the GIS database in the onboard computer. Each State thus constitutes a data polygon, indicated by the dotted lines outlining the State borders. Travel within a State would be measured by the GPS receiver, and the appropriate per-mile charge would be applied as this travel occurs. When a vehicle crosses into another State, travel in it would be treated in the same way. Thus, what would be stored in the computer is the dollar amount owed to each State. The arrows indicate trips, either within or between States.

Research completed for the consortium shows that for a mileage-based user charge to work well, it is not necessary for a vehicle's location to be transmitted on a real-time basis. Further, it is not even necessary to store information that constitutes a record of where the vehicle is or has been. The only data that need to be stored are the dollar amounts owed to each jurisdiction in which travel has occurred. While the only identifiable data value will be the total amount owed for all jurisdictions, through encryption, anonymous information will be uploaded that specifies the jurisdictions to which the revenue is to be distributed. Therefore, a mileage-based user charge could in fact guarantee privacy protection while ensuring that the user charges collected are directed to the jurisdictions in which travel has occurred. There are tradeoffs between the need for privacy and the need for taxpayers to be able to verify the accuracy of charges. In the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), there are provisions to perform field tests on this type of user charge.

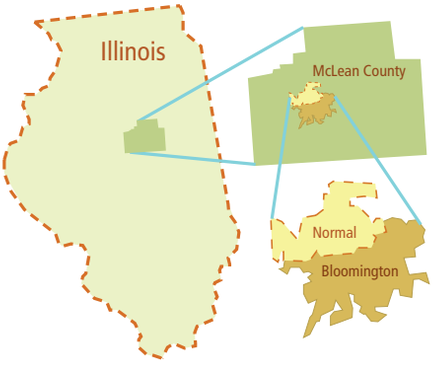
Parallel Operation

As a practical matter, retrofitting existing vehicles with the onboard computer, GPS receiver, and associated equipment generally would not be feasible. It would be relatively expensive to the vehicle owner, and because the onboard equipment would not be fully integrated with the vehicle's electrical system, tampering with or disabling it would be difficult to prevent. The central issue thus becomes how best to proceed with two very different approaches operating side by side as the vehicle fleet turns over.

Using production forecasts and scrappage data, the research team at the University of Iowa Public Policy Center concluded that if, beginning with the model year 2005, all new autos and trucks sold were equipped with the onboard computer necessary to implement the mileage-based user charge, by 2015 almost two-thirds of the autos in operation would be so equipped. By 2025 almost 95 percent of autos would be capable of supporting the mileage-based user charge. The researchers estimated comparable but slightly lower percentages for trucks.

One of the most pressing issues related to phasing in a mileage-based user charge, as it applies to conventional gasoline- and diesel-powered vehicles, is how to handle the payment of the motor fuel tax. On the one hand, motorists may argue that it would be unfair for conventional vehicles to pay both the fuel tax and a per-mile user charge. On the other hand, care must be taken to prevent fraudulent nonpayment of the motor fuel tax by operators of conventional vehicles.

One way to address this issue is for vehicles with the onboard equipment supporting the new approach to have a simple in-vehicle system to monitor fuel intake during refueling. The onboard computer would take note of the number of gallons of fuel transferred and the jurisdiction in which the fuel was purchased. A small data file stored in the onboard computer could contain the applicable motor fuel tax rates for all jurisdictions. Through a simple computation, the onboard computer could store a credit for motor fuel taxes paid, which would be applied against the total per-mile user charges due to the jurisdictions.



Source: Transportation Research Record.

This smaller scale map shows data polygons for a State, county, and municipality. The figure highlights the capacity to assess a mileage-based user charge at the State level and supplement it with local charges at the county or municipal level. Vehicles traveling within a locally defined polygon would pay the State per-mile rate and that assessed by the metropolitan area, county, or municipality. To finance its streets and roads, a participating community would be able to rely on user charges paid by all travelers within it and depend much less on nonuser taxes, such as sales or property taxes.

Policy Initiatives

A mileage-based user charge system would need to be designed with sufficient flexibility to facilitate pursuing other public policy objectives as well. Road pricing, for example, is one method that road managers could consider for promoting more efficient traffic flow as well as greater equity among road users (that is, user charges that more accurately reflect the costs that specific classes of users impose). Mileage-based road user charges could facilitate the following forms of local road pricing:

Cost Recovery. As documented in the FHWA Federal Highway Cost Allocation Study, the cost imposed by heavy vehicles varies greatly with the type of road traveled. Charging a higher per-mile rate for lower standard roads helps recover the higher costs, and it can encourage the operators of heavy vehicles to use roads that are better able to accommodate them. The potential for

New Auto and Truck Sales in United States, 1980–2000

Year	Autos	Light Trucks	Medium-to-Heavy Trucks	Total
	(Millions of Units)	(Millions of Units)	(Millions of Units)	(Millions of Units)
1980	8.979	1.964	0.268	11.211
1990	9.300	3.984	0.278	13.562
1995	8.635	5.703	0.388	14.726
2000	9.005	8.405	0.462	17.872

Source: U.S. Census Bureau and Automotive News.

Estimated New Vehicle Sales and Scrappage in United States, 2005–2025

Year	New Auto Sales	Autos Scrapped	New Truck Sales	Trucks Scrapped
	(Millions of Units)	(Millions of Units)	(Millions of Units)	(Millions of Units)
2005	8.5	8.0	9.0	6.2
2010	8.5	8.0	8.8	6.1
2015	9.0	8.5	9.1	6.2
2020	9.0	8.5	9.2	6.3
2025	9.0	8.5	9.2	6.3

Source: Public Works Management & Policy, *October 2005.*

Estimated Number of Autos and Trucks in Use in United States, 2005–2025

Year	Total Autos In Use	Percent Autos Year 2005 or Newer	Total Trucks In Use	Percent Trucks Year 2005 or Newer
	(Millions of Units)	(Millions of Units)	(Millions of Units)	(Millions of Units)
2005	130.2	6.5	85.6	10.2
2010	130.7	33.4	102.7	31.3
2015	131.2	62.7	123.1	58.8
2020	131.7	83.2	147.6	79.0
2025	132.2	94.4	177.0	91.4

Note that sport utility vehicles and minivans are classified as light trucks and therefore are included in the truck totals. Source: Public Works Management & Policy, *October 2005.*

savings in road repair and reconstruction is considerable.

Traffic Reduction. In some communities during rush hours, arterials become congested and impatient motorists may cut through residential areas to save time. Heavier, relatively fast traffic on residential streets can pose dangers to children and other residents. By charging a relatively high per-mile rate on residential streets, particularly during peak hours, road managers could discourage cut-through traffic.

Congestion Management. According to FHWA, the Texas Transportation Institute, and others, traffic congestion is a steadily increasing problem facing most large metropolitan areas. In addition to policies such as greater investment in public transportation and more sustainable land use patterns, road pricing is a way of encouraging higher vehicle occupancies and trip shifts away from peak periods. Experiences in such applications as I–15 in San Diego suggest that public acceptance of this type of pricing may be increasing. To the extent that this is the case, road managers could readily structure a mileage-based road user charge to support congestion pricing.

Facilitating Privately Financed Commuter Routes. Privately financed facilities become much more feasible with a mileage-based road user charge. Revenue collected on private facilities could be directed to the firms operating them. Multiple points of entry and departure would pose no problem, and toll collection facilities would be unnecessary.

Encouraging Use of Environment-Friendly Vehicles. Transportation officials and local decisionmakers could encourage use of alternative fuel vehicles by charging a lower per-mile rate for environmentally friendly vehicles or those that are fuel efficient. Each vehicle could be assigned to one of several categories based on fuel efficiency and/or level of criterion emissions as defined by the U.S. Environmental Protection Agency. At its discretion, a State or

Mileage-based user charges would allow for tiered fees, such as a higher rate for large trucks like the one shown here, since they cause disproportionate wear and tear on roads, something not accurately accounted for in gas taxes.

AAA Foundation for Traffic Safety

Traffic and congestion like this could be better managed through mileage-based user charges, proponents say.

metropolitan area could assign a different per-mile rate to each of the vehicle categories.

Improving Transportation Planning. Travel demand models are among the most important tools for transportation planning because they help analysts understand where travelers begin and end their trips. According to Professor Edward Beimborn of the University of Wisconsin-Milwaukee, current models have many serious limitations, including the quality of travel data that are fed into them. For one thing, behavioral elements (such as trip-chaining, which involves making multiple stops on a single trip) need to be more accurately represented. A mileage-based approach to assessing road user charges has the potential to provide origin-to-destination and route data that are dramatically better than those currently used in travel demand modeling. A system that collects only the necessary billing information from all motorists but offers the option of tying into the travel data collection system in return for minor reductions in user fees would provide enough detailed data to greatly improve analyses while protecting privacy.

Conclusion

A mileage-based road user charge would offer a means of generating a stable revenue stream that would be unaffected by the method of vehicle propulsion. Once implemented, the system would entail a low cost of collection for both agency and users, and it could provide road users with improved information on the costs they impose on the road system. A mileage charge also would allow flexibility in pursuing a variety of public policy objectives. This system could facilitate pursuing other initiatives such as congestion pricing, privately operated tollways, lane-specific user charges to encourage carpooling, pricing to encourage use of environment-friendly vehicles and to reflect road damage imposed by different classes of vehicles, improved travel demand analyses, and a shift of the financial burden for roads from property owners to road users.

Although not without its challenges, this new form of road financing has the potential to be a powerful tool for road managers to consider when forming Federal, State, and local transportation policy.

David J. Forkenbrock is director of the Public Policy Center and professor of urban and regional planning and civil and environmental engineering at the University of Iowa. His research focuses on transportation finance and policy initiatives to advance social and economic objectives. For the past 7 years he has led a research team to develop and test a multijurisdictional mileage-based road user charge. He now is leading a team that is conducting a national evaluation of this form of user charge.

Paul F. Hanley is an assistant professor of urban and regional planning and civil and environmental engineering at the University of Iowa. He also holds an appointment as a research faculty member at the Public Policy Center. His research focuses on transportation infrastructure investments as a policy tool. He is a member of the national mileage-based road user charge evaluation study team.

For more information, see http://ppc.uiowa.edu/dnn4 or contact David J. Forkenbrock at david-forkenbrock@uiowa.edu.

Mileage-based user charges could be set up to encourage use of environment-friendly vehicles, such as the vans shown here fueling up on cleaner burning natural gas.

American Honda

The evolving energy sector offers potential ramifications far beyond the gas tax. Shown here is one car manufacturer's prototype for a system that would power both a home and a vehicle.

This article is the fourth in a PUBLIC ROADS series on innovative financing. One of FHWA's priorities is encouraging the use of innovative financing.

Preservation Act

by Earl E. Dubin

Whether they swing, retract, or are raised, New York City's movable bridges are receiving a much-needed dose of care.

Of the nearly 600,000 bridges listed in the Federal Highway Administration's (FHWA) 2004 National Bridge Inventory, close to 1,000 fall into the category of movable spans. As the name suggests, movables can rise, pivot to the side, or even slide away to accommodate boat traffic on the rivers below.

Movable bridges are common sights in rural areas such as upstate New York, where a dozen or so cross the Erie Canal. Likewise, they are familiar fixtures along the Nation's shorelines, spanning the Intracoastal Waterway. And they are workhorses in metropolises such as Chicago and New York City. In short, movable bridges are small in number compared to their more numerous fixed cousins, but they fulfill the important role of spanning navigable waterways in areas where development or other constraints preclude the construction of a fixed high-level bridge.

Of course, all bridges must be properly maintained to withstand the forces of heavy traffic, weather, aging, and other factors that can weaken their structural integrity. Movable bridges, however, must endure the additional stresses of motion. New York City has found an effective way to address this challenge.

"An essential component of keeping movables in good working condition is a multidisciplinary team of engineers and maintenance personnel knowledgeable in structural, mechanical, and electrical engineering," says Dave Hart, senior area engineer with FHWA's New York Division. "New York City has found that balanced approach."

Movables in New York City

Both types of bridges—fixed and movable—helped to create New York City's reputation as one of the world's foremost urban centers. Engineering marvels such as the Brooklyn Bridge, George Washington Bridge, Verrazano-Narrows Bridge, and others join New York's many boroughs and suburbs, enabling motorized vehicles, trains, bicycles, and even pedestrians to travel safely each day. The bridges connect the city, as a thriving center of commerce, with the broader U.S. economy.

Within the New York City Department of Transportation's (NYCDOT) inventory of more than 2,000 bridges are 25 movable spans that serve a critical role, accommodating more than 1 million daily vehicle crossings. To ensure the safe passage of traffic, both on streets and waterways, the movables must be maintained in prime working condition.

A Few Tons of Prevention

To address the structural, mechanical, and electrical needs of its movable bridges, New York City has implemented an aggressive reconstruction and rehabilitation program. During the next 10 years, it will spend an estimated $1 billion in city, State, and Federal funds, based on estimates from NYCDOT, to rehabilitate and reconstruct most of the movable bridge inventory.

Federal highway bridge funds are important to the successful rehabilitation and replacement of the city's movable bridges. In cooperation with FHWA and the New York State

(Above) The Third Avenue Bridge, shown here, carries nearly 70,000 vehicles per day from the Bronx into Manhattan over the Harlem River. The bridge is an example of a type of movable bridge called a swing span. *Photo: Raymond Moran, PE, Parsons Brinckerhoff Construction Services, Inc.*

New York City Movable Bridges by Location and Type

	PROJECT NAME	TYPE	STATUS	CONST. YEAR	ESTIMATED CONST. COST ($ millions)	AVERAGE DAILY TRAFFIC
1	Willis Ave.	Swing	Design	2007	319	74,700
2	Third Ave.	Swing	Const.	2001	119	47,053
3	Madison Ave.	Swing	Completed	2003		48,723
4	145th Street	Swing	Const.	2004	69	25,994
5	Macombs Dam	Swing	Const.	1999	137	40,558
6	University Heights	Swing	Completed	1984		47,350
7	Broadway	V. Lift	Design	2011	22	35,190
8	Unionport	Bascule	Design	2007	38	60,908
9	Pelham	Bascule	Design	2011	100	18,292
10	Eastern Blvd.	Bascule	Completed	1994		178,724
11	Hutchinson River Pkwy.	Bascule	Completed	1989		119,029
12	Wards Island	V. Lift	Design	2012	13	n/a
13	Hamilton Ave.	Bascule	Const.	2005	55	60,240
14	Ninth Street	V. Lift	Completed	2003		10,216
15	Third Street	Bascule	Design	2015		9,846
16	Carroll Street	Retractile	Future Design			1,099
17	Union Street	Bascule	Future Design			4,399
18	Metropolitan Ave.	Bascule	Const.	2003	31	38,529
19	Greenpoint Ave.	Bascule	Completed	1985		28,437
20	Grand Street	Swing	Future Design			13,459
21	Borden Ave.	Retractile	Future Design			15,765
22	Hunter Point Ave.	Bascule	No work planned			6,885
23	Mill Basin	Bascule	Design			145,760
24	Pulaski	Bascule	No work planned			40,146
25	Roosevelt Island	V. Lift	Design	2006	55	9,100
	Total				**958**	**1,080,402**

Source: NYCDOT.

Department of Transportation (NYSDOT), the city implemented an aggressive preventive maintenance program for four fixed East River Bridges (see "Protecting New York City's Bridge Assets," PUBLIC ROADS, May/June 2005). As part of the next phase of the program, a contract will be granted to perform preventive maintenance on the city's movable bridges, including lubrication and maintenance of mechanical gears and components, cleaning and repainting of structural members, and upkeep of vital electrical motors, control panels, and other electrical components.

"The extension of the city's East River Bridges preventive maintenance plans to the movable bridges was a logical next step," says FHWA's Hart. "The city and FHWA are spending a lot of money to rehabilitate and replace these bridges. It's important to protect our investment, and the development and implementation of a well-thought-out preventive maintenance plan is the best way to do that."

Beyond a Fixed Inspection

The inspection and maintenance of mechanical and electrical components provide two of the more significant challenges in any movable bridge rehabilitation or replacement plan. The National Bridge Inspection Standards (NBIS) inspection procedures were developed when the failure of critical structural components led to significant and often tragic events. For example, overall requirements for bridge inspection programs came into existence after the December 1967 collapse of the Silver Bridge between Gallipolis, OH, and Point Pleasant, WV, which killed 46 people. Likewise, the June 1983 Mianus River Bridge collapse in Connecticut resulted in inventory and inspection guidelines related to fracture-critical requirements. And the April 1987 collapse of the Schoharie Creek Bridge in New York State gave rise to new guidelines for underwater inspection.

In the past, the NBIS did not contain specific requirements for the inspection of mechanical and electrical components. Recent NBIS revisions now require the development of a comprehensive plan for the inspection of complex bridges (including movables). These revisions suggest that mechanical and electrical components should be inspected as part of a regular bridge inspection program.

According to the first edition (1998) of the American Association of State Highway and Transportation Officials' (AASHTO) *Movable Bridge Inspection, Evaluation, and Maintenance Manual*, inspection frequency requirements for structural components of fixed bridges also should apply to mechanical and electrical components of movable bridges. But in many cases, team leaders, who are structural engineers, carry out inspections of the mechanical and electrical components as well. These inspectors receive little instruction in how to determine whether mechanical and electrical components are functioning properly. Typical inspections involve nothing more than performing a bridge opening and listening for unusual noises such as grinding or banging.

The AASHTO manual encourages a visual check of mechanical and electrical components during

routine inspections without major disassembly, depending on the condition of the components. The guidelines do encourage, however, a more indepth inspection of those components approximately on a 6-year cycle. According to AASHTO, this inspection should be more extensive and involve disassembling mechanical components, measuring shaft and gear clearances, testing electrical components, and conducting other tests using nondestructive testing equipment.

Of equal importance is interpretation of inspection data by a multidisciplinary team that includes structural, mechanical, and electrical engineers. In addition, as more and more drive systems are computerized, engineers who understand those types of systems should be an integral part of the team.

Currently, the attention given to the inspection of mechanical and electrical components varies from State to State and from owner to owner. According to Dan Byer, bridge engineer in the FHWA New York Division, results of a recent survey by the division show that "we have a long way to go in developing and implementing consistent inspection practices for these types of bridges."

He adds, "Recent NBIS revisions require the development of inspection procedures for complex bridges, including movables. However, it remains to be seen how movable bridge owners will respond to these revisions and if more consistent inspections of mechanical and electrical components occur nationwide."

Regardless of the current state of practice, a viable inspection program must work hand-in-hand with the owner's maintenance activities. For NYCDOT, these activities are closely interwoven.

Maintenance, Rehabilitation, And Replacement Responsibilities

In addition to meeting the demands of the traveling public, NYCDOT must carry out U.S. Coast Guard

Types of Movables

Movable bridges are categorized as four basic types: bascule, vertical lift, swing, and retractable. A few distinguishing features of each type include the following:

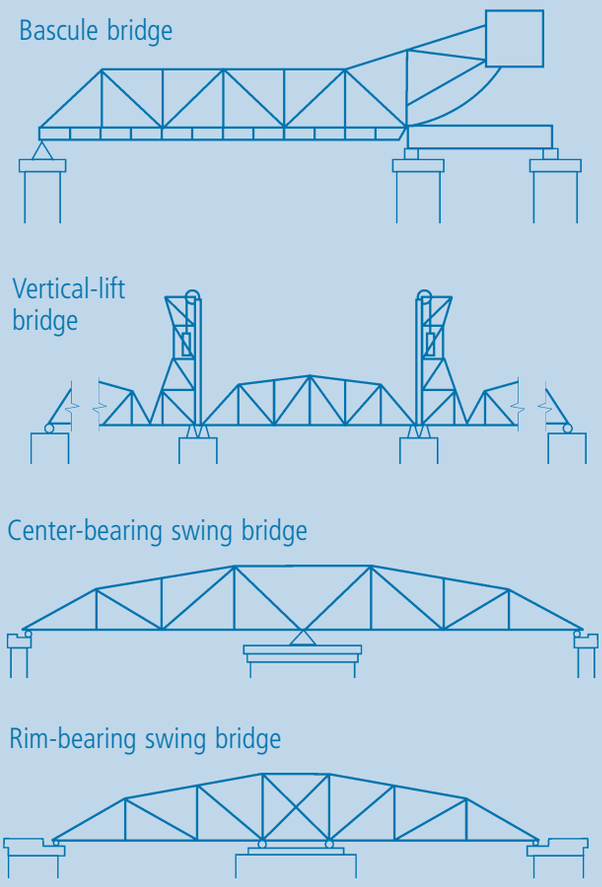
Bascule—In layman's terms, the bascule is a drawbridge. Some have two sections that open from each end of a bridge, and others have a single piece that opens from one end only. Either way, the moving section(s) often reach a nearly perpendicular position when fully opened.

Vertical Lift—The movable roadway or walkway portion rests between two towers on either end of the bridge. Cables attached to large drums in the towers raise and lower the bridge with the help of counterweights.

Swing—From the bird's eye viewpoint, the swing bridge pivots on a fixed axis (usually at the center point) from its normal position perpendicular to a waterway to a position running nearly in the same direction as the river or stream.

NYCDOT

The bridge shown here is an example of a swing span.



All diagrams: Virginia Transportation Research Council.

regulations that require movable bridges to be opened to navigation either on demand or according to an agreed-upon schedule. These regulations require NYCDOT to maintain an aggressive maintenance, rehabilitation, and replacement schedule to ensure that all bridge components function reliably.

The responsibility for maintenance, rehabilitation, and replacement of movable bridges rests with NYCDOT's Bureau of East River Bridges/Movable Bridges/Tunnels. Within the bureau's Movable Bridge Design section, approximately 25 engineers, technicians, and support staff work out of two floors of a lower Manhattan high-rise office complex. The skills needed for the job cover a wide range of expertise and experience.

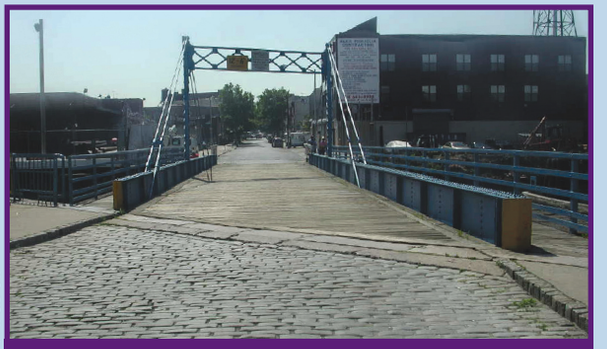
"Within my design staff," says section director Balram Chandiramani, "I look for engineers with training in civil, mechanical, and electrical fields as it pertains to design of structures, power transmission, and modern electrical controls. My team consists of engineers and technicians at various levels of experience and education, from entry level up to project managers."

Working closely with Chandiramani's staff are maintenance engineers and personnel from the Bridge Maintenance, Inspections, and Operations division. "This division offers a multitalented resource that adds a wealth of global know-how to the program," says Russ Holcomb, NYCDOT deputy chief engineer for bridge maintenance, inspection, and operations.

"The New York City Department of Transportation is fortunate to have an in-house force of professional engineers, ironworkers, electricians, and other tradesmen," Holcomb adds. "Many were trained or practiced overseas, making the bureau a truly world-class organization. Specialized training, new hires, and outreach to recent graduates provide a proper mix of established and innovative practices to NYCDOT's knowledge base. The specialized knowledge and skills help keep the bridges operational, ensuring compliance with Coast

Retractable (or Retractile)—The retractable originally used many design principles, as well as components, from the railroad industry. Underneath the retractable section, the bridge's load-bearing beams rest on railroad train wheels. Steel cables attached to the structure pull, or retract, the bridge horizontally into a clear area adjacent to the span, creating an open crossing over the channel. To close the span, the drive motors are reversed.

According to NYCDOT, the United States has only three nonfloating retractable bridges, and two of them are owned by New York City. Those two bridges, which were built in the late 1800s and early 1900s, are still in operation. One of them, Brooklyn's 50-meter (165-foot)-long Carroll Street Bridge, carries one 5-meter (17-foot) roadway. NYCDOT maintenance crews recently rehabilitated the bridge, which was designated as a New York City Historic Landmark in 1987.



NYCDOT

The Carroll Street Bridge over the Gowanus Canal in Brooklyn is the oldest operating retractile bridge in the country.

NYCDOT

A pair of steel cables attached to pulleys (above, right) pulls the Carroll Street Bridge roadbed (left) away from the Gowanus Canal to enable water traffic to pass without obstruction. The pulley direction is reversed to move the roadbed back into place.

NYCDOT

A set of railroad-type wheels under the bridge rolls the structure's roadbed away from the canal to create a clear channel for water traffic.

Guard regulations with minimal impact on marine traffic."

New York City tries to address component deficiencies in the movable bridges with a program of scheduled electrical and mechanical maintenance tasks. The current maintenance program is run by NYCDOT staff but will be supplemented with contract personnel in the future. In addition to addressing existing maintenance of components, the program provides an opportunity for maintenance engineers and staff to observe that these elements are functioning properly.

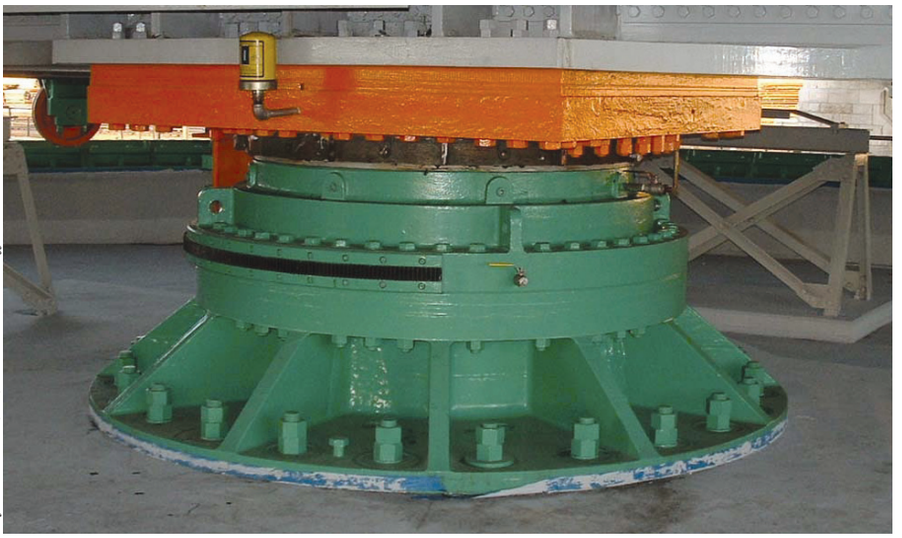
This program supplies detailed information on the condition of a host of mechanical and electrical components. This information, coupled with the work of the city's bridge inspection and management unit, provides Chandiramani's staff with detailed data for assessing the existing needs of the city's bridges. These inspections then can be used to identify components in need of future repair or attention.

Balancing Needs

According to the AASHTO movable bridge maintenance manual, the balance system is one of the most important, yet often overlooked, design features of movable bridges. A poorly balanced movable span puts excessive loads on the machinery components of the bridge, reducing the life of the components and jeopardizing the proper functioning of the structure.

Balancing the movable spans is therefore a key maintenance and operational component. "In addition to performing routine electrical and mechanical maintenance tasks, our engineers use electronic instrumentation, such as strain gauges, to monitor the balance of the movable bridges," says Holcomb. These gauges are installed on drive shafts and other mechanical components to determine if they are being overstressed due to load imbalance. If a bridge is determined to need balance adjustment, this can be accomplished by the addition or removal of concrete, steel, or lead blocks from hollow chambers within the counterweights.

"The leaves of the bascule bridges [drawbridges] are very sensitive to changes in the movable span's dead load [that is, the bridge's own weight]," Holcomb says. "Structural repairs, system upgrades, even accumulations of roadway debris can alter the balance of the bridge, putting additional stress on the machinery [that moves the bridge] and reducing the service life of those components. NYCDOT's balance monitoring program reduces that risk by identifying bridges in need of balance adjustment."



Raymond Moran, PE, Parsons Brinckerhoff Construction Services, Inc.

This photo shows the pivot-bearing assembly for the Third Avenue Bridge. When the bridge is opening, the entire weight of the swing span rests on this assembly, which is believed to be the largest pivot-bearing assembly ever used for a swing bridge.

In the case of vertical lift bridges, steel cables anchored to the lift span extend up the lift towers and over large gear wheels, called sheaves. The other end of the cables is attached to large concrete counterweights that assist the drive system when the bridge is raised or lowered by counterbalancing the weight of the lift span. However, unlike bascule bridges, the weight of the lift span of a vertical lift bridge changes as the bridge is raised or lowered. As the lift span is moved and the cables connecting it to the counterweight pass over the sheaves, auxiliary weight is needed to compensate for the weight of the cable now on the counterweight side of the sheave. On large vertical lift bridges, these lifting cables can weigh many tons, thus creating potential imbalance during the lifting process. Balance chains therefore are installed to provide auxiliary weight to compensate for the weight of the lifting cables. Proper balance of vertical lift bridges is critical to ensure that the bridge remains level as it is raised and lowered. If the lift span tilts (skews), it could become jammed, a complex and difficult condition to resolve.

Third Avenue Swing Shift

Sometimes maintenance and rehabilitation are not enough, and replacement becomes necessary. One of the NYCDOT projects, the replacement of the Third Avenue Bridge, used fast-tracked construction techniques to place an innovative new swing span over the Harlem River. Floated into place in October 2004, the new structure replaces a span built in 1898.

Each day, the five-lane Third Avenue Bridge carries more than 70,000 vehicles across the Harlem River from the Bronx into Manhattan. Measuring 107 meters (350 feet) long and 27 meters (88 feet) across, the main movable span pivots on bearings to provide two channels for river traffic.

In the past, most swing bridges of this size employed a rim-bearing type of construction that traveled on a large number of tapered rollers or wheels that rested on a curved or circular rack positioned around the center of the swing span. With this method, the bridge's dead load is transferred through the rollers into the rack and then into the pivot pier as the bridge opens.

The Third Avenue swing span, however, relies on a center pivot-bearing assembly that transfers the entire dead load of the span directly to the pivot pier. This assembly

Raymond Moran, PE, Parsons Brinckerhoff Construction Services, Inc.

This photo, taken south of the existing Third Avenue Bridge over the Harlem River, shows large, self-propelled transport units used to position the new swing span for transfer to two barges.

houses a spherical roller thrust bearing that supports the 2,721-metric-ton (3,000-ton) swing span and can resist the impact forces associated with the operation of the bridge plus horizontal forces due to a seismic event. The bearing assembly is large, with an overall height of nearly 1.5 meters (5 feet) and a base diameter of about 3 meters (10 feet).

"A spherical roller thrust bearing was selected because it provides several significant advantages," says Sean Bluni, structural designer at Hardesty & Hanover, LLP, who designed the structure and provided construction support. "Its low coefficient of friction decreases the power required to open and close the swing span, which results in smaller, less expensive drivetrain components. In addition, the physical layout of the bearing with a hollow cavity through the middle allows for the main electrical cables to pass through its center, which protects and consolidates the power and control wiring. The load-carrying capability of the bearing allows for high thrust loads and moderate radial loads, which simplified the design details, allowing the compact assembly to take periodic horizontal seismic loads that would otherwise need to be resisted by special seismic restraining fixtures. The spherical roller thrust bearing designed for this project is believed to be the largest, in terms of load-carrying capacity, ever used for a center bearing swing span."

The removal and installation process is known as float-in and float-out, which is being used more and more in accelerated bridge construction. The old structure is removed by cutting it into sections and setting it on barges for removal from the site. The new swing span is then floated into place, thus accelerating the construction schedule over traditional disassembly and assembly techniques.

With the Third Avenue Bridge, the innovative center pivot-bearing assembly allowed for a simpler float-in of the swing span structure, which was constructed in Alabama and shipped by oceangoing barge to New York City. Upon arrival, the 15,419-plus metric ton (17,000-plus ton) replacement was transferred from the ocean barge to two smaller barges before being placed onto the pivot pier. While docked at staging areas adjacent to the bridge, the new main span was secured on four multitracked, self-propelled transport trailers. Then the ocean barge was moved to the middle of the navigation channel and secured to the north and south banks. The two smaller transfer barges were brought alongside the ocean barge and secured. The transport units then turned the swing span 90 degrees. Finally, river water was pumped into the main barge, thus lowering the swing span onto support systems on the smaller barges.

According to Sam Scozzari, a senior engineering manager at the construction firm of Parsons Brinckerhoff, the entire placement process took approximately 6 hours. "The project team was confident of the engineering that went into the transfer process," says Scozzari. "It was a team effort that involved the contractor's engineers and the NYCDOT design team. Float-ins of these types of spans are occurring more and more in urban areas as space becomes limited and as urban traffic demands become more pronounced. However, this isn't done every day and was very interesting to witness."

Moving into the Future

"Although maintenance of the Nation's bridges, including movable bridges, was given low priority during the 1970s and 1980s," says FHWA's Byer, "a greater understanding of and dedication to the task of maintaining highway structures has been gained over the past 15 years."

New York City's preventive maintenance program will ensure that the time and money invested in rehabilitating and replacing these bridges is well spent and that the bridges will continue to provide viable service for highway and waterway users well into the future.

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Helping Roadway Contractors Fulfill Public Expectations

by Kathleen A. Bergeron

Incentive and disincentive provisions can help motivate highway builders to complete projects economically, safely, and quickly.

(Above) Long lines such as this one and motorists' short tempers are among the costs borne by the public when roadwork drags on. How to motivate contractors to complete projects quickly is an increasingly important issue for DOTs. *Photo: AAA Foundation for Traffic Safety.*

A joke that made the rounds a few years back tells of a software mogul who, speaking at a computer trade show stated that if the automobile industry had kept up with technology the way that the computer industry does, everyone would be driving $25 cars that average 1,000 miles to the gallon.

The joke continues: In response, the auto industry issued a press release stating that if it had developed technology the way the software industry does, cars would have

Traffic circles, such as the one shown here under repair, and other areas where vehicles need to merge are especially susceptible to wear and tear—and to public frustration when the merging areas are tied up during maintenance projects.

AAA Foundation for Traffic Safety

some rather odd quirks. Every time workers repainted the lines on the road, motorists would have to buy a new car. For no reason whatsoever, the car would crash twice a day. Maneuvers such as a left turn occasionally would cause the car to shut down and refuse to restart, and the motorist would have to reinstall the engine. The airbag system would ask, "Are you sure?" before deploying. And every time a new car was introduced, buyers would have to learn to drive all over again because none of the controls would operate the same as they did in the older car.

Although amusing, the story perhaps is more valuable as an object lesson than as a joke: People in the highway community might well ask themselves, "How well do I serve *my* customers compared to the way other industries serve theirs?"

How does the highway industry compare, for example, with utilities such as water, electricity, or natural gas, or with other public services? Better yet, how does it compare with more competitive consumer-products industries—manufacturers of laundry detergents, breakfast cereals, soft drinks, and, yes, automobiles and computers? On some level, all are trying to do the same thing—make their customers happy. Further, State departments of transportation (DOTs) also have the

Repairing or replacing bridges such as this one seems to guarantee inconvenience for motorists, but State DOTs are chipping away at that "fact" through incentives to speed construction.

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The public's desire for smooth roads has motivated DOTs to resurface rural lanes, such as those shown here, as well as urban roads.

responsibility to provide a safe and efficient driving experience.

"One of the greatest challenges for State DOTs is motivating construction contractors to achieve or even surpass an agency's goals for customer satisfaction," says former New Jersey Department of Transportation Commissioner Jack Lettiere. When several contractors bid on a highway construction project, and the lowest bidder gets the job, how does the DOT motivate the winner to complete the project better, faster, or with less impact on the traveling public? In other words, how does a DOT encourage contractors to build highway projects in such a way that the process responds to the public's desires and needs?

The obvious way is simply to demand it—write specifications and contract provisions that clearly define the schedule requirements. The problem with such an approach is that the DOT may not receive *any* bids if it makes the project requirements too stringent, or contractors may include large contingencies in their bids to offset potential loses if they do not meet the contracting agency's schedule. Moreover, if the agency specifies exactly how it wants the project done, it is not benefiting from the creativity of the marketplace. The very basis of a free-market economy is that the company or individual who can come up with a better approach gets the advantage. So if a DOT can somehow devise a way for a contractor to use its own creativity to reach a specified level of performance, the result will be a win-win for both the DOT and the private firm.

A Two-Way Street

Of course, the challenge is not simply persuading contractors to respond appropriately to what is required of them. It also entails knowing exactly what to demand in the first place. What, precisely, does the public want with regard to particular roads or projects? And how do DOTs gather that information?

Like other government organizations, most transportation agencies maintain an office that has the responsibility of communicating with the public. Usually the office is dubbed Public Affairs or Public Information or Public Outreach. Much of the office's work is one-way communication: telling the public the story the agency wants to deliver. The office sends press releases to the media (which, it is hoped, will convey the story to the public), distributes brochures at hearings and trade shows, and publishes newsletters geared toward specific projects that target businesses and residents who may be affected by the projects.

Although such communications help demonstrate how an agency is spending the funds entrusted to it, something may be missing. In comparison to the volume of information leaving the agency, very little feedback from highway users is brought into the organization to help determine its responses to the public's wants and needs. True communication, however, is a two-way street, providing information and listening or receiving feedback.

This deficiency is not unique to highway agencies. In a 1976 article published in *Public Relations Review*, authors Sue H. Bell and Eugene C. Bell discuss two approaches to public relations, one they call "functionary" and the other "functional." The functionary approach is based on the assumption that the purpose of public relations (or public affairs, or public outreach) is limited to effecting changes to the environment *outside* the organization. On the other hand, functional public relations assumes that changes can be made to the organization itself as a result of information gained from outside.

"Functionaries" attempt to preserve and promote a favorable image of the organization in the community based on the hypothesis that if the organization is "liked," the public will continue to absorb its outputs. In contrast, "functionals" seek outside information to see where the organization can better serve its constituents. So, instead of talking about "relating to the public," or "public relations," the reference is to two-way communication. And in private industry, being able to change a product or service (whether it is computers, automobiles, or whatever) to meet the public's changing needs can be critical to survival. This is important for public agencies too. Consider for a moment how local fire departments have changed over the last 50 years. Today they encompass emergency /medical response departments in addition to traditional fire suppression/prevention departments, as a result of the changing public need for these services.

In the Federal highway business, Section 128 of Title 23 of the United States Code requires public hearings whenever Federal funds are included in a highway project. But too often, comments are merely recorded. As stated in the forward to the report *Public Involvement Techniques for Transportation Decision-making* (FHWA-PD-96-031), "Acting in accord with basic democratic principles means that public involvement is more than simply following legislation and regulations. In a democratic society, people have opportunities to debate issues, frame alternative solutions, and affect final decisions in ways that respect the roles of decisionmakers. Knowledge is the basis of such participation. The public needs to know details about a plan or project to evaluate its importance or anticipated costs and benefits. Agency goals reflect community goals. Through continued interaction with the entire community, agencies build community support and, more importantly, assure that the public has the opportunity to help shape the substance of plans and projects."

Opening a Dialogue

Beyond two-way communication, where information is gained from both sides, lies the realm of true *dialogue*, where one side makes a point and the other responds constructively, and where there is, in effect, a conversation. One good example of dialogue in the highway community is now occurring on the topic of pavement performance.

In late 1995, FHWA sponsored a national survey of highway users. The survey consisted of an 18-minute telephone questionnaire with 2,205 interviews completed in the end. The responses were weighted to reflect U.S. Census Bureau norms for gender, age, race /ethnicity, education, and census region. The report that came from the interviews, the *National Highway User Survey*, looked at the public's overall satisfaction with various aspects of the highway system. "It is clear that the top priority for improving the Nation's highways is to focus on the quality of the roadway surface," FHWA and its consultants concluded. "This is the factor that will most significantly increase public satisfaction with the highway system."

Responding to that call for action, FHWA created a multiagency team in 1997 to develop and market a national pavement smoothness initiative. Using as models the pioneering incentive program for asphalt pavement smoothness created by the Arizona Department of Transportation (ADOT) and a similar program for portland cement concrete championed by the Kansas Department of Transportation, FHWA strongly encouraged State DOTs and their contractors to focus on building smoother pavement surfaces.

When a 1995 FHWA survey revealed pavement smoothness to be motorists' highest priority, several State and Federal initiatives encouraged contractors to focus on that objective. Here, technicians test to see how well the contractors responded.

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Boston's "Big Dig" project, part of which is shown here completed, encapsulated nearly all the public's frustrations with major transportation projects—construction delays, cost overruns, traffic tieups, safety concerns—some of which were revealed in FHWA's 2005 survey. Today the project is finished and sends motorists whizzing on their way beneath the city.

The challenge was determining how to motivate construction contractors to perform above and beyond their normal levels. This is where the concept of incentives came into play. "Incentives are great tools because they enable a transportation agency to set a goal for contractors and, within certain limits, allow the contractor to use its ingenuity to come up with the means by which to achieve the goal," says FHWA Senior Pavement Design Engineer Mark Swanlund.

This approach is similar to the way the Federal Government works with automobile manufacturers to ensure regulatory compliance. Rather than specifying exactly how the car companies should build their products, the Government sets a number of general standards to which manufacturers must adhere. For example, Corporate Average Fuel Economy standards guide the fuel efficiency of a company's products in general, National Ambient Air Quality Standards govern the volume of air pollution that companies can emit, and the New Car Assessment Program sets standards

Motorists on this street might settle for any pavement at all, let alone smooth pavement, as they negotiate an especially troublesome work zone.

AAA Foundation for Traffic Safety

for how well vehicles should handle front-end crashes.

According to Swanlund, encouraging State DOTs to adopt incentive specifications through the FHWA-sponsored pavement smoothness initiative was one of many factors that resulted in significantly improved pavement conditions on the national highway system. The "response" to the public's call for action was, in effect, the other half of a conversation between the motoring public and the Nation's transportation professionals.

Surveys Say . . .

But that was not the end of the conversation. In 2000 FHWA again brought the driving public into the conversation through a survey and issued a report the following year. FHWA intentionally modeled the survey on the 1995 instrument to facilitate comparison, study customer satisfaction trends, and direct future activities based on changes in the public's priorities or on improvements in public satisfaction with pavement smoothness.

The 2000 survey revealed that although pavement conditions still resonated as a significant concern (21 percent) among highway users, traffic flow (28 percent) and safety (26 percent) were now more important priorities.

In 2005 FHWA and its partners completed a third effort, the Traveler Opinion and Perception Survey. This latest effort tracks closely with earlier user surveys. The following "Important Characteristics of an Effective and High Quality Transportation System" were listed as priorities:

- Highway and roadway safety
- Ability to get where I want to go easily
- Bridge conditions
- Being able to get around as a pedestrian safely and easily
- Pavement conditions

"These results clearly show that travelers place high value on their ability to get around safely and easily," says Rebecca Elmore-Yalch, president and CEO of Northwest Research Group, Inc., the firm that conducted the survey on behalf of FHWA. "These represent the most important aspects of a high-quality and effective transportation system, and travelers wish to see this as a continued focus."

By 2005, it seemed, highway users had relegated pavement conditions to the fifth position on their list of priorities. The results do not indicate whether the highway community made a significant enough impact on pavement conditions to have an impact on user perceptions or whether user priorities simply changed over the previous decade.

A Work Zone Incentive In Arizona

Several highway agencies are using innovative incentives to encourage contractors to minimize the negative impact of highway construction on their customers. In Arizona, for example, ADOT kept an eye on customer service when it developed an incentive/disincentive approach for a $42 million project in the northwestern part of the State. The project called for widening 21.7 kilometers (13.5 miles) of State Route 68 (S.R. 68) from a two-lane rural road into a four-lane divided highway.

Rather than looking at the job as simply building a highway from point A to point B, ADOT officials took the time to understand the customers who use the route. From that, ADOT determined that this section of S.R. 68 is a major commuter route for people who are employed by casinos and other entertainment venues across the State line in Laughlin, NV. But a large number of commercial truckers and vacationers travel the route as well. Thus, S.R. 68 does not have the morning and afternoon peak traffic periods typical of other parts of the country. Rather, a steady stream of traffic generally runs from early morning to late evening, meaning that construction crews could not simply schedule their work around the traditional rush hours.

ADOT realized early on that the construction project, which ultimately lasted almost 2 years, could have been a major headache for its customers, so agency officials set up what they termed a traffic management incentive specification. Under the specification, ADOT established an incentive/disincentive fund of $400,000 to encourage the design-build contractor to maintain a target travel time through the work zone during the entire construction schedule. To determine whether the target was met, the contractor was required to measure the amount of time it took travelers to go through the work zone. Further, the contractor had to select a method for collecting the raw data, calculating the average travel times through the

Kaneen Advertising & Public Relations, Inc.

A recent widening project on northwestern Arizona's S.R. 68 featured contractor incentives /disincentives, a public relations program, and other features that helped result in ontime completion with minimal driver inconvenience.

Selected Customer-Focused Activities at FHWA

Knowing what needs to be done and having the tools to do it are two separate things. So how does one move to a more customer-focused approach, both in personal approaches and organizationally? FHWA sponsors a number of programs and activities that can help State and local agencies improve their delivery of quality roadway projects. They include the following:

National Highway Institute Course. Public Involvement in the Transportation Decision-Making Process (#142036) is 3-day course that teaches attendees how to identify key decision points where the public should be involved. Among the topics covered are selecting and applying specific techniques for sharing information with the public, identifying and adapting to different cultural sensitivities, and developing public involvement plans. For more information, visit www.nhi.fhwa.dot.gov.

Accelerated Construction Technology Transfer (ACTT). ACTT is a program through which State DOTs can gain access to a team of nationally recognized leaders in an array of disciplines who conduct a workshop focused on a single highway corridor or project selected by the host agency. For more information, visit www.fhwa.dot.gov/construction/accelerated.

Performance Specifications Strategic Roadmap. FHWA developed this report as a tool to guide the highway community in developing, implementing, and accepting performance specifications as viable tools for highway construction. To view the roadmap document, visit www.fhwa.dot.gov/construction/pssr04tc.htm.

Transportation Curriculum Coordination Council (TCCC). The TCCC is a partnership between FHWA, State DOTs, and the highway transportation industry to support the training of the highway construction personnel. The council provides a core curriculum of materials and training available to State and local transportation agencies. For more information, visit www.nhi.fhwa.dot.gov/tccc.

work zone, and then reporting those averages to ADOT. The specification required that the average travel time not exceed 27 minutes. For each minute above that time, the contractor would be charged $21.50.

The contractor chose a measuring system that employed cameras, positioned at both ends of the work zone, to snap pictures of the license plates of vehicles entering and leaving the work zone. A central processor then matched photos of the same plates and determined the elapsed time between when the car entered and left the work zone. At the end of the project, only $14,857 had been deducted from the $400,000 incentive, thereby earning the contractor 96 percent of the bonus fund.

ADOT had hired a public relations firm for the project as well. The firm developed public service announcements, radio media alerts, a Web site, an informational phone number, and a newsletter, all aimed at keeping the public informed on the status of the project.

Critics might question whether the $400,000 incentive might have been better spent building more

Construction of toll plazas, border crossings such as the one shown here, and similar highway-related facilities can pose special problems to State DOTs because they cannot use detours to steer traffic away. The New York State Thruway Authority reduced the resulting congestion through application of a performance disincentive.

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Concentrating manpower, as shown here, is one way to speed construction, as contractors are increasingly urged—even required—to complete work in urban and other high-traffic areas as quickly as possible.

roadways elsewhere in the State. "Due to the lack of detour routes for S.R. 68," responds Jennifer Livingston, then-resident engineer for ADOT's Kingman District, "the traffic management incentive/disincentive clause was vital in minimizing delays to the traveling public, especially for commuters and those getting to and from medical appointments, government facilities, and other daily trips."

The case becomes clearer when individual costs are considered as well. In the *2005 Urban Mobility Report*, the Texas Transportation Institute estimates that, as a national average, being stuck in a work zone costs each motorist $13.45 per hour in terms of the value of lost time. Further, each hour a commercial motor carrier sits in a congested work zone costs the firm $71.05. But in the end, ADOT received a great deal of positive feedback from the public, both for the agency's outreach related to construction and for minimizing delays in the work zone.

A Work Zone Disincentive In New York

When congestion delays due to work zones are potentially significant, some States require contractors to suspend construction entirely during peak traffic periods. In June 2005, experts from around the country joined the New York State Thruway Authority (NYSTA) for an intensive, 2-day workshop focused on a deck replacement project on the Tappan Zee Bridge. Sponsored by FHWA's Accelerated Construction Technology Transfer (ACTT) initiative, the workshop helped NYSTA settle on a prefabricated system that would shorten construction time and improve safety and quality.

NYSTA selected a construction method using precast concrete slabs, which offered speedy construction and minimized exposure of workers to traffic. The project involved sawing up and removing the existing pavement, putting down a bedding material, installing the slabs, grouting dowels, and then placing the bedding grout. The contractor installed about 279 square meters (3,000 square feet) of panels in each 8-hour, offpeak traffic closure.

The toll plaza services more than 125,000 vehicles per day, so any delay in opening it on time could be disastrous. NYSTA, therefore, devised a performance standard to meet the need: For every minute past 6 a.m. that the toll plaza was delayed in opening, the contractor faced a penalty of $1,300, up to a maximum penalty of $250,000 per day. The installation proved so successful that no penalties were assessed.

When Time Is Of the Essence

The ADOT and NYSTA projects used incentives, an approach that says to the construction contractor, "Here's the goal you need to reach to get some bonus money. You figure out the best way of getting there." And, as in the New York case, if the contractor fails to look for innovations, it might actually lose money on the project.

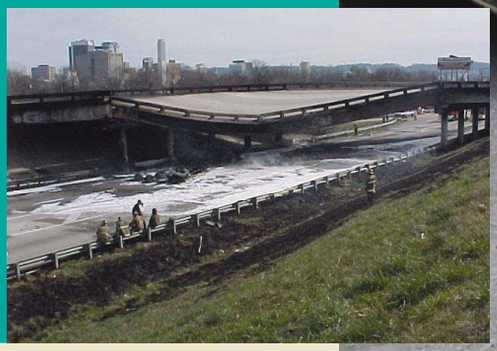
Perhaps the most widely used performance specification is one focused on how quickly a contractor can complete a project. More and more, agencies are recognizing that the bottom line construction cost of a project has to include the impact on the driving public. So the DOTs offer contractors monetary incentives for early completion with the daily incentive amount based on estimated road-user costs.

A case in point: On January 5, 2002, a gasoline tanker traveling Interstate 65 (I–65) within the I–20/I–59/I–65 interchange in Birmingham, AL, crashed and burned under a bridge. The fire caused the steel girders of the main span over southbound I–65 to sag about 3 meters (10 feet), which required closing all northbound and southbound lanes. Removal of the damaged bridge began as soon as the wreck was cleared, and northbound traffic was restored the next day. The Alabama Department of Transportation (ALDOT) estimated costs to road users caused by the southbound closure at $90,000 per day.

ALDOT designed a new concrete girder bridge and awarded the contract on January 16. Construction began January 21. The contract allowed 90 days for completion of the new bridge, with an incentive/disincentive provision of $25,000 per day. The successful bidder completed the new bridge in 37 days, earning an extra $1,325,000. The contract cost, including the incentive payment, was still less than the cost proposed by the second-place bidder.

"Within 53 days, the damaged bridge was removed, the design completed, and a new bridge built,

On January 5, 2002, a gasoline tanker crashed and burned under a bridge along I–65 in Birmingham, AL. Seen here (below), emergency personnel responded immediately, but the fire caused steel girders to sag dangerously and forced the closing of northbound and southbound lanes.



After the crash, the FHWA Alabama Division and ALDOT responded immediately, designing a new bridge and awarding a construction contract within 13 days of the tanker crash. Incentives motivated the contractor to finish the job in little more than a month, and the new bridge, shown here, was opened February 27.

demonstrating intense commitment and cooperation among all parties involved," says FHWA Alabama Division Administrator Joe Wilkerson, "especially State engineers, the concrete fabricator, and the contractor that built the new bridge."

New Mexico Uses Innovative Incentives

A look at a New Mexico example ties many elements of the story together. A recent project needed speedy construction, and the New Mexico Department of Transportation (NMDOT) added its own twist.

Reconstruction of the I–25 and I–40 interchange in Albuquerque required construction or rehabilitation of 55 bridges and 177 kilometers (110 miles) of roadway. Lacking viable alternate routes, NMDOT had to complete the project while motorists continued to use the roadway.

The original interchange was designed in 1967 to support 40,000 vehicles per day. At the time of its reconstruction, however, it was severely overutilized, with an estimated 300,000 vehicles daily. Congestion resulted in an average 1.7 crashes per day, with an economic impact estimated at $12 million annually.

In the end, reconstruction enhanced the level of service and reduced the crash rate on the most heavily traveled interchange in the State. NMDOT estimates that the new interchange will benefit the Albuquerque economy by approximately $1 billion over the first 10 years. The public benefits from

Steve Harris, NMDOT

This aerial photo from October 2001 shows the Big-I in New Mexico during construction. In the lower left corner of the interchange (in the vicinity of the concrete mixing tower) is a 6.9-hectare (17-acre) parcel of land that the construction contractor earned as a bonus for completing the project ahead of schedule.

AAA Foundation for Traffic Safety

Construction-related traffic tieups, such as the one shown here near I–95 in Boca Raton, FL, continue to inconvenience motorists, but transportation planners are refining incentive clauses and other contract elements with the goal of reducing disruption levels lower than ever.

reduced travel time, enhanced safety, and environmental improvements.

To minimize disruption to the community, NMDOT decided to reconstruct the interchange under a single contract with incentives to keep construction time under 2 years. But with little funding available for monetary incentives, the agency offered the contractor innovative incentives, most notably ownership of excess right-of-way if the project was finished ahead of schedule. NMDOT purchased an 8.5-hectare (21-acre) parcel that included about 1.6 hectares (4 acres) of required right-of-way, with the remainder used as a staging area during construction. Since construction was substantially complete before the contract calendar date, the contractor received the deed to the remaining 6.9-hectare (17-acre) parcel. Ultimately, several tracts of land owned by NMDOT and deemed in excess of future highway needs were transferred to the contractor in lieu of cash incentives.

To minimize the impact on traffic, the project team used progressive techniques, such as segmental bridge construction, and established a traffic surveillance system and incident response program for the construction area. Through close contact with the media during the project, NMDOT cultivated public support by apprising motorists of potential delays. In the end, the incentives and careful management paid off: The completed interchange opened to traffic in May 2002, after only 23 months of construction.

Staying Tuned

The need to learn what the public wants has been recognized for decades. As noted in the FHWA report *Moving America: New Directions, New Opportunities*, published in February 1990, "An understanding of what Americans want from their transportation system is as important to the formation of transportation policy as analysis of facts and figures."

But understanding what the public wants and needs—whether smoother roads, less interference with traffic by construction, or something else—is not necessarily the same as attaining the desired level of performance from U.S. highways. Incentives and disincentives are an invaluable tool for attaining those levels of response.

Kathleen A. Bergeron is a marketing specialist with FHWA in Washington, DC. She works on Highways for LIFE, a program with the goal of dramatically enhancing the quality, safety, and speed of highway construction in the United States. Prior to joining FHWA, she managed communications and marketing programs for consulting engineering firms and transportation agencies at the State and local levels. She holds a bachelor's degree in journalism from the University of Texas at Austin and a master's degree in transportation management from San Josè State University. Bergeron is accredited by the Public Relations Society of America.

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Geospatial Technologies Improve Transportation Decisionmaking

by Lindsay Banks and Mark Sarmiento

Geographic information systems enable State DOTs to streamline tasks and projects related to operations, road routes, safety, engineering, conservation, and more.

Faced with the daunting task of managing the Nation's transportation system with limited resources, the work of State departments of transportation (DOTs) is driven by the need to produce quick, high-quality results without overspending. Delivering transportation projects on time without sacrificing quality requires accurate and complete data. Geographic information systems (GIS) and advanced data collection technologies such as remote sensing and global positioning systems (GPS) have helped many DOTs produce that data, enabling them to improve decisionmaking while saving time and money.

"GIS should be the tool of choice for forward-looking executives—those who . . . want to 'skate to where the puck *will* be,'" says Federal Highway Administration (FHWA) Associate Administrator for Planning, Environment, and Realty Cynthia J. Burbank. "GIS can improve the speed and quality of decisions, cut costs, and allow multiple teams to work together effectively. What executive isn't seeking that?"

Many State DOTs are going a step further, using the systems in conjunction with Internet technologies and the Web to distribute the information more widely and in a more cost-conscious manner. As more and more States apply GIS, and as they share their experiences with others, the benefits of using geospatial technologies can multiply.

"But it isn't going to happen without an executive-level commitment to GIS—a commitment to funding and staff for GIS, and executive-level time to figuring out what decisions could be aided by GIS applications," Burbank says.

FHWA's Role

Recognizing the potential impact that geospatial technologies can have on the work of State DOTs, FHWA has taken an active role in promoting these technologies through courses and workshops. FHWA encourages State DOTs to exchange their knowledge of geospatial technologies and their experiences with using them. In addition to providing support for GIS activities, FHWA is seeking champions to share their work with other DOTs.

A number of States have charted successes with geospatial technologies and report satisfaction with their experiences in using those technologies to improve decisionmaking and save time and money. A sampling of six States offers examples from various regions of the country: Arkansas, Delaware, Georgia, Nevada, Virginia, and Washington.

Arkansas

The Arkansas State Highway and Transportation Department (AHTD) used GIS to streamline the transportation decisionmaking and permitting process for the Southeast Arkansas I–69 Connector. GIS enabled AHTD to share and consolidate environmental and engineering data, and to refine and efficiently analyze large amounts of information on study areas. The agency also used GIS to foster coordination with resource agencies, the public, and Native American tribes early in the environmental review process while efficiently addressing review requirements. Partner agencies supported using GIS because the project steps occurred more quickly.

Mainly through the use of this technology, AHTD was able to reduce by almost 60 percent the amount of time required to move from notice of intent to record of decision. The maps and analyses that GIS investigation provided also gave partners and communities tangible examples of how various project alternatives would affect environmental, cultural, and economic resources.

Randal Looney, environmental coordinator at FHWA's Arkansas Division Office, says, "The use of GIS as a preliminary screening tool for environmental constraints has greatly accelerated the decisionmaking process for us, particularly on large-scale study areas associated with EIS [environmental impact statement] -level projects."

Robert Fuhler, the section head for GIS in AHTD's Environmental Division, also praises the technology, especially its use on the I–69 project. "Generally, the use of GIS has greatly increased efficiency and data distribution on projects," he says.

His team has been successful in providing others at AHTD with GIS training, data coordination, and method development, making for a

(Left) Remote sensing and GPS use satellites similar to this one to gather data that can be used by State DOTs to improve decisionmaking and save time and money.
Photo: Lockheed Martin Corp.

Geospatial Technologies

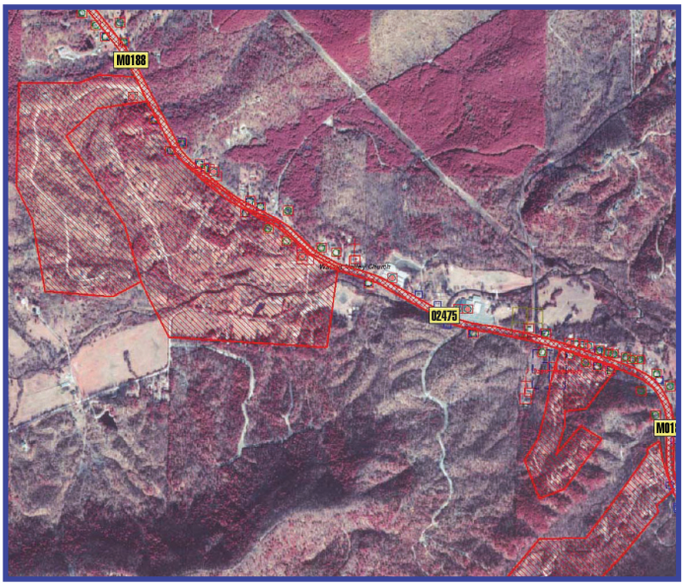
The terms "GIS," "remote sensing," and "GPS," often are used together when discussing geospatial technology. Engineers collect data with a global positioning system (GPS) unit or using remote sensing and then integrate that data into a GIS program.

The phrase "geographic information systems" and the acronym "GIS" refer to the systems of hardware and software used to analyze, process, and store geographic data. Although GIS often is associated with producing maps, its true power lies in its ability to maximize the quality and use of spatial data with analyses to help answer questions such as where, how far, how many, what size, and within what area?

Remote sensing is the acquisition of data from a distance, usually with the use of satellite imaging, aerial photography, radar (*ra*dio *d*etecting *a*nd *r*anging), lidar (*li*ght *d*etection *a*nd *r*anging), sonar (*so*und *na*vigation *r*anging), or other technologies. It allows users to obtain information about an area without sending people to that area.

GPS units operate through a satellite-based navigation system made up of a constellation of 24 satellites orbiting 19,320 kilometers (12,000 miles) above the surface of the Earth. The U.S. Department of Defense launched the system, which was originally intended for military applications but was made available for civilian use in the 1980s. There are no subscription fees or setup charges to use GPS. It works in any weather conditions, anywhere in the world, 24 hours a day.

GPS satellites circle the Earth twice daily in very precise orbits and transmit signal information to the planet's surface. GPS receivers use this information to calculate the user's exact location through triangulation. A GPS receiver must be locked on to the signal of at least three satellites to calculate a two-dimensional (2–D) position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's three dimensional (3–D) position (latitude, longitude, and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset times, and more.



AHTD

This screen capture from one of AHTD's GIS programs features highway bridges in yellow and potential impact sites along the roadway in red. Aerial imagery also can be used to identify terrain features such as the pipeline in the northeastern quadrant and subdivision development, which is the large areas crosshatched in red.

smoother transition and improved incorporation of data within the department, he says.

In addition, with the incorporation of GPS technologies, accuracy in identifying and collecting constraint locations and their delineation has increased substantially. "Processes and procedures covering the gamut from project start to final output of analyzed data for decisionmaking increases efficiency [and] productivity, and greatly reduces redundant efforts," according to Fuhler.

Delaware

For transportation professionals at the Delaware Department of Transportation (DelDOT), GIS is a powerful, efficient tool to construct and analyze transportation networks; conduct impact assessments; and create visual representations of assets, project locations, and transportation data layers. DelDOT had adopted GIS technology in its day-to-day operations, but various limitations remained: data were maintained in several locations, and employees had to have GIS software installed on their desktops to access the data and create maps, or needed to contact DelDOT's GIS group to request data or maps.

DelDOT officials recognized that collecting information was a time-consuming obstacle to completing projects quickly and efficiently. Also, many employees needed access to spatial data but lacked the skills to navigate desktop GIS programs. In 2004 DelDOT decided to pursue a more cost-effective and user-friendly system that would accommodate its burgeoning volume of spatial data.

The agency teamed with GeoDecisions®, a Pennsylvania-based consulting firm specializing in GIS and information technology, to create an online information portal for DelDOT employees. The portal is known as the "Information Network for Online Resource Mapping" (INFORM).

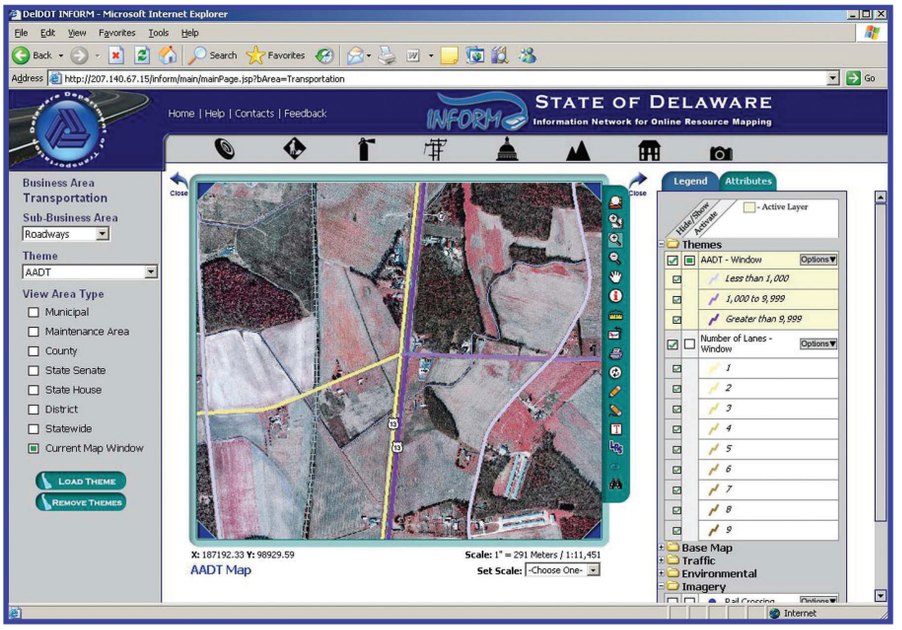
"The goal was to provide optimized data dissemination in a cost-effective manner," explains Brian Smith, GeoDecisions project manager. "A Web portal provides easy data access without the need of additional client software and with little training involved."

By allowing key decisionmakers and planners access to a database of project information that is regularly updated and maintained, and with all stakeholders sharing the same information, INFORM leads to more informed decisionmaking.

"These data were available before, but they weren't easily accessible," says Don Burris, DelDOT's manager of transportation assets and engineering systems. "With INFORM, the data are found at one location, most data can be accessed with three simple mouse clicks, and everyone within DelDOT is now looking at the same dataset."

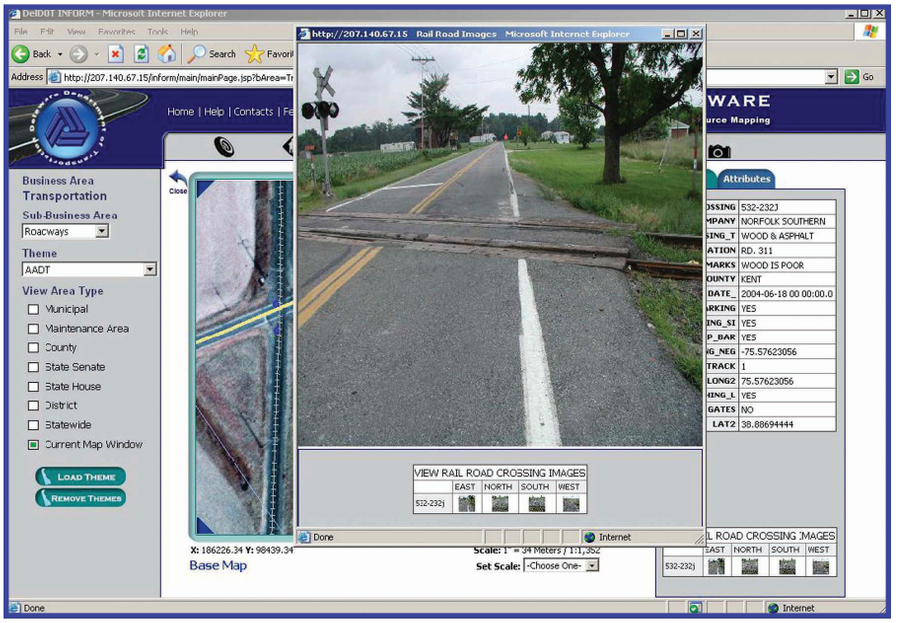
INFORM also integrates data from a variety of DelDOT business systems. Among other things, it enables employees to analyze multiple types of projects to ensure correct scheduling or to view various types of traffic information. Crash, road, bridge, transit, environmental, and basemap data features are available for analysis throughout the network. Users also can display various basemap features at one time and create multiple thematic maps based on business data.

"Overall," says Burris, "the new Web application has increased productivity, improved decisionmaking, and trans-



GeoDecisions

Shown here is a screen shot of the "INFORM" homepage. INFORM enables users to compare multiple themes from different DelDOT business areas.



GeoDecisions

This screen shot shows railroad crossing images that have been saved within the INFORM database for display. Users click on the rail-crossing layer and select the crossing of their choice, where they can then view pictures of that crossing from all four directions.

lated into cost savings for the Delaware Department of Transportation."

Georgia

After undertaking a thorough review of day-to-day activities and general areas that could benefit from improved technology, the Georgia Department of Transportation (GDOT) decided that a GIS portal could improve the agency's business operations. The GDOT reviewers realized that GIS could not only improve existing services but also provide new services by centralizing various databases and making them accessible through an Internet portal.

Using in-house resources and personnel, GDOT created the "Transportation Explorer Information Portal" (TREX), an online GIS portal that enables the department to present information to State employees, citizens, elected representatives, and officials from FHWA. "We are now addressing a greater diversity of needs from a much larger audience than we were before," says Teague Buchanan, GDOT's GIS manager.

To meet the rapidly increasing demand for maps and spatially enabled data, GDOT wanted to make this information readily available to anyone who may need it. Due to the powerful capabilities of GDOT's ArcIMS®/ArcGIS® server, users can access information about current projects, review plan details, view photos, and look at contract details—all with the click of a button.

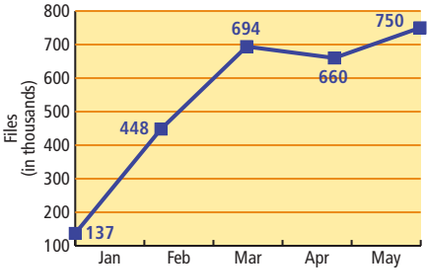
"Fulfilling information needs is more effective than teaching everyone to be a GIS user," Buchanan says. "Web-based GIS helped us simplify the end-user experience." Unlike other static Internet maps, this system enables the user to interact with the data, selecting and finding features by attributes. Easy access to data makes the project development process more inclusive and helps organize the management of projects.

GDOT has reported significant improvement in the delivery of services and information. Some tasks that formerly required hours or even days of information gathering now take only minutes. While increasing the timeliness of response to data inquiries, GDOT also was able to decrease the cost of responding. Additionally, agency officials have noted an increase in the amount of citizen participation. The program is easy to use and can be accessed from the comfort of private homes. The considerable amount of information available publicly has increased the transparency of GDOT's work, which could result in an increase in public trust.

"Our greatest satisfaction is watching people use our application in their day-to-day business," says Buchanan. "It's very gratifying to know that our application is providing a valued service to the public and our transportation partners."

TREX recently won a Best of Georgia Award in the category of redefining government. The award, created by the Government Technology Conference (GTC) with Governor Sonny Perdue and the Commission for a New Georgia, is presented to the agency or organization "that has adopted the best practices already being utilized by the private sector wherever appropriate to make State government function as productively, effectively, and as efficiently as possible," according to GTC.

Number of Files Accessed Using TREX
(January–May 2005)



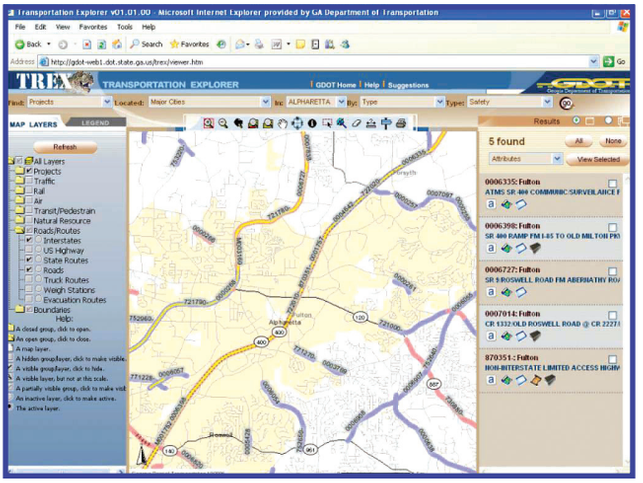
This graph illustrates the rising use and popularity of TREX within GDOT over just a 5-month period in 2005.
Source: GDOT.

Nevada

The Nevada Department of Transportation (NDOT) built a transportation GIS that merges crash data with a roadway basemap and relates the two. NDOT compiled partial datasets from several State and local offices into a single, consistent basemap in a new database, converting the data regardless of its native format. The new, geospatially enhanced Safety Management System (SMS) also stores and retrieves all of the various linear referencing methods used by police to locate crash sites, including intersection offsets, milepost offsets, and address matching. Dynamic segmentation capabilities that correctly maintain the relationships between roads and their crash attributes also are incorporated in the new system.

With SMS, NDOT staff can perform the following additional applications:

- Corridor analysis to examine crashes occurring within certain given proximities of intersections



GDOT

Screen shot of GDOT's TREX portal.

- Midblock analysis to track crashes occurring away from intersections
- Dataset merges to facilitate identifying relationships between crashes and other factors such as pavement conditions

Practically, NDOT's use of GIS technology means that it can better coordinate with other authorities and field staff to improve highway safety, says Chuck Reider, principal safety engineer for NDOT. "GIS technology can display information in a way that's much more intuitive and easy to understand." Tables, spreadsheets, and the like are easily usable by some, especially experts and professionals, but graphically displaying a problem can drive a point home to decisionmakers, the public, and any other interested stakeholders, he says.

For instance, GIS data can pinpoint and show a problem area, say, an intersection with a high rate of injury crashes. It may further show problems with nearby intersections and graphically reveal a swath of areas, perhaps a whole transportation corridor, that warrants attention by safety professionals. "A picture really is worth a thousand words," Reider says.

The GIS system serves as a conduit of sorts, he says. Just as NDOT headquarters staff can go to local authorities to point out a problem revealed by GIS, field personnel can transmit information back to educate headquarters about a safety issue.

Virginia

The Virginia Department of Transportation (VDOT) used GIS to facilitate an improved working relationship with its partner agencies. VDOT formed a partnership with the Virginia Natural Heritage Program (VNHP) to develop a spatial database of natural heritage resources. VNHP—with the mission to identify, protect, and preserve Virginia's biodiversity—did not have the financial resources to develop a GIS database to catalog and monitor those resources. Because the two agencies shared a need for the data, VDOT entered into an agreement with VNHP to fund the development of the database. Once the agencies agreed that the basic structure of the first iteration would consist of comprehensive conservation sites coverage and thorough metadata, VDOT provided $119,000 for staff and $4,000 for computers. A memorandum of agreement outlined the terms of use of the resulting natural resource heritage data and ensured that VDOT would have no-fee access to the database for 5 years.

As expected, the agreement has proven mutually beneficial. The database has provided VDOT with easy access to data that were previously difficult to locate, enabled regional visualization of resource distribution, simplified decisionmaking, and created the ability to streamline project review procedures. For VNHP, advantages include a reduction in the volume of projects to review for VDOT, enhanced ability to respond to problem projects, and the database itself, which enables the agency to fulfill its mission more effectively.

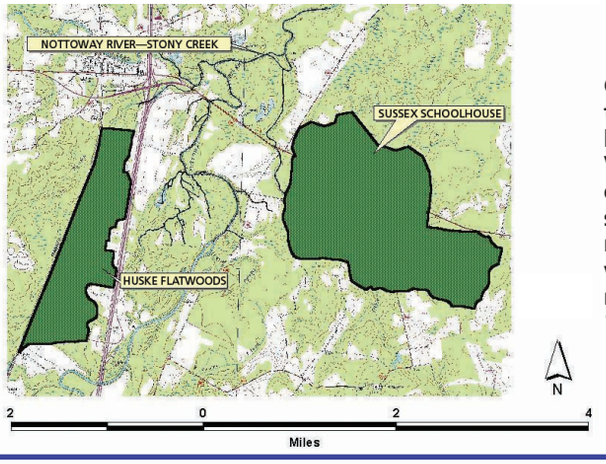
More generally, GIS has helped VDOT fulfill a mandate for greater openness to the public, says Dan Widner, the agency's GIS program manager. "We are spatially enabling our business processes," he says, to allow for improved tracking of construction and maintenance projects. GIS supports other informational efforts of the agency and helps with integrating information. Clearer data can be supplied to decisionmakers, VDOT constituents, taxpayers, and the public at large, Widner says. "We are making GIS part of our everyday business processes."

Washington

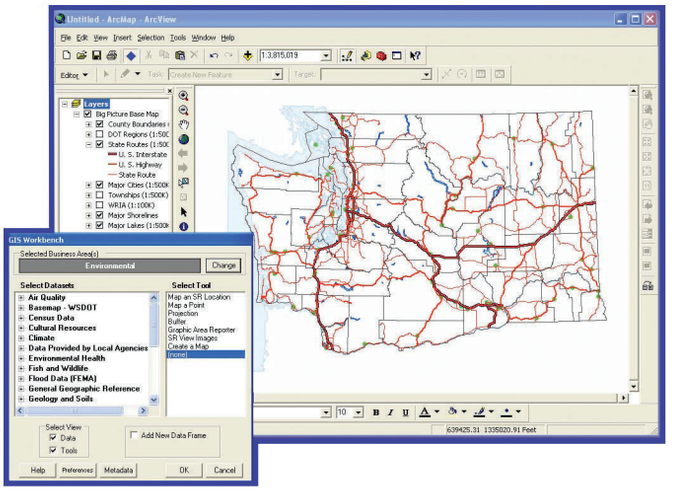
When conducting environmental assessments, the Washington State Department of Transportation (WSDOT) obtains environmental information from its partner resource agencies. Gathering data from many agencies for each project can be a time-consuming process. The Environmental GIS Workbench is a custom-built, online GIS application designed to give WSDOT staff access to a broad range of statewide environmental and natural resource management data. The application is a step toward eliminating redundant data and improving data quality. WSDOT supports the GIS tool by coordinating with numerous Federal, State, and local agencies to ensure that datasets are updated continuously and remain accurate.

With this tool, users are able to produce their own maps that combine environmental data on wetlands,

Conservation Sites and Stream Conservation Units



GIS maps, such as the one shown here for an area in Virginia, can display environmentally sensitive sites that need to be avoided when constructing new roads. *Source: VDOT.*



WSDOT

Screen shot of "Environmental GIS Workbench" application showing various roadways lacing Washington State.

historic sites, and parkland with a proposed highway corridor to see how these natural and cultural resources might be affected. The digitized data layers are available as ArcView® readable files and may be easily downloaded, overlaid, and manipulated.

"The Environmental GIS Workbench was so successful for environmental assessment work that other groups started asking for their own workbench," says Elizabeth Lanzer, environmental GIS/information technology program manager for WSDOT. "Rather than building many different tools, we built an updated workbench that provides GIS support to multiple agency functions."

The project has seen promising results. The increased availability of information has reduced decision review time, while centralized control of the system by WSDOT continues to maintain and improve data accuracy.

How to Learn More

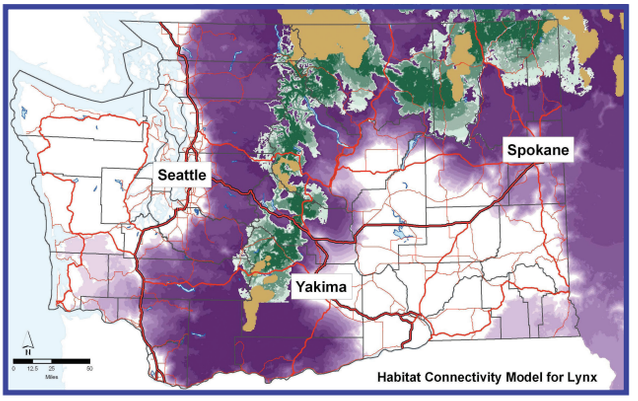
With more and more States interested in geospatial technologies, FHWA has worked to provide opportunities for States to come together and share their knowledge and experiences. The National Highway Institute offers a course, Applying GIS and Spatial Data Technologies in Transportation (FHWA-NHI-151039), that helps managers at State DOTs become familiar with geospatial technologies and their relevance to transportation planning. Also, the GIS for Environmental Streamlining and Stewardship workshop, developed by the FHWA Resource Center, provides opportunities for State DOTs and resource agencies to learn about and discuss other States' experiences with GIS related to environmental streamlining. See www.nhi .fhwa.dot.gov or www.fhwa.dot.gov/resourcecenter for more information about these training opportunities.

In the summer of 2006, the FHWA Office of Project Development and Environmental Review will offer workshops on Application of Conservation Planning Tools for Transportation Planning and Project Development. The workshops, cosponsored with NatureServe and Defenders of Wildlife, will focus on coordinating State conservation and transportation planning and the GIS tools available to help.

Finally, FHWA has a "GIS in Transportation" Web site (http://gis.fhwa.dot.gov), which highlights innovative transportation-related applications of GIS across the country.

In addition to these resources, a GIS-T (GIS for Transportation) Symposium in Columbus, OH, was held March 27–29, 2006. Hosted by the American Association of State Highway and Transportation Officials, Urban and Regional Information Systems Association, Highway Engineering Exchange Program, and the U.S. Department of Transportation, the workshop offered an opportunity for State DOTs interested in using geospatial technologies to learn from the experiences of others.

From high-tech mapping to information sharing, many State DOTs have seen the benefits of using geospatial technologies. GIS allows for complex analyses, easily understandable graphics, and scenario comparison. Indirectly, it has facilitated improved working relationships between State DOTs and their partner resource agencies.



WSDOT

Researchers used the Environmental GIS Workbench to create this map of lynx habitat in Washington State. Tan areas are primary habitats. Green areas are the least cost/best habitat corridors between the primary habitats. Purple areas are more difficult landscapes for lynx to travel through.

Mark Sarmiento is a planning analyst with FHWA's Office of Interstate and Border Planning. Currently he is promoting the use of geospatial technologies by State DOTs and metropolitan planning organizations. He has been with FHWA since 1995. He has a bachelor's degree in civil engineering from Worcester Polytechnic Institute and a master's degree in civil engineering, with a concentration in transportation, from the University of Virginia.

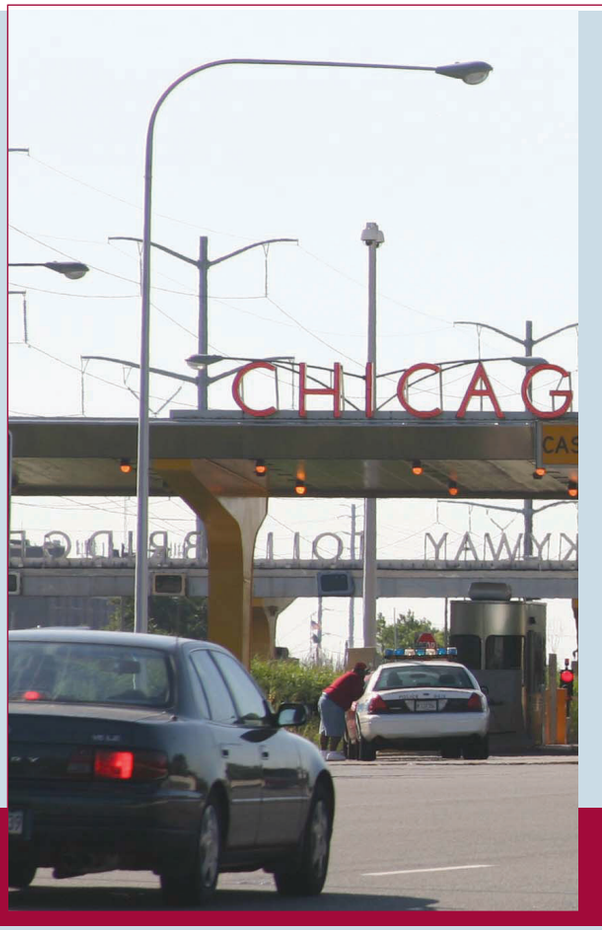
Lindsay Banks is a GIS specialist with FHWA. Her position in the Office of Interstate and Border Planning focuses on promoting advanced geospatial technology at the State DOT level. She has a bachelor's degree in urban planning from the University of Illinois at Urbana-Champaign and a master's degree in GIS from the University of Redlands.

For more information, contact Lindsay Banks at lindsay.banks @fhwa.dot.gov or Mark Sarmiento at mark.sarmiento@fhwa.dot.gov.

GIS is an FHWA priority, market-ready technology and innovation. For more information, see www.fhwa.dot.gov/resourcecenter /teams/planning/plan_5gis.pdf.

The Return of Private Toll Roads

by Robert Poole and Peter Samuel



Private concessions offer an alternative to managing American highways.

In little more than 12 months, beginning in late 2004, the following events occurred: A Spanish toll road company proposed to invest $7.2 billion to build the first leg of the Trans-Texas Corridor (TTC), a major highway, rail, and utility corridor running north-south from Oklahoma to Mexico. A global consortium agreed to pay $1.8 billion to lease, toll, operate, and maintain the Chicago Skyway for 99 years. And an Australian toll road operator bought out a struggling public-private toll road in Virginia.

These events illustrate a growing trend in highway investment. The reality today is that increasingly the public and private sectors are looking toward partnerships to build, operate, and maintain highway infrastructure in the United States.

During the 1980s and 1990s, investment in new highway capacity lagged considerably behind the growth in automobile travel and freight movement. In the future, improvements in the fuel efficiency of automobiles and the growing availability of alternative fuel sources will increasingly affect highway revenues from gas taxes. At the same time, public and political support for increasing fuel taxes, which have served as a traditional source of highway funding, was and continues to be weak. In this environment, as Federal, State, and local departments of transportation (DOTs) look for solutions to improve safety and mobility on the Nation's roadways, global capital markets are just beginning to see the U.S. highway sector as a potential investment opportunity.

How the United States responds to these forces will help shape the country's highway system in the 21st century. What follows is an overview of the emerging rebirth of toll roads in the U.S. landscape and strategies for making the best use of this model through long-term concessions to private toll operators.

(Above) The city of Chicago recently leased the Chicago Skyway toll road (shown here) for 99 years, making a substantial return on the arrangement. *Photo: Peter Samuel.*

The Challenge Of Highway Investment

"One key element of surface transportation, now and in the future, will be toll roads," says Gary Hausdorfer, chief executive officer of Cofiroute USA, a private toll road company. "Neither State nor Federal levels of highway funding are sufficient to keep pace with demand."

The most commonly used reference for assessing the adequacy of highway investment is the Federal Highway Administration's (FHWA) biennial *Conditions & Performance Report to Congress.* The 2002 edition reported that Federal, State, and local capital investment in the Nation's highway system in 2000 totaled $64.6 billion. But based on projected increases in automobile and truck vehicle miles traveled (VMT), as estimated by the States, the annual investment needed to maintain the asset value and expand the capacity of this tremendous resource was $75.9 billion. In a no-growth society, bridging that $11.3 billion annual gap might be enough to solve the highway investment challenge. But with the number of VMT increasing every year and truck VMT growing at an even faster rate, simply maintaining the existing system is not sufficient to address the Nation's mobility needs.

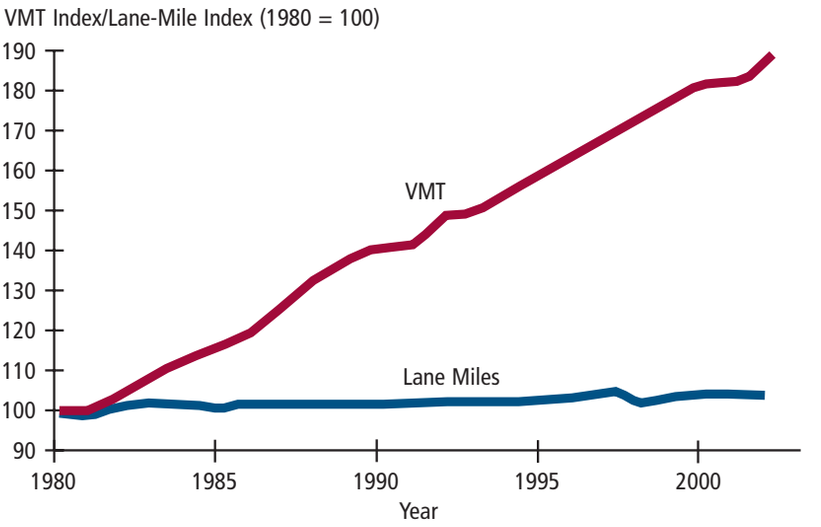
FHWA analysts estimate that the Nation could be investing $106.9 billion per year if all potential improvements having a benefit/cost ratio of 1.0 or greater were made. This estimate points to a much larger gap of $42.3 billion per year—or 65 percent more than the

United States currently is investing. In *The Bottom Line* report, published in 2002, the American Association of State Highway and Transportation Officials (AASHTO) offered an even higher estimate of $125.6 billion for improving the physical condition and performance characteristics of highways and bridges over 20 years. Both estimates send the same message: the Nation is not investing enough in the system upon which both personal mobility and most freight movement are based.

The new Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) legislation has helped to increase Federal investment in highways. But because the fuel taxes used for highway development and maintenance are not indexed for inflation or automobile fuel economy, today's Federal-plus-State gas tax, in real (inflation-adjusted) terms, produces between 2 and 3 cents per mile driven (in light vehicles). That is about half of what the gas taxes of the 1960s and 1970s produced, when much of the interstate system and many core urban freeways were built. Many of the systems built during those decades now need major reconstruction, in addition to capacity expansion, but the resources are inadequate to complete the task.

From 1980 to 2000, while VMT grew by 82 percent, highway miles increased by just 4 percent. One symptom of rapidly growing VMT is that urban freeway systems are now choked with traffic. The 2005 edition of the annual *Urban Mobility Report* produced by the Texas Transportation Institute (TTI) estimates that it costs motorists $63 billion per year in lost time and wasted fuel sitting in traffic congestion. Although some may argue that adding capacity is not the answer, each year TTI's data show that those few urban areas that added capacity to nearly keep pace

Vehicle Miles Traveled and Roadway Lane Miles
Growth Index, 1980 to 2002



As shown in this figure, VMT has far outpaced the addition of new lane miles of roadway in the United States since 1980. *Source: FHWA.*

Pennsylvania Turnpike Commission

Motorists queue up at the tollbooth for the Blue Mountain Interchange on the Pennsylvania Turnpike during its opening weekend in October 1940. The Pennsylvania Turnpike became the design and financing model for other States that wanted to build superhighways before significant funding for the interstate system began in 1956.

with VMT growth have the least increase in congestion, while those that add little or no capacity suffer the most from congestion.

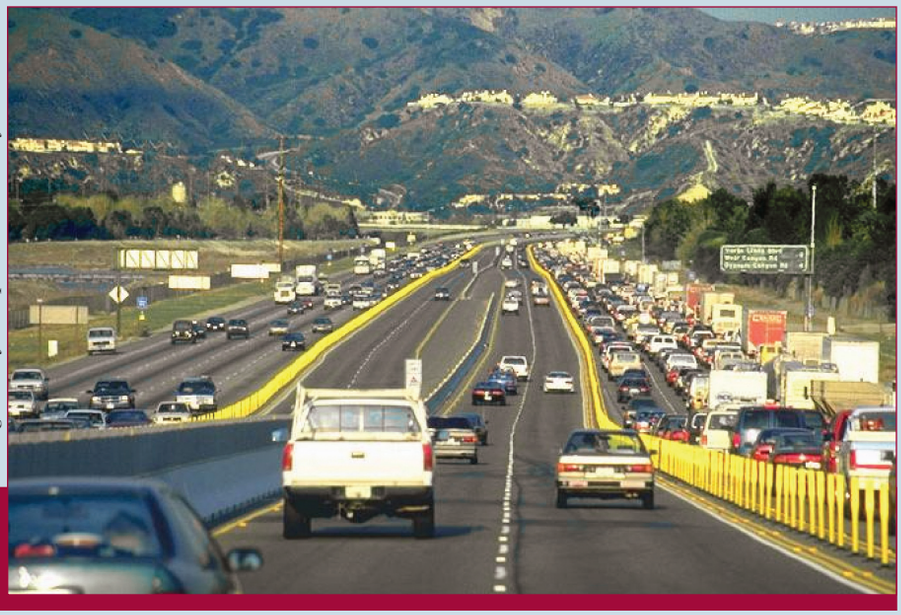
A New Model: Long-Term Concessions

The three highway projects cited earlier are based on a model for highway finance, management, and operation known as the toll-funded, long-term concession. Under this approach, in exchange for the right to collect tolls for a long period (typically anywhere from 30 to 99 years), a private firm or consortium will design, finance, build (or rebuild), operate, and maintain a large-scale highway project.

In 18th-century Britain, the concept was used to develop hundreds of turnpikes in the preauto era. The United States imported the model, where it became the principal means of developing bridges and highways between towns and cities in the eastern States, many of which still bear the name "turnpike" or "pike" 150 years after they collected their last tolls. And when the West was settled in the second half of the 19th century, again this model was used to develop important mining roads and intercity roads in California, Colorado, Nevada, and other States. The concession model also saw a limited revival in the early days of the automobile era, with the Long Island Motor Parkway (1908), the Ambassador Bridge in Detroit (1929), and the Detroit-Windsor Tunnel (1930) as prime examples. Most of the toll bridges on the upper Hudson and Delaware Rivers, on the Mississippi River, and in the San Francisco Bay area, also were developed using this model. Some became insolvent during the Great Depression and were taken over by State agencies. Others were bought up by State and bi-State agencies with the expectation that they would become toll free.

According to researchers at the Reason Foundation, several factors prevented the full-fledged development of a private toll road industry in the automobile era. The highly publicized scandals surrounding the New York Bridge Company and the frauds committed during construction of the Brooklyn Bridge in the 1870s gave toll bridge charters a bad reputation. Second was the invention of highway trust funds supported by dedicated motor fuel taxes. This form of highway funding proved highly effective and inexpensive to collect. The fuel tax was quickly adopted by every State, thanks to the Good Roads Movement in the late 1800s. Also, the invention of the State toll road agency provided a way to fund large-scale projects with toll revenue bonds, with the cost advantage of being able to issue the bonds at tax-exempt rates. The Pennsylvania Turnpike became the model for a host of other State and later urban and regional toll authorities that built and maintained some of America's most important highways.

But Europe had neither highway trust funds nor tax-exempt bonds. So as the need for limited-access motorway networks became obvious after World War II, first France and then Italy, Spain, and Portugal rediscovered the toll-funded, long-term concession model. All four countries developed their large, national motorway networks using this model. Many of the toll road companies started out as state owned and retained majority state control, but in the last decade, most of them have been privatized. Thus, Western Europe today has a thriving private toll roads industry that has started investing in Latin America, the former Eastern Europe, and the United Kingdom.



Orange County Transportation Authority

Eastbound traffic is shown here on the 91 Express Lanes in Orange County, CA.

Shown here is a four-level interchange at Toronto's highway 407 ETR. To relieve congestion, drivers' willingness to pay directly affects the setting of toll rates.

407 ETR

One of the newer adherents to this model is Australia. Toll road companies operating under long-term concession agreements have developed and now operate nearly all of the urban expressway capacity added since the early 1990s in the country's two largest cities, Melbourne and Sydney. Another major city, Brisbane, now seems to be moving in the same direction. Australia's leading toll road firms also have gone global, acquiring ownership stakes in overseas toll roads and even developing toll road mutual funds aimed at long-term investors.

Workable for Major Projects

The long-term concession model appears to work well with large-scale highway, bridge, and tunnel projects for several reasons. First, these are precisely the kinds of projects that are the most difficult to develop using traditional highway funding. Amassing a large sum of money like $2 billion for a single project in one location is both financially and politically challenging. But if the economics of the project pencil out (that is, there exists an unmet demand and a willingness to pay), the capital can be raised in exchange for a suitable long-term right to toll.

Second, it is megaprojects that pose the greatest risks of cost overruns, schedule slippage, and traffic shortfalls under public ownership. With a properly structured long-term concession, these risks can be shifted to the private sector. Because the flow of toll revenues depends on the project getting finished on time (or early), the concessionaire has a powerful incentive to ensure that its design-build contractor delivers the project on schedule. And with a financing structure in place, based on acceptable estimates of what drivers are willing to pay, it is crucial to keep project costs within budget so toll revenues will cover operating and debt-service costs.

In this model, the concessionaire also does not have an incentive to cut corners on design or construction, because it will have to operate and maintain the project for the life of the concession. The minimum in construction standards might decrease short-term development costs but would likely increase long-term operating and maintenance costs.

Innovation is a third reason for looking to this kind of long-term, public-private partnership. Private firms appear more willing than public agencies to take risks and "think outside the box" to solve difficult problems. For example, it was a private company operating under California's pilot program for long-term concessions that invented the value-priced, congestion-relief tollway. California's 91 Express Lanes in Orange County, which are located in the median of State Route 91 (S.R. 91), rely on an electronic toll-collection system with a variable toll based on the time of day and day of the week to achieve a smoother traffic flow.

In France, a private toll road company (whose U.S. subsidiary was a major shareholder in the company that developed and now operates California's 91 Express Lanes) resolved a 30-year impasse in completing the missing link on the A86 Paris ring road by developing it as a congestion-priced, deep-bore tunnel beneath (rather than through) historic Versailles.

And in Melbourne, Australia, a private toll road company linked three existing freeways into a network, using a combination of tunnels and elevated construction (with a "sound tube," similar in function to a "sound wall" in the United States except in the shape of a cylinder, to minimize noise) through dense urban areas.

"Sooner or later, more and more transportation officials will embrace congestion pricing," says Cofiroute USA's Hausdorfer. "Why? To encourage fewer cars on the road. Whether it is higher tolls at peak hours or general road charging, the commuting public will come face to face with a very different form of public policy. [Because] no one wants to propose additional taxes of any kind, road charging and public-private partnerships become the alternative."

In Ontario, Canada, the concession agreement for the 407 Express Toll Route (407 ETR) set a number of policy objectives that needed to be met. According to Imad Nassereddine, vice president for traffic operations and planning at 407 ETR Concession Company Ltd., the main objectives included operating the 407 ETR as an open-access, all-electronic toll collection system; requiring the concessionaire to adhere to provincial safety and environmental standards in the design, construction, and operation of the highway; and providing congestion relief to the alternative public highways. To relieve congestion, a separate tolling agreement was established whereby the road users' willingness to pay would directly affect the setting of toll rates.

"Research . . . [shows] that customers mainly value three factors in their decision to use the toll

Orange County Transportation Authority

California's 91 Express Lanes facility, shown here, was the first privately financed toll road in the United States in more that 50 years, the world's first fully automated toll facility, and the first application of value pricing in America.

highway," Nassereddine says. "These include the time savings achieved, the reliability and convenience of the trip, and safety of the highway."

Capturing Innovation

The long-term concession model can be applied to developing new capacity as well as taking over and modernizing existing toll roads. The arguments for enlisting investors rather than following the traditional U.S. model of a public toll authority are twofold. Many public toll facilities are fully borrowed (that is, they are unable to sell additional bonds), making them unable to take on major new projects. Second, during the competitive bidding process, private investment groups sometimes devise innovative approaches to adding new capacity, potentially bringing to the table new ideas that the public sector had not considered.

In southern California, for example, inspiration from the private sector led to the notion of having variably priced express lanes in the middle of the Riverside Freeway. It took a law (AB 680) inviting investor proposals to produce the idea for the 91 Express Lanes. "It is doubtful whether a public agency could have implemented such a radical, untried scheme, in addition to carrying out the intense marketing and customer relations needed to get it to work," says Carl B. Williams, former director of the Office of Public-Private Partnership at the California Department of Transportation. "It was a risky project, and public agencies do not tend to reward risk taking, at least not to the extent that the private sector can with stock options and bonuses for those who succeed and dismissal for those who fail."

Similarly, the toll lanes currently being negotiated for use on the Washington (DC) Beltway (I–495) in northern Virginia rescued a traditional Virginia Department of Transportation (VDOT) widening project that was collapsing under a barrage of local opposition. Under the Virginia Public-Private Transportation Act, a private company proposed a widening scheme that would almost eliminate the need to acquire extra right-of-way (and thereby remove hundreds of homes), which reduced the project cost from about $3 billion to about $1 billion. This alternative approach transformed the political situation.

The original VDOT proposal was more standard, featuring barriers separating the toll lanes, four sets of breakdown shoulder lanes, and high-speed ramps at all the interchanges. The private company proposed the same widening scheme—from 8 travel lanes to 12—but eliminated a pair of breakdown lanes. The company also proposed deferring some interchange improvements.

VDOT and the private company are working to incorporate some of VDOT's planned interchange improvements into the scheme. And to ensure that enough funding will be available to cover the additional work, an Australian toll road company agreed to commit more than $100 million in "patient capital" (a long-term equity investment that does not need to earn a return during the early years when toll revenues are hardest to predict). This example shows how the private sector can bring both ideas and capital to a project.

Virginia

Other unsolicited proposals are in various stages of consideration in Virginia. Two groups proposed major enhancements to the two-lane, reversible, high-occupancy vehicle (HOV) facility including the Shirley Highway (I–395) and I–95 from the Beltway to the Fredericksburg area, about 64 kilometers (40 miles) south of Washington, DC. In December 2005, the VDOT commissioner

selected one firm for VDOT to negotiate an agreement with to further develop the high-occupancy toll (HOT) lane concept. The selected proposal suggests converting the facility to HOT lanes by adding a third lane to about 45 kilometers (28 miles) of the existing two-lane, reversible facility, extending the facility southward about 32 kilometers (20 miles). Other enhancements would include installing new entry and access points and ramps at the Springfield Interchange and other locations and improving park-and-ride and bus facilities. Negotiations are underway between VDOT and the private sector partner, but innovative aspects under consideration are substantial private sector investments and a possible concession arrangement.

In 2002, VDOT solicited proposals for upgrading the 523-kilometer (325-mile) I–81 corridor, an overstressed four-lane interstate with heavy truck traffic both ways. After an extensive review process and touring I–81, Commissioner Philip Shucet directed VDOT to enter negotiations with a private company selected as the potential operator of I–81 corridors. Negotiations are still under way toward a comprehensive agreement.

Concurrent with the review of private proposals, VDOT has been conducting the National Environmental Policy Act study on the entire length of the corridor. The study will serve as a basis for making an informed decision before proceeding with any design and construction improvements.

The private sector proposal considers innovative financing mechanisms, such as truck tolling and Transportation Infrastructure Finance and Innovation Act loans, along with traditional formula funding from gasoline tax sources. The scale of the anticipated improvements proves that innovative financing tools could represent more than just a supplement to traditional formula funds.

California

Southern California is another area with potential for new toll projects and private sector innovations. A major new toll road, the South Bay Expressway (S.R. 125 South), is being constructed under a long-term concession held by a private company based in Chula Vista, CA. The $635 million toll road, due to open in late 2006, is 15 kilometers (9.3 miles) long and will serve the rapidly developing communities on the eastern fringe of the area and provide a new connection to the Otay Mesa border crossing to Mexico.

Currently the company is negotiating with the California Department of Transportation and local agencies for a 10-year extension of the concession, from 35 to 45 years. In exchange for the extended concession, the company proposes covering the cost of adding a single HOV lane in each direction on the I–805 freeway within the franchise zone.

"The South Bay Expressway, or S.R. 125 South as it was formerly known, has been a line on the map since 1959," says Greg Hulsizer, chief executive officer of California Transportation Ventures, Inc., the owner /operator of the South Bay Expressway. "It wasn't a regional priority for funding, and there likely wouldn't have been funding for a long time into the future. So the use of the private concession model is bringing this new transportation alternative to life. It would have been literally decades before it would ever be funded with public funds."

At least four tolled megaprojects are being considered in the Los

South Bay Expressway

Shown from above, construction begins on California's South Bay Expressway Otay River Bridge, which will span 1.2 kilometers (0.75 mile) and reach 55 meters (180 feet) high.

Peter Samuel

These long, double trailer trucks are at a service area on the Indiana Toll Road, which is a major east-west corridor for freight shipping.

Angeles area. As an alternative to a contentious 9.6-kilometer (6-mile) surface road, for example, transportation officials are considering building an 8-kilometer (5-mile) tunnel that would serve as the missing link in the I–710 freeway in South Pasadena.

Further north in Glendale, local officials including the Los Angeles County Board of Supervisors, the city of Palmdale, and the Southern California Association of Governments are considering a proposal to tunnel under the mountains of Angeles National Forest to improve the connection to Palmdale. The facility would cut 45 minutes off the trip over the mountains. With tunnels measuring 17.4 kilometers (10.8 miles) and 7.6 kilometers (4.7 miles) plus about 8 kilometers (5 miles) at grade, the project is estimated to cost less than a surface highway—a reflection not only of the challenges inherent in building a road through such rugged topography but also of improvements in tunneling technology.

A third tunneling project, under consideration by the Orange County Transportation Authority and the Riverside County Transportation Commission, would link the Foothill/Eastern Toll Road in Orange County to I–15 in Riverside County to provide an alternative to the S.R. 91 Riverside Freeway and the winding S.R. 74 Ortega Highway through the mountains of Cleveland National Forest. This tunnel would be about 22.5 kilometers (14 miles) long.

A nontunnel project would add truck lane capacity in the corridor following the I–710 freeway from the ports of Los Angeles/Long Beach to intermodal yards, then eastbound along the S.R. 60 Pomona Freeway. Truck volumes in this area are among the highest in the country because of a heavy concentration of truck-related businesses. The project would connect the growing array of warehousing and logistics businesses in Riverside and San Bernardino Counties, then go north toward Nevada along I–15. With Mountain State-style triple trailer rigs and other longer combinations operating behind jersey barriers, such truck lanes could improve mobility and safety in the regional transportation network. The enhanced productivity of managed truck lanes totaling some 117 kilometers (73 miles) in urban areas and 277 kilometers (172 miles) to the Nevada State line would provide the basis for toll financing.

California Governor Arnold Schwarzenegger's administration is supporting a bill to facilitate concession agreements, which are envisioned to be open for negotiation for investors, nonprofits, and public toll agencies alike.

Indiana

Indiana also is pursuing the concession model. In September 2005, Governor Mitch Daniels announced that his administration would seek investor proposals for a long-term concession to take over the Indiana Toll Road. In January 2006, Daniels announced the winning bid: a joint venture by toll road companies from Spain and Australia bid $3.85 billion for the 75-year concession. Daniels also announced that 228 kilometers (142 miles) of the planned I–69 southwest of Indianapolis will be built as a toll road and that the State will seek investor proposals to build and operate the facility as a concession.

"The Indiana Toll Road is an economic engine for northern Indiana," says Indiana Department of Transportation Commissioner Tom Sharp. "For 50 years it has served as a vital east-west link in facilitating the movement of commerce across the United States."

He continues, "Grants and no-interest loans generated from Indiana Toll Road revenues assist local communities with transportation improvements at little or no cost. The latest grants are being used to upgrade and integrate air and rail transportation systems for passengers and freight. The Indiana Toll Road is a successful model [that] Indiana plans to use for future toll highway projects."

Concessions on Existing And New Facilities

Although the concession model may be applied equally to existing toll facilities and to new ones, the distinction is not clear-cut. Many existing toll facilities need considerable investment. According to the proposed concession agreement, the Indiana Toll Road (now operated by a State toll authority), for example, could be improved by widening its western commuter section, modernizing its toll system, and repaving.

In considering a long-term lease for the State-operated New Jersey Turnpike, New Jersey would likely make extension of the dual-dual (dual roadways both directions) roadways south of Interchange (IC) 8A a condition. The State already announced that it wants to widen the existing six lanes that extend some 32 kilometers (20 miles) from IC–8A to IC–6 to four roadways of three lanes.

By contrast, in Texas, the primary focus is not on privatizing the existing regional toll authorities but instead on seeking investor involvement in concessions for new roads to address soaring traffic growth. In addition to embarking on the TTC project noted earlier, the Texas

Department of Transportation now requires that all major new projects forwarded from its regional offices be assessed for toll feasibility.

Further, Texas defines the term "comprehensive development agreement" (CDA) as including both the traditional public toll authority model and the concession model. The Central Texas Turnpike Project, covering some 105 kilometers (65 miles) of toll roads under construction in the Austin area—including State Highway (SH) 130, SH–45 North, and Loop 1—is being constructed under a CDA that covers design, build, and operations but excludes financing. The exclusion of financing and the fact that the toll revenues will go to the State make it a public authority toll road.

The first TTC project (TTC–35) may mark the start of using the full-fledged concession model. The winning proposal for the first TTC–35 project involves a 50-year concession. (For more information, see "Trans-Texas Corridor" in the July /August 2005 issue of PUBLIC ROADS.)

In Colorado and Georgia, State legislation allows private toll roads to operate along with two major State toll facilities, E–470 and GA–400 respectively. There, the concession model would be used almost exclusively to build new toll roads. In North Carolina, where no toll facilities as yet exist, the North Carolina Turnpike Authority is considering a concession for the Mid-Currituck Bridge, a proposed new multilane facility connecting U.S. 158/NC–168 at Barco on the mainland to Corolla on the Outer Banks.

Steps in the Concession Process

1. Select qualified, third-party legal and financial consultants to advise the State on all aspects of the process.
2. Appoint a qualified and respected selection and negotiating panel.
3. Publish a timetable for the selection process.
4. Prepare informational materials on the history and present state of the facility.
5. Commission a professional traffic and revenue study.
6. Release a formal request for expressions of interest to potential proposers.
7. Release informational materials to potential proposers and the public.
8. Release the results of the traffic and revenue study to the public, although independent assessments by bidders are encouraged.
9. Issue a request for conceptual proposals and qualifications to potential proposers.
10. Select the best three to five potential proposers (short list) and formally ask them for detailed proposals.
11. Review proposals by selection panel.
12. Negotiate with best proposer, holding others in reserve.

Why Sell or Lease an Existing Toll Road?

When Chicago leased the Skyway for 99 years for $1.8 billion, the city earned a substantial return on the arrangement. In fact, according to a city press release, the mayor plans to set aside $875 million to establish a $500 million long-term reserve fund and a $375 million mid-term annuity the city can use to smooth the effects of economic cycles and stabilize the need for additional revenues. Further, the city plans to use $463 million of the proceeds to retire existing Skyway debt and $392 million to pay off other existing city obligations.

By contrast, in 2002, the city earned a profit of approximately $8.4 million from Skyway tolls, which is a return of a mere 0.4 percent on the capital value of $1.8 billion as revealed by the successful concession bid. Therefore, one way to determine if taxpayers would be better off holding onto a toll road or selling it is to compare the relative rates of return.

A second consideration in deciding whether to lease an existing toll road is how the proceeds will be used. If the proceeds are dedicated to other needed infrastructure investments for which the government would otherwise have to borrow, the transaction is more likely to be viewed by the public in a positive light. For example, nearly one-third of the proceeds from the concession of the Indiana Toll Road (or roughly $1.35 billion) are earmarked for Lake, Porter, and the five remaining counties that surround the toll road.

All of this presumes that the State can find a buyer experienced in owning and operating toll roads, with the capabilities needed to manage such an asset and deliver quality service to its customers. It also presumes that adequate protections for the public interest, such as adherence to proper maintenance standards and avoidance of monopolistic pricing, can be included in the terms of the concession agreement.

Peter Samuel

Traffic is shown here traveling on the Chicago Skyway just east of the toll plaza.

Why Use Concessions On a New Toll Road?

Choosing to use concessions on a new toll road offers a number of potential benefits. As noted earlier, one benefit is the private sector's ability to be innovative and think outside the box in coming up with creative solutions to difficult problems. Second, funding a large project all at once can facilitate completing the project and delivering its benefits to the public years or even decades sooner than with traditional procurement methods. But the latter benefit also would be available using public toll authorities. What else does the private sector bring to the table? A more robust financing approach is one feature.

As illustrated by the Washington Beltway express toll lanes example, conventional all-debt financing fell short by $200 million of what was needed. But because equity (rather than assets for collateral) is patient capital, investors are willing to wait longer for a larger return. The concession approach made it possible to finance a larger and more serviceable project. A mix of equity and debt also is less vulnerable to default in the early years of a new toll road, when traffic may be less than was forecast. With a project 100 percent funded by debt, the debt-service burden that must be met by toll revenues is higher than if only, say, 65 percent of the project is funded with debt that must be serviced like clockwork in those critical early years.

Another advantage is risk transfer. In a long-term concession, the company or consortium takes on the risks of cost overruns and inadequate traffic, relieving the State and its taxpayers of the burden. This is especially important on megaprojects, where those risks are larger in magnitude.

A technician mans a computer station in the traffic operations center for the 91 Express Lanes in California. The center is staffed 24 hours a day, 7 days a week, and 365 days a year to dispatch emergency vehicles in the event of a traffic incident.

Orange County Transportation Authority

To Toll or Not to Toll

The long-term concession represents a major new approach to providing and managing highway infrastructure. Some in the transportation community will welcome the opportunity to breathe new life into 20th-century institutions. Others may approach the concept reluctantly or do so out of financial necessity. What seems clear, however, is that in a changing world, stepping beyond highway "business as usual" can open doors to improving the delivery and operation of the Nation's surface transportation system.

Tips for Planning Long-Term Concessions

- *Pay for professional advice.* Dealing with global companies requires the State to have legal and financial expertise on its side of the table, with comparable experience in long-term toll concession agreements. If such expertise does not exist in-house, the State should be prepared to pay for it in the marketplace.
- *Ensure an open process.* The more open the process, the better, except that there will always be a need for some temporary confidentiality. For example, bids should be sealed so the bidders offer what they are prepared to pay, not just enough to beat the next bidder. Also consider allowing proposers to keep some of their ideas confidential until all proposals are submitted. At the same time, the public needs to be assured that the selection process is fair, so confidentialities should be kept to a minimum and be maintained only as long as essential.
- *Protect road users from monopoly.* To a certain extent, concessioned toll roads represent a new form of public utility in the United States, bearing at least some characteristics of a monopoly. Accordingly, it may be necessary to regulate either the toll rates charged or the overall rate of return that can be earned under the agreement to protect the public. Generally, these provisions are best incorporated into the concession agreement, to be enforced by the State DOT, rather than subjecting the toll road company to regulation by a public utility commission unfamiliar with toll roads. In addition, so-called noncompete clauses, which limit the degree to which the State can build parallel nontolled roads, must be used judiciously, as it is extremely difficult to predict potential needs 40 to 100 years into the future.
- *Provide for future modifications.* A 35-, 50-, or 99-year concession term is a long time. No one knows what the world will be like in 20 years, let alone 50. So it makes sense to spell out in the agreement procedures for dealing with future needs, such as major additions to the toll road or allowances for a future administration to buy it back before the end of the agreement. The more the risk of unknowns can be minimized through such provisions, the better the deal that the State will be able to secure.

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Peter Samuel is a journalist who has specialized in toll roads issues for the past 10 years. He produces TOLLROADSnews, a Web-based news service and writes for *World Highways* and *ITS International* magazines. He also is a senior fellow with the Reason Foundation and has authored and coauthored policy reports on toll roads issues. He received a bachelor of commerce at the University of Melbourne, Australia, and taught economics at Monash University.

For more information, see the Reason Foundation's policy paper, "Should States Sell Their Toll Roads?" available at www.rppi.org/ps334.pdf.

The first decade of the greatest public works project in history began a transportation system yet unrivaled in the world—along with problems to match.

by Richard F. Weingroff

Essential to the National Interest

The Bureau of Public Roads developed an exhibit in 1957—one of many over the years—to let the public know about the "controlled access Interstate System being built under the Federal-Aid Highway Act of 1956." Left to right, Robert M. Monahan, special assistant for public affairs; Federal Highway Administrator Bertram D. Tallamy; Harold C. Wood, Sr., of the Motion Picture and Exhibits Section; and Assistant Commissioner for Research E. H. "Ted" Holmes.

President Dwight D. Eisenhower understood the value of roads. In 1919 he was aboard the U.S. Army's first transcontinental convoy, a 2-month journey from Washington, DC, to San Francisco, CA, to assess the readiness of military vehicles to make such a long trip and to promote good roads. The trip convinced the participants, which included military personnel, road advocates, and members of the press, of the country's need for better roads. During and after World War II, he traveled on Germany's Reichautobahnen network of rural superhighways, which were studied and envied by American engineers during the prewar 1930s. Eisenhower would say, "The old convoy had started me thinking about good, two-lane highways, but Germany had made me see the wisdom of broader ribbons across the land."

In 2006 the transportation community celebrates the 50th anniversary of the Eisenhower Interstate System. The second in a three-part series, this article examines the birth of the Interstate System, from the grand ideas to the day-to-day challenges of executing the country's largest public works project.

The Interstate Idea

The concept of the Interstate System was born in two reports to the U.S. Congress, *Toll Roads and Free Roads* (1939) and *Interregional Highways* (1944). The reports recommended construction of what the 1939 study called a "system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense in time of war and the needs of a growing peacetime traffic of longer range."

Congress agreed. The Federal-Aid Highway Act of 1944 directed designation of a 65,000-kilometer (40,000-mile) "National System of Interstate Highways" by joint action of State highway agencies, subject to approval by the U.S. Bureau of Public Roads (BPR). In August 1947, Major General Philip B. Fleming, the Federal Works Administrator, and Commissioner of Public Roads Thomas H. MacDonald announced designation of 60,642 kilometers (37,681 miles) of principal highways, including 4,638 kilometers (2,882 miles) of urban thoroughfares carrying the main line through cities. The remaining 3,732 kilometers (2,319 miles) of the authorized mileage were reserved for circumferential and distributing routes. This process was completed when BPR released the publication *General Location of National System of Interstate Highways Including All Additional Routes at Urban Areas Designated in September 1955* (known as the "Yellow Book" because of the cover's color).

What was missing was a program to fund and build the Interstate System.

The "Grand Plan"

President Eisenhower's Grand Plan is sometimes misunderstood as simply recommending construction of the Interstate System. His vision was far grander than that.

The President intended to present the plan to the Governors' Conference meeting in upstate New York in July 1954. However, following the death of his sister-in-law, Eisenhower was unable to attend. Instead, he provided notes to Vice President Richard M. Nixon for delivery to the Governors.

The Grand Plan, Nixon explained, was that each level of Government—Federal, State, county, and municipal—would contribute to upgrading the Nation's entire road network over a 10-year period. The goal was "a properly articulated system that solves the problems of speedy, safe, transcontinental travel." The benefits would be improved safety, reduced traffic jams, less traffic-related litigation, increased economic efficiency, and elimination of "the appalling inadequacies to meet the demands of catastrophe or defense should an atomic war come."

Finally, the Grand Plan included "very probably, a program initiated by the Federal Government, with State cooperation, for the planning and construction of a modern State highway system . . . to construct new, or modernize existing, highways." That was as close as Eisenhower came to mentioning the Interstate System in his Grand Plan speech.

Federal-Aid Highway Act of 1956

The President asked his friend and adviser General Lucius D. Clay to head a committee to develop a Federal response to the challenge. The

The Map That Started the Interstate System

In February 1938, President Franklin D. Roosevelt decided to discuss one of his pet ideas with Thomas H. MacDonald, head of BPR. At the White House, the President drew lines on a map of the United States where he thought a system of east-west and north-south transcontinental toll highways should be built. He asked MacDonald for a report on the idea.

Two months later MacDonald submitted *Proposed Direct Route Highways* to the White House. BPR found that "a national system of direct route highways designed for continuous flow of motor traffic, with all cross traffic on separated grades, is seriously needed and should be undertaken." BPR concluded that most sections would not carry enough traffic for toll revenue to liquidate bonds used to finance construction, but the report emphasized that "any expenditure actually required for the accommodation of the traffic on these highways will be more than repaid by the normal road-user taxes generated by their use."

Having heard about the internal study, Congress decided to seek a public report. The Federal-Aid Highway Act of 1938, which President Roosevelt approved in June 1938, asked BPR to submit a report on a toll network of no more than three east-west and three north-south "superhighways." *Toll Roads and Free Roads* would be an extensive study based on data from traffic surveys around the country. Again, the report rejected a toll network but proposed "a special, tentatively defined system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense in time of war and the needs of a growing peacetime traffic of longer range." President Roosevelt submitted the report to Congress in April 1939.

With enactment of the Federal-Aid Highway Act of 1956, what began as a few red lines drawn by President Roosevelt on a map almost 20 years earlier would become a system of direct interregional highways known as the Interstate System.

Dwight Eisenhower Library

President Dwight D. Eisenhower (seated) received the report *A Ten-Year National Highway Program* from his Advisory Committee on a National Highway Program (the Clay Committee). The report would provide the basis for the President's proposal to Congress on financing construction of the Interstate System. Left to right, General Lucius D. Clay (U.S. Army, retired), committee chairman; Francis C. "Frank" Turner of BPR, committee executive secretary; and members Steve Bechtel of Bechtel Corp.; Sloan Colt of Bankers' Trust Co.; Bill Roberts of Allis-Chalmers Manufacturing Co.; and Dave Beck of the International Brotherhood of Teamsters.

resulting Clay Committee believed the Interstate System would cost $27 billion, with $23 billion of that for rural segments. In February 1955, Eisenhower submitted the committee's report to Congress along with legislative proposals. The Clay plan—which entailed $25 billion in bonds and redirection of the gas tax—was a flop.

As Congress searched for an alternative financing plan in 1955, the highway-related interests that supported the Interstate System agreed on only one thing—they did not want to pay for it. Why, they asked, should only users pay for a highway network that would benefit the entire country? In July 1955, the Congress adjourned without completing action, mainly because of disagreement over financing.

Supporters realized they would have to compromise to get the highways they wanted. With tax compromises in place, the Federal-Aid Highway Act of 1956 moved through Congress with little controversy. It included a financing mechanism drafted by Representative Hale Boggs (D–LA) of the House Ways and Means Committee. At the suggestion of Secretary of the Treasury George Humphrey, Boggs used the Social Security Trust Fund as a model for the Highway Trust Fund. Revenue from taxes on highway user products would be credited to the highway fund for use exclusively on the Interstate System and other Federal-aid highway and bridge projects. The revised bill sailed through the Congress, which approved the bill on June 26.

Having fought for this bill, President Eisenhower would be denied a signing ceremony. He was at Walter Reed Army Medical Center following emergency surgery for an intestinal ailment. On June 29 he was given a stack of bills, including the highway act. Without fanfare, a photograph, or statement, he signed the legislation and was, according

Missouri Department of Transportation

Missouri claimed the first project on which actual construction began under the Federal-Aid Highway Act of 1956. A sign to that effect, shown here, was erected beside U.S. 40 (the future I–70) in St. Charles County.

to Press Secretary James C. Hagerty, "highly pleased."

The legislation changed the name of the Interstate System to reflect its importance to national defense: The National System of Interstate and Defense Highways. It expanded the system by 1,609 kilometers (1,000 miles) to 65,983 kilometers (41,000 miles) and authorized $25 billion to be made available in fiscal years (FY) 1957 through 1969 for construction to accommodate traffic demand in 1975. The Federal share of costs would be 90 percent.

The Firsts

The first project to go to construction under the new law was the Mark Twain Expressway portion of U.S. 40 (future I–70) in St. Charles County, MO. Construction on the $1.87 million project, which included 5 kilometers (3.1 miles) of bridging, grading, and concrete paving leading to a new bridge over the Missouri River, began on August 13. The Missouri State Highway Commission placed a sign on the project declaring it to be the first on which "actual construction" was begun under the 1956 act.

On August 31, the Kansas State Highway Commission awarded a contract for concrete paving of a 12.9-kilometer (8-mile) section of U.S. 40 (I–70) outside Topeka. Construction had begun before enactment of the 1956 law, but under the new contract, paving began on September 26 with funds provided under the new program. Joined by BPR officials, First District State Highway Commissioner Ivan Wassberg marked the historic occasion by scratching "9-26-56" in the fresh concrete. On November 14, 1956, highway officials held a ribbon-cutting ceremony and posted a sign proclaiming the project to be the first completed under the 1956 act.

Off to a Flying Start

In July 1956, BPR and the American Association of State Highway Officials (AASHO), as it was called at the time, agreed on design standards for the Interstate System. Access would be controlled, with crossroads carried over or under the routes. The system would consist of divided highways with four or more 3.7-meter (12-foot) lanes. In sparsely settled rural areas where traffic volumes were low, the standards would be relaxed, with at-grade crossings permitted in some cases; two-lane sections with one lane in each direction would be built to one side of the right-of-way so additional lanes could be added when traffic warranted.

The highways would be designed for speeds of 80.5 kilometers per hour, km/h (50 miles per hour, mi/h) in mountain terrain, 96.6 km/h (60 mi/h) in rolling terrain, and 112.7 km/h (70 mi/h) in flat terrain. Bridges and overpasses would be built without overhead obstructions, but all structures would allow at least 4.3 meters (14 feet) of vertical clearance over the roadways and shoulders.

To maintain the program's quick start, President Eisenhower believed that BPR would need a leader with the prestige of Presidential appointment and Senate confirmation as he worked with State highway leaders appointed by Governors. With the support of Senator Al Gore, Sr. (D–TN), Senator Prescott Bush (R–CT), and others, the Administration's proposal for a position of Federal Highway Administrator became law in August 1956. The Administrator would be a top adviser on highway policy and take charge of the Interstate program, while the Commissioner of Public Roads, Charles D. "Cap" Curtiss, would oversee day-to-day operations of BPR and its other programs.

President Eisenhower's choice was Bertram D. Tallamy, who had held several positions with the New York Public Works Department and helped create the New York State Thruway. But because Tallamy was unable to sever his New York connections until February 1957, the President appointed John A. Volpe, who had recently resigned as Massachusetts Commissioner of Public Works to return to the private sector, to serve as interim Administrator. Like Tallamy, Volpe was a seasoned veteran within the highway community, having started his own construction company with initial capital of $300 and built it into a multimillion dollar contracting firm.

Thus, on October 22, 1956, Volpe became the first Federal Highway Administrator (although not confirmed by the Senate). At the White House ceremony, President Eisenhower said he wanted to make certain that the highway program

got off to a "flying start." He held the Bible while Frank K. Sanderson, White House administrative officer, administered the oath of office to Volpe, the only Administrator whose swearing-in ceremony was attended by a President.

Volpe coordinated important decisions with Tallamy, and in his brief tenure, he reorganized BPR and delegated authority to field offices to handle the increased workload more efficiently. The States, he reported to the President on February 1, were moving forward aggressively; only five had not obligated any of their FY 1957 Federal funds. In submitting his resignation, Volpe said, "My 100 days in Washington have been exciting, challenging, busy, action-packed, and, I trust, productive."

On February 5, 1957, U.S. Secretary of Commerce Sinclair Weeks administered the oath of office to Tallamy, who was unanimously confirmed by the Senate. Tallamy understood the task he would oversee. As he told the Economic Club of Detroit in May, the 1956 act provided the highway community with "the greatest challenge that has ever been given to any peacetime public works agency." It was bigger, he said, "than the St. Lawrence Seaway, the Panama Canal, the Grand Coulee Dam, the Egyptian Pyramids, and a lot of other big projects . . . all rolled into one." Despite the scale of the project, he said, the highway community had only 13 to 16 years to complete the job.

Dwight Eisenhower Library

On October 22, 1956, President Eisenhower holds the Bible as John A. Volpe (left) takes the oath of office as the first Federal Highway Administrator. White House Administrative Officer Frank Sanderson administers the oath. The President said he participated in the ceremony because he wanted to be sure the Interstate program got off to a "flying start."

Kansas Department of Transportation

Kansas claimed the first project completed under the 1956 highway law for a 12.9-kilometer (8-mile) section of U.S. 40 (I–70) west of Topeka. Here, four representatives of the engineering contractor and State highway commission mark the occasion on a windy day.

As the first year ended, BPR General Counsel Clifford W. Enfield said, "Perhaps the greatest advancement to be enjoyed by Americans during the 20th century may not come about because of nuclear energy, startling medical advances, or interplanetary communications, but by enactment of the Federal-Aid Highway Act of 1956." He added, "This legislation calls for environmental changes for the United States on a scale so staggering as to dwarf any prior peacetime endeavors of mankind."

Enfield called it "America's New Design for Living."

Pivotal Year: 1957

The highway engineers who launched the Interstate System may, perhaps, be forgiven for thinking they would be part of one of the most popular programs in American history. Today, with the automobile long since a key part of the American way of life, traffic volumes increasing every year, congestion in cities sapping urban energy, suburban life spreading into exurban sprawl, and continuing concern about highway safety, the system's popularity may have decreased a bit. But in the 1950s, support for Interstates was widespread and bipartisan. During the debates in Congress in 1955 and 1956, no opposition was expressed whatsoever.

As the first fiscal year of the Interstate program ended in June 1957, Tallamy reported that based on engineering and economic studies, BPR had approved 80 percent of the locations within the original 65,000-kilometer (40,000-mile) limit. Further, State highway agencies completed improvements on 1,190 kilometers (737 miles) of the Interstate System at a total cost of $173.3 million (Federal share: $117.8 million). BPR added that planning and construction were "going on at a furious pace throughout the Nation."

But Tallamy acknowledged that problems had been encountered. For example, he noted that

AASHO Road Test

The design of pavements and bridges on the Interstate System largely followed the results of a road test by the American Association of State Highway Officials (AASHO).

The test site in Ottawa, IL, was financed by the State highway agencies, BPR, U.S. Department of Defense (DoD), Automobile Manufacturers Association, American Petroleum Institute, American Institute of Steel Construction, foreign countries, and U.S. materials and transportation associations. The Highway Research Board administered the project.

Aerial view of the AASHO road test site in Illinois.

In August 1956 workers began constructing 11.3 kilometers (7 miles) of two-lane pavements in the form of six loops and a tangent (straight), half concrete and half asphalt. The 836 test sections employed a range of surface, base, and subbase thicknesses, and included 16 short-span bridges. Test traffic was inaugurated on October 15, 1958, with DoD providing drivers and heavy vehicles. The road test ended November 30, 1960.

The test data established the relationships for pavement structural designs based on expected loadings over the life of a pavement. Although the bridge findings were consistent with predictions, the road test provided the foundation for the analytical evaluation of stresses and deflections from moving vehicles.

The AASHO road test is a landmark in highway and bridge design. The straight portion of the track is now part of I–80 in Illinois.

engineers and steel were in short supply. Indeed, throughout 1957, highway engineers would be buffeted by surprises, even shocks.

One of the problems was a requirement in the 1956 act that the States hold public hearings to consider the economic effects of the location if a Federal-aid highway project involved bypassing or going through a city, town, or village. Based on early experience, AASHO Executive Secretary A. E. "Alf" Johnson warned highway officials that the hearings required "the finest in public relations" and must present "factual data and logical reasons."

Right-of-way acquisition was another concern because so much of the Interstate System would be built on new locations. State highway agencies had rarely needed to acquire land or to do so by eminent domain. The States needed new legislation, standards, appraisers—and they needed them quickly. The first problems arose in Indiana, where speculators were buying land in the Interstate corridors to resell to the State at "preposterous profits," as *The Washington Post and Times-Herald* reported.

Perhaps the greatest shock of 1957 involved the urban routes, which—contrary to the estimate of requiring just $4 billion of the total $27 billion—would take about half the Interstate funds. From the earliest description of the Interstate System, in BPR's 1939 report to Congress *Toll Roads and Free Roads*, the goal was to use the new highways to invigorate blighted urban areas, reverse suburbanization, and restore city tax bases. To achieve these goals, BPR had used sampling techniques developed with the U.S. Census Bureau to conduct extensive urban origin-and-destination surveys and worked with State and local officials before designating the urban Interstates in 1955. BPR urged the States to concentrate on projects in urban areas because that was where the need for traffic relief was the greatest.

The highway community would find out how hard providing that traffic relief would be at a September 1957 conference in Hartford, CT, on the effect of highways on metropolitan areas. Tallamy, reinforcing statements by Administrator Albert M. Cole of the Housing and Home Financing Agency, told conference attendees that "we have the chance of a century to make our cities sparkle brightly among our Nation's brilliant collection of really wonderful cities." The Interstate System, he added, was "probably the greatest single tool" in reversing urban problems.

Tallamy recognized, however, that

Signs of Progress

Although 1957 held serious controversy for the Interstate System, the year included considerable progress. AASHO and BPR, for example, applied the route numbers to the Interstate highways in September. They adapted the U.S. numbering plan for the system, but in mirror image. Where the lowest, odd-numbered, north-south U.S. route was on the East Coast (U.S. 1), the lowest, odd-numbered Interstate route would be on the West Coast (I–5). Similarly, the lowest, even-numbered east-west U.S. route ran along the Canadian border (U.S. 2), while the corresponding Interstate route was in the South (I–10).

The Interstate sign was unveiled at the same time. The States had submitted designs that AASHO then narrowed to four. Full-size versions of the signs were erected on a road near the AASHO road test site while a special meeting of the organization was underway in August 1957. State highway officials were able to observe the signs in daylight, dark, rain, and shine. They decided on a combination of designs submitted by Missouri and Texas—the now familiar red, white, and blue shield.

as soon as "a fine new highway project" is developed, "there will develop forces opposed to it." He was confident that those who criticized the program the most at the start would "probably be pushing the real supporters of the program in the background at the finish so they can cut the ribbons and take the credit they do not deserve."

The final speaker at the conference, nationally known author and social scientist Lewis Mumford, was skeptical, however. "We have good reason to be anxious," he said, since it was obvious "that neither of these Administrators had the slightest notion of what they were doing."

The real blame fell on Congress, Mumford said, which approved the 1956 act based on a study of highways, "not a study of the real problems." It had been "jammed through Congress so blithely and lightly," Mumford said, "on a dubious pretext," namely America's love of the automobile and the idea that it was "a necessary part of our defense program." He dismissed the latter claim as "nonsense" because "there is no defense against total extermination in nuclear warfare, no defense except peace."

The conference made national news, painting the highway experts as the "bad guys." The consensus among critics was that the urban Interstates should be suspended until comprehensive land use plans could be drawn to incorporate them.

The initial reaction of State highway officials is reflected in a speech by AASHO President William A. Bugge to a regional AASHO branch. He rejected the suggestion that highway officials needed "some expert assistance from outsiders." The idea of a 2-year moratorium for urban Interstates, as some had called for, "is a bit ridiculous," because the "economic penalties for delaying already vitally needed facilities for another 2 years would be tremendous," he said.

Despite the warning signs, the highway community had much to celebrate as 1957 ended. The States broke the record in dollars invested in all highway development by spending nearly $4.6 billion. Through December 1, more than $1 billion in Federal and State funds had been committed to Interstate projects, and projects totaling $247 million were completed.

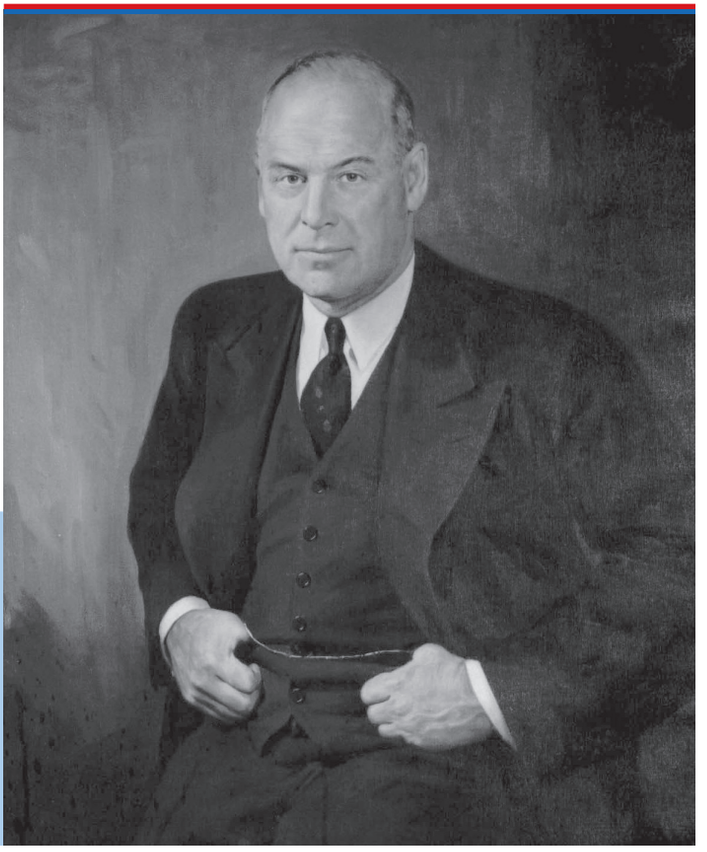
Funding Problems

Secretary Weeks released the first Interstate Cost Estimate (ICE) in January 1958. It covered 62,037 kilometers (38,548 miles) of the Interstate System (excluding mileage added in 1957) and pegged costs at $37.6 billion (Federal share: $33.9 billion). However, the Secretary did not see a need for additional authorizations. As techniques for estimating costs were refined, he said, future estimates would more accurately reflect trends "either upward or downward." Until then, an increase in funding "would be premature."

The Secretary's caution was soon confronted by economic reality. By August 1957 the country had slipped into a recession that would increase unemployment to 7 percent and reduce corporate profits by 25 percent by April 1958. One of the reasons the President had promoted the Interstate System was to counteract just such a situation—so that he would have a public works program that could be expanded or contracted to influence the economy.

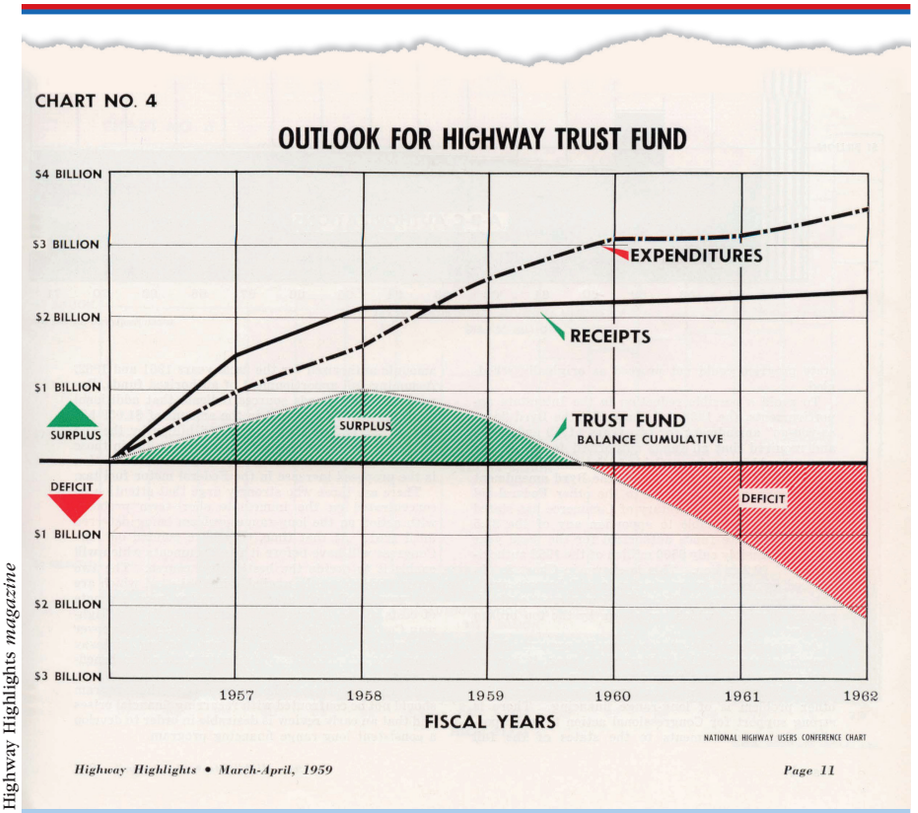
To stimulate the economy and avoid losing momentum, Congress passed the Federal-Aid Highway Act of 1958. It increased Interstate funding by $800 million for FYs 1959–1961 and included an emergency increase of $400 million for the Federal-aid systems in FY 1959.

Because these increases occurred without a change in taxation to boost revenue, the 1958 act also suspended the 1956 law's "Byrd Amendment"—for deficit hawk Senator Harry Flood Byrd (D–VA)—which required the Commerce Secretary to hold apportionments below the point of creating red ink in the Highway Trust Fund.



U.S. Department of Agriculture

Secretary of Commerce Sinclair Weeks, whose department included BPR, was a businessman from Massachusetts and chairman of the Republican Party's Finance Committee. President Eisenhower said of him, "This great highway system will stand in part as a monument to the man in my Cabinet who headed the department responsible for it, and who himself spent long hours mapping out the program and battling it through the Congress—Secretary of Commerce Sinclair Weeks."



Highway Highlights *magazine*

The National Highway Users Conference used this chart to illustrate the problems affecting the Highway Trust Fund in the late 1950s. The group explained: "The ascending solid black line represents cash receipts coming in each year to the Fund; the broken black line, annual cash expenditures. The shaded green areas show the cumulative surplus in the Trust Fund, and the shaded red areas the cumulative deficit."

President Eisenhower approved the legislation in April 1958, just as the recession was ending.

By the end of the year, Interstate construction expenditures exceeded trust fund receipts. Additional income would be needed to avoid reduced apportionments in FY 1961 under the restored Byrd Amendment. The looming crisis led many in the highway community to fear what the American Road Builders Association (ARBA) described as "a complete collapse of work on the Interstate System."

Critics attributed the funding imbalance to "gold-plating," especially in urban areas. They created the term "90-itis" to describe the attitude of State highway officials who, they said, had no reason to be economical because the Federal Government was picking up 90 percent of the cost. As Representative John A. Blatnik (D–MN) of the House Committee on Public Works would say, "Congressman after congressman got up on the floor of the House and made wild speeches, frightening speeches . . . saying we had a shortage of funds because the States were playing fancy-free and foot-loose with the taxpayers' dollars."

To maintain the construction schedule, President Eisenhower recommended a temporary 1.5-cent increase in the gas tax, but the Federal-Aid Highway Act of 1959 added only a penny (increasing the tax to 4 cents a gallon) through June 1961. The legislation, which the President approved on September 21, also reduced FY 1961 Interstate authorizations to $2 billion, but because of the Byrd Amendment, BPR could apportion only $1.8 billion.

While signing the 1959 act, President Eisenhower disclosed that he had asked a member of his staff, Major General John Bragdon (U.S. Army, retired), to study the Interstate program with attention to delineating Federal versus State and local responsibilities in financing, planning, and supervising the highway program. Bragdon also would be responsible for determining ways to improve coordination between planning for Federal-aid highways and State and local planning, especially for urban areas. At the same time, Speaker of the House Sam Rayburn (D–TX) appointed Representative Blatnik in September 1959 to head the Special Subcommittee on the Federal-Aid Highway Program investigating corruption allegations.

The Urban Problem

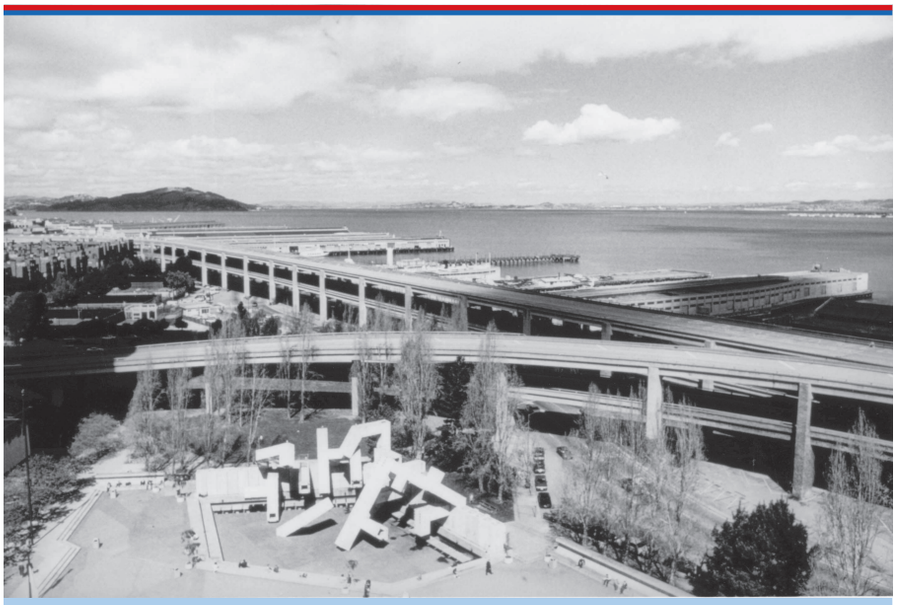
Shocked by the intensity of objections to the Interstate System from Mumford and others, the highway community tried to regain its footing by holding a summit at Syracuse University in October 1958. Committees of the American Municipal Association, AASHO, and Highway Research Board joined the university in what was billed as the first National Conference on Highways and Urban Development. Funded by the Automotive Safety Foundation, the conference featured highway officials and elected officials, primarily mayors, who supported the goal of making the Interstate System work for the orderly development of urban communities. The critics were not invited.

The goal was a "grand accounting" in which the advantages and disadvantages of each alternative for highway users and the community were to be evaluated. As E. H. "Ted" Holmes, BPR's assistant commissioner for research at the time, would recall many years later, "Probably no one present, however, had any notion of the difficulty of measuring the community costs and benefits."

The Urban Revolt Begins

If the highway community left the Syracuse conference with renewed optimism, it soon had a reminder of how difficult a challenge it faced in urban areas.

Several cities were seeing resistance to Interstates, particularly from those whose homes or businesses would be acquired for rights-of-way. In San Francisco, for example, opposition focused on the Embarcadero Freeway (I–480) that was to link the San Francisco-Oakland Bay Bridge (I–80) with the Golden Gate Bridge



Darius Aidala for the City of San Francisco

One of the earliest Interstate battles took place in San Francisco, CA, where the double-decked Embarcadero Freeway (I–480) became a focal point for objections. Although additional construction was blocked, the freeway remained in place until it was damaged by the Loma Prieta Earthquake in October 1989.

(U.S. 101). City officials had proposed the freeway in 1943 as a way of using a needed transportation artery to revitalize a blighted area near the Ferry Building and a former farmer's market. State highway officials used a double-deck design that they considered "an ultramodern highway facility." After the initial section opened in February 1959, it came to symbolize what the *San Francisco Chronicle* called "a crime which cannot be prettied up."

In January 1959, the Board of Supervisors of the City and County of San Francisco met to discuss the proposed Western Freeway (I–80) through the Sunset District. With more than 160 freeway opponents cheering, the board adopted a resolution opposing construction of all freeways in the San Francisco Master Plan. The resolution cited "the demolition of homes, the destruction of residential areas, the forced uprooting and relocation of individuals, families and business enterprises" as well as the loss of property from the tax rolls.

Concerns about the impact of the Interstate System on urban areas would be summarized in the April 14, 1960, issue of *The Reporter* magazine. "New Roads and Urban Chaos" was written by Daniel P. Moynihan, a professor who had served on the staff of New York Governor Averill Harriman. Moynihan began by quoting *The Wall Street Journal*'s description of the Interstate program as "a vast program thrown together, imperfectly conceived and grossly mismanaged, and in due course becoming a veritable playground for extravagance, waste, and corruption."

Moynihan declared that "the crisis has come. In one metropolis after another, the plans have been thrown together and the bulldozers set to work." At this late stage, metropolitan planning would be difficult, especially given the shortage of planners. Still, he said, "almost any effort to think a bit about what we are doing would help." He advocated funding flexibility because he was convinced that city officials would use at least 50 percent of the Interstate funding for mass transit and commuter facilities if they could.

Moynihan was sure the pending congressional investigations would turn up thieving, mischief, and blunder. "If not," he said, "it will be necessary to investigate the investigators," but he hoped for a more serious reappraisal in the next Administration. "We may yet impart some sanity and public purpose to this vast enterprise." He closed, "Roads can make or break a Nation."

As Ike Leaves Office

Meanwhile, the highway community awaited two reports, namely Bragdon's report to the President and the new ICE, both of which were expected to provoke additional concerns. Rumors about the Bragdon report were circulating for months, particularly that it would call for abandoning the urban Interstates, downsizing the program, and converting it to toll facilities. Bragdon and his staff had peppered BPR with questions and requests for a year before issuing a 12-page report embodying these concepts just 3 days before the end of the Eisenhower Administration. It was quickly forgotten.

Although Bragdon's untimely report was ignored, Congress could not ignore the 1961 ICE. This estimate, submitted to Congress on January 11, put the total cost of the Interstate System, including past expenditures, at $41 billion (Federal share: $37 billion). Based on work underway and previous authorizations of $25.4 billion, Congress would have to authorize an additional $11.5 billion to complete the Interstate construction program on schedule—or scale it back.

As the Eisenhower Administration ended on January 20, 1961, 16,802 kilometers (10,440 miles), or 25 percent, of the Interstate System was opened to traffic. More than $10 billion was spent. Lingering concerns would need to be addressed by incoming President John F. Kennedy and his appointed officials. General L. W. Prentiss, executive vice president of ARBA, put the situation facing the Interstate System in stark terms: "The highway program is in for the battle of its life."

To be continued in the May/June 2006 issue of PUBLIC ROADS magazine.

Richard F. Weingroff is the information liaison officer in the FHWA Office of Infrastructure.

For more information on the early days of the Interstate System, visit www.fhwa.dot.gov/interstate/homepage.cfm or www.fhwa.dot.gov/infrastructure/history.htm.

Multipedestrian Tracking

by David R. P. Gibson, Bo Ling, Michael Zeifman, Shaoqiang Dong, and Uma Venkataraman

A new detection system using computerized stereovision promises greater pedestrian safety in the years ahead.

Every year, nearly 5,000 pedestrians are killed in traffic incidents in the United States. To improve safety in the roadway environment, researchers at the Federal Highway Administration (FHWA) are applying the latest technologies to detect and track pedestrians in crosswalks. Accurate computer tracking of pedestrians offers the possibility of developing in-vehicle instruments for helping motorists detect and avoid individuals in crosswalks. It also could lead to provision by the traffic control system of safe "walk" and "don't walk" clearance periods for pedestrians.

(Above) New research at FHWA to track pedestrians like these crossing a street in a crosswalk promises to reduce fatalities and injuries. *Photo: AAA Foundation for Traffic Safety.*

A five-member team of FHWA researchers and contractors deployed a set of two video cameras aimed at an intersection from various angles, using the cameras and a computer to record the movements of pedestrians. An important component of the research was to distinguish multiple people from each other and the intersection's background environment. The system also estimated the pedestrians' walking speed and their location as they traversed the intersection.

"We need to find ways to know that pedestrians are at intersections and need to be served," says Tom Dodds, P.E., pedestrian and bicycle engineer, South Carolina Department of Transportation (SCDOT). "I have noted here in South Carolina that pedestrians are not always particularly amenable to locating and pushing the pedestrian button. It would be more critical to locate pedestrians during nighttime as opposed to daytime because drivers have a more difficult time seeing and perceiving pedestrians [at night]. Nighttime conditions, along with various foul weather scenarios, are critical for pedestrian safety."

In addition to offering the potential for reducing injuries and fatalities at intersections, the FHWA line of inquiry may soon be reflected in new in-vehicle instrumentation or other technologies that could reduce vehicle-pedestrian crashes.

Need for Passive Detection

William C. Kloos, P.E., signals and street lighting division manager for the city of Portland, OR, lays out the case for passive detection of pedestrians: "Accurate and reliable detection of pedestrians and bicyclists is a key to providing safer and more

efficient traffic signal operations," he says, citing various reasons:

"At several locations in Portland, pedestrians will push the pedestrian button, but if a gap appears in traffic, will cross against the signal. Shortly after that, the pedestrian phase comes up, but no pedestrian is there. Motorists wonder why they are stopping. If we had reliable pedestrian detection, we could cancel the call [because] the pedestrian phase is served."

Kloos continues: "At many locations, pedestrians don't realize that they have to push the button to get the pedestrian phase. With reliable passive detection of pedestrians, the button would not be needed. We currently use passive detection to extend the pedestrian clearance interval for pedestrians. This method allows us to program the minimum pedestrian clearance time but extend that time as needed for slower pedestrians.

"Passive detection of pedestrians can improve our service to pedestrians with special needs. At many existing intersections, the push buttons may be located some distance from the curb. This location issue is difficult for people in wheelchairs and for people who have low vision. The bicycle mode shift is continuing to increase. With improved bicycle detection we could improve the timing of signals to meet the unique performance needs of cyclists."

Regarding the possible benefits derived from passive detection for those with low vision, the United States Access Board recently released its latest version of the *Draft Guidelines for Accessible Public Rights-of-Way,* which will require the installation of accessible pedestrian signals at all new signalized pedestrian crossings.

Challenges In Computerized Pedestrian Detection

Vision-based pedestrian detection in an outdoor environment is a challenge. Although it may be simple for the human eye to visually survey an outdoor scene, this task is highly problematic for a computer. In computer vision, the image is divided into elements (pixels). Each pixel carries information about color and luminance (defined here as intensity information). To pinpoint a certain part of an image, the computer must use meaningful selection criteria, such as object appearances. The problem is complicated by the fact that people dress in colors that sometimes blend with the background; wear hats or carry bags; and stand, walk, and change direction unpredictably. Further, the appearance of the background environment varies considerably with the presence of stationary elements, such as buildings, street signs, traffic signals, and parked cars, as well as moving objects, such as moving vehicles, bicycles, and pedestrians.

The traditional approach to computer-aided pedestrian detection is based on the use of a single video camera. Three different methods are in use to date: template matching, background subtraction, and motion-based detection.

In the *template matching* approach, researchers create a library of possible visual patterns of pedestrians to seek similarity between a segment of the actual video frame and a library image, or *template*. Once such similarity is found, the frame part is classified as a pedestrian image. Although this approach can be useful in some circumstances, the FHWA researchers deemed this approach not very efficient because it requires the creation of a huge library of templates.

The goal of the *background subtraction* approach is to extract the pedestrians from the background. The key here is prior knowledge of the background setting. If the background is fixed, the researcher can easily "subtract" the pedestrian from subsequent registered images. When the background is not fixed, certain statistical background models may be substituted. The major drawback of this approach is the lack of generalization, which means the model may not be valid when the background settings are relatively new.

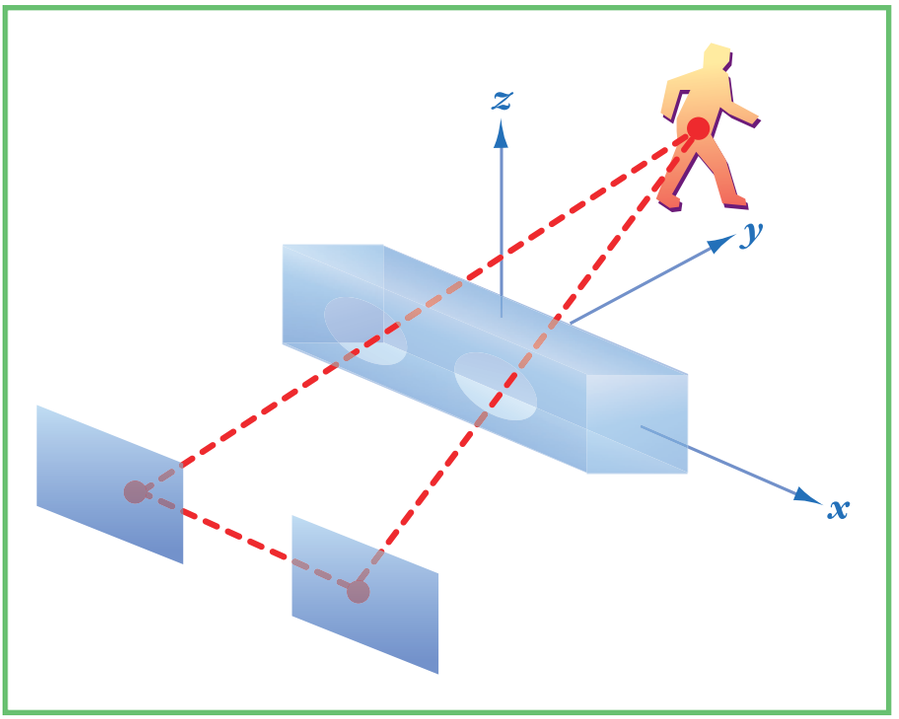
In *motion-based detection*, the researcher assumes that pedestrians are moving and that all moving objects can be treated as potential pedestrians. Although it is relatively easy to detect moving objects from registered image frames, researchers have found that it is not so easy to discriminate moving pedestrians from other moving objects, such as vehicles.

These traditional approaches may be insufficient for real-world conditions with multiple people and moving backgrounds. A recently proposed three-dimensional (3-D) stereovision approach allows distances to features to be estimated, thus enabling identification and tracking of pedestrians. This approach uses two video cameras surveying the same area from different viewpoints. The difference in the viewpoints causes a relative displacement, or disparity, of the corresponding features in the stereo images. This disparity prompts the system to embed information on distance between objects and the cameras. Typically, when a single monocular camera captures a 3-D scene, this information on distance is lost. With stereovision, the distance

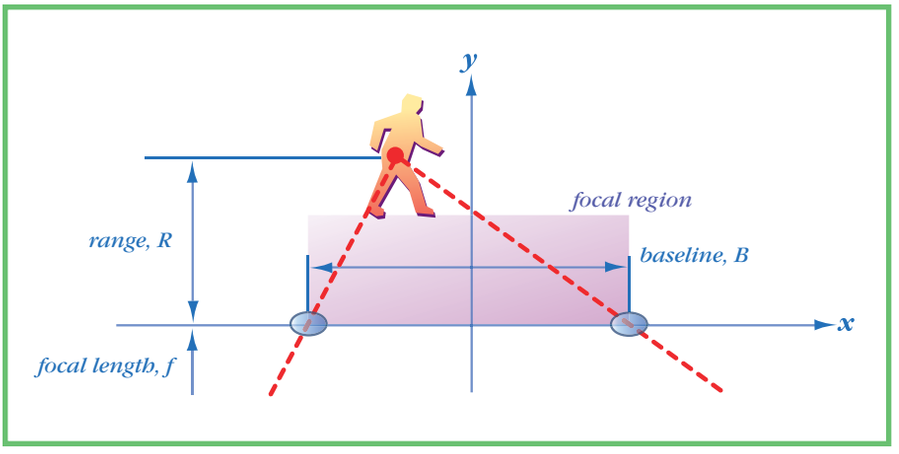
Intelligent Vehicle Initiative

FHWA's work in multipedestrian tracking is one of the latest studies under the U.S. Department of Transportation's (USDOT) Intelligent Vehicle Initiative (IVI), a research and development program focused on vehicle safety and driver information systems. IVI is a multiagency effort involving FHWA, the National Highway Traffic Safety Administration, and the Federal Transit Administration. USDOT's Intelligent Transportation Systems (ITS) Joint Program Office provides a single budget for the agencies' vehicle-related ITS projects, economizing resources and fostering synergies in research. IVI's role is to research and advance integrated concepts that have safety implications or benefits that are not likely to be accounted for by the marketplace or are too far from commercialization to be of interest to most companies.

IVI projects have investigated the human factors, user acceptance, and technical development of individual driver information systems, advanced collision-avoidance and vehicle safety systems, and automated highway systems. An increasing number of IVI applications rely on pedestrian monitoring: traffic control, security monitoring, pedestrian flow analysis, and pedestrian counting, among others.



The diagram shows the basic stereo camera formation in three dimensions, *x*, *y*, and *z*. The rectangular box represents a stereo camera with two lenses. The other boxes represent the focal planes within the camera, and the plane outlined by the dashed triangle is called the epipolar plane. *Source: Migma Systems, Inc.*



This figure shows a 2–D view of a stereo camera formation. The line between the right and left focal centers is called the baseline, *B*. In general, *B* is quite small. For instance, the baseline is just 12 centimeters (4.7 inches) in the stereovision system set up for FHWA's research. The distance between the image plane and focal center is called focal length, *f*. The area between right and left focal rays is the focal region. The factor of most interest is the distance between the object and stereo camera baseline, often called range, *R*. *Source: Migma Systems, Inc.*

to a vertically aligned object such as a pedestrian will be relatively shorter than that to the ground beyond the pedestrian or to background objects around the pedestrian. This is the key feature in pedestrian detection using stereovision.

Even though use of a stereo image is a major step forward in finding vertically aligned objects among background "noise," several challenges still need to be overcome to apply the method to pedestrian detection and tracking.

Why Use Stereo Disparity?

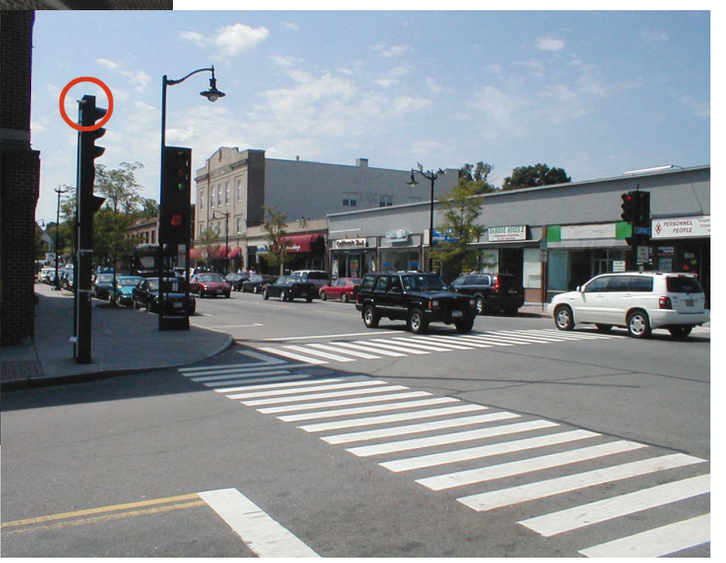
Stereopsis is the process in visual perception leading to depth perception, or the distance of an object from a viewer. The term comes from two Greek roots: *stereo*, meaning solidity, and *opsis,* meaning vision or sight. Computer stereovision entails recovering the 3–D information from two images of the same scene taken by two cameras in slightly different locations. Motion analysis looks at a sequence of images taken at different times and attempts to locate and measure movement between them. The challenges of using stereopsis and motion analysis are similar, both essentially involving a correspondence problem, a process of matching the same object in two or more images. In both cases the key task is to locate the image of a scene point in a set of images.

To create computer stereopsis requires three conditions. First, the stereo cameras each need to have a pair of thin lenses. Next, the two focal rays of both lenses have to be parallel and perpendicular to the stereo baseline. And, finally, the image planes of both lenses are colinear, which implies that both of these planes lie on a single plane. Assuming that these criteria are met implies that the third axis, z, can be omitted in a disparity analysis. By properly rotating the x-y-z coordinate system, researchers can visualize a 3–D formation in a 2–D representation.

One of the main advantages of using a stereovision system is to relate the distance between the object and camera baseline and the disparity obtained from two images taken by the right and left lenses. When the object lies outside the focal region (a rectangular region between two lenses), the disparity is essentially the difference between the locations of a scene point in both right and left images. Many researchers have concluded that range is inversely proportional to the disparity. However, this statement is correct *only* when the scene point is located outside the focal region.

When the object point is inside the focal region, the range and disparity are not inversely proportional. To minimize the impact of the discrepancy, the baseline of the stereo camera needs to be small. A small

(Left) This stereo camera is attached to a traffic signal pole at an intersection. *Photo: Migma Systems, Inc.*



(Right) FHWA researchers installed a stereo camera at this intersection in Norwood, MA. *Photo: Migma Systems, Inc.*

baseline also facilitates estimating the disparity values (or "disparity map" when the entire image is considered) because both right and left lenses will most likely take images from the same scene.

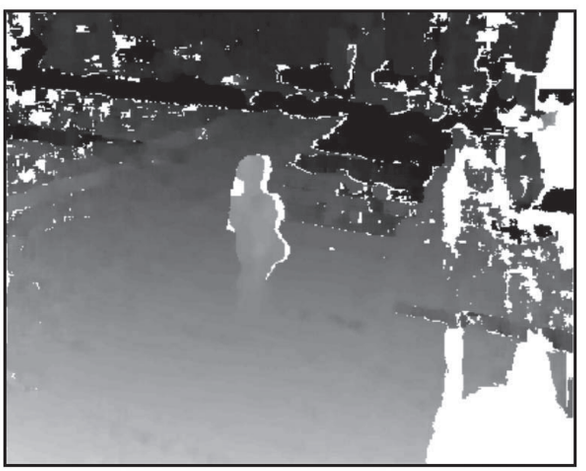
Now the remaining question is how to estimate the disparity values. In a typical disparity estimation scheme, finding conjugate points in the right and left images is one of the main problems. The search is typically based on a matching process that estimates the similarity of points in the two images on the basis of local or punctual information. Researchers typically use one of three methods: the correlation- or feature-based approach, intensity-based approach, or phase-based approach.

Feature-based methods require fairly advanced image analysis to identify features by treating pixels differently. They can be more reliable than intensity-based methods, especially for long-range correspondences, if a sufficiently dense and reliable feature map can be computed. Feature-based approaches also suffer from high computational load and classification problems.

Intensity-based methods do not require feature identification, as all pixels are treated identically. Apart from block matching, intensity-based methods using deterministic or statistical methods to solve the matching problem of disparity estimation have been predominant.

Over the past decade, many researchers have viewed the *phase-based approach* as one of the most effective methods of disparity estimation. This approach relies on the fact that the depth information from the left and right raw images can be related to the local phase difference between them.

In the FHWA stereovision system, the disparity is estimated based on feature matching.



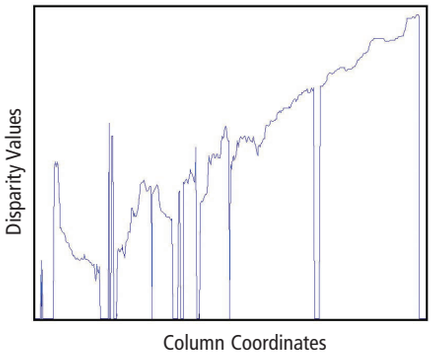
Migma Systems, Inc.

This disparity map shows a pedestrian in the center. As sometimes happens in disparity maps, the pedestrian's legs have merged into the background. The holes (white patches) represent the invalid disparity values, which mean that no disparity information at those pixels is available.

Stereovision System at FHWA

The FHWA stereovision system features a camera that has two lenses (left and right) with a resolution of 1,024 by 768 pixels, a 12-centimeter (4.7-inch) baseline, and a 70-degree horizontal field of view. As the camera is not self-powered, the researchers

Disparity Values Versus Column Coordinates



In this figure the *y*-axis represents the disparity values and the *x*-axis represents the column coordinates in the disparity map. The researchers observed that the disparity values increase (although not monotonically). Therefore they can detect the pedestrians in individual layers of the disparity map. *Source: Migma Systems, Inc.*

connected it to a laptop, which provides the power to the stereo camera. The researchers used the application programming interface from the camera's manufacturer for data collection and estimating the disparity map. Various stereo parameters, such as image resolution, mask size, validation, and disparity range, were used for calculating the disparity. The researchers used a software program to adjust the values of the parameters for the images. To collect data, the camera was mounted on top of a pole 2.7 to 7.3 meters (9 to 24 feet) high. The pole was tied to a traffic light pole at an intersection.

In the FHWA system, the data sampling rate was 5 to 15 frames per second (fps). The actual sampling time depends on the speed of both data transmission and the computing platform. The researchers chose a sampling time of 5 fps. After analyzing the average speed of a pedestrian walking across a street, they decided to set the data collection time at 12 seconds, which is equivalent to 60 frames per dataset. The researchers then used the stereovision system to record pedestrians crossing street intersections. A total of six sets of images were collected during sunny, partly cloudy, and cloudy days. Instances when both single and multiple pedestrians were crossing the intersection were included for each weather condition. (Note: The datasets are available from FHWA upon request. See the authors' note at the end of the article.)

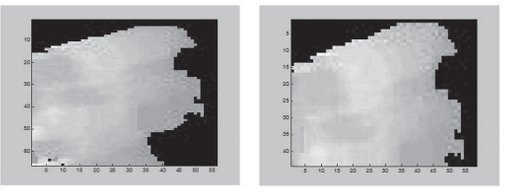
Disparity Layered Thresholding

A disparity map is often used in stereovision systems. In general, the size of the map is the same as the size of either the right or left image. Each pixel represents the disparity value at the corresponding pixel, not the intensity value of the image. Since the disparity value is somewhat related to the range (distance between the object and stereo camera baseline), a disparity map can be viewed as a 3-D image. Holes or white patches in the map represent the invalid disparity values, which mean there is no disparity information at those pixels.

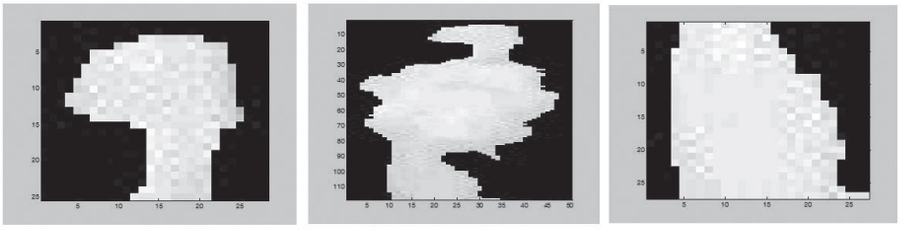
In a disparity map, some elements of the background near some features of the pedestrian, such as the pavement and the pedestrian's feet, are at approximately the same distance from the camera. This means that the disparity values will be similar and that it is difficult to separate the pixels associated with the pedestrian's feet from those associated with the pavement by the disparity values alone. The shapes associated with the pedestrian in the map may vary from those in the original right or left images. In fact, the pedestrian shapes in the map largely depend on the way disparities are calculated, which implies that the texture of the clothes a pedestrian is wearing will alter his or her disparity shapes. Therefore, the traditional template-matching approach will be less reliable in detecting the pedestrian in a disparity map.

To overcome this problem, the researchers developed a "thresholding" method based on the estimation of background boundary values. Because the disparity values are usually (but not always) inversely proportional to the ranges, they expected that the disparity values along the vertical lines would increase in a disparity map. In such a plot, the *y*-axis represents the disparity values and the *x*-axis represents the horizontal coordinates in the disparity map. The researchers observed that the disparity values increased (although not monotonically due to the noise in the disparity map), therefore they could analyze the disparity map in a layered fashion and detect the pedestrians in each layer.

To separate the pedestrians from the background, the researchers developed an estimation algorithm for the background boundary. They estimated the values for the boundary in each thresholded disparity map. For each map, they applied the morphological operator, a method



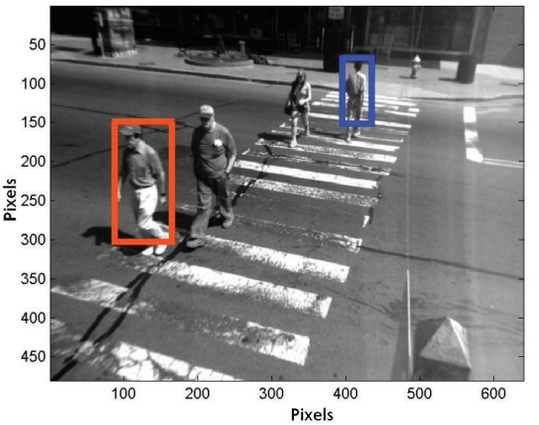
This figure shows two small disparity chips representing various background parts. *Source: Migma Systems, Inc.*



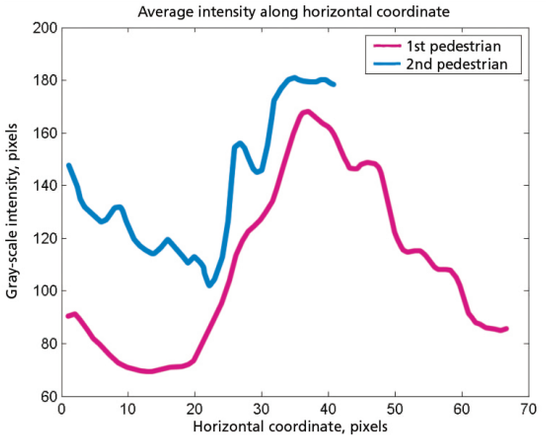
This figure shows three small disparity chips representing various body parts of a pedestrian. *Source: Migma Systems, Inc.*

Projection Intensity Features

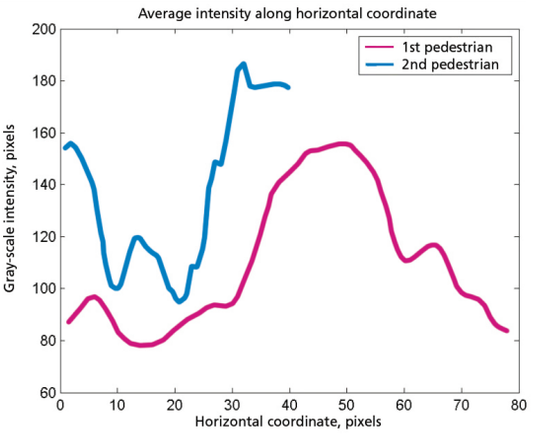
Frame k_1 with two windowed pedestrians.



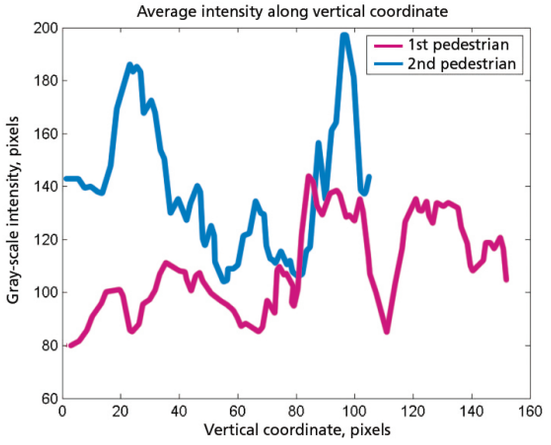
Frame k_2 with two windowed pedestrians.



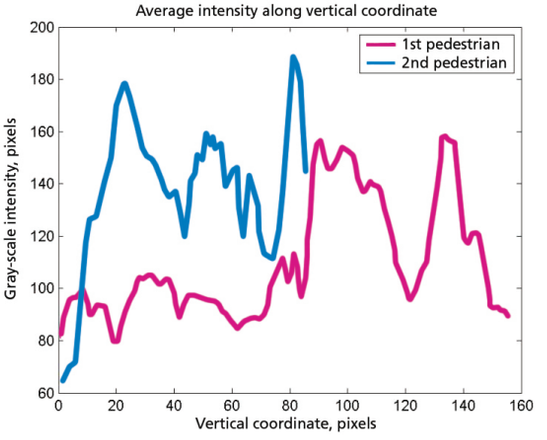
X-projection intensities for the selected pedestrians, frame k_1.



X-projection intensities for the selected pedestrians, frame k_2.

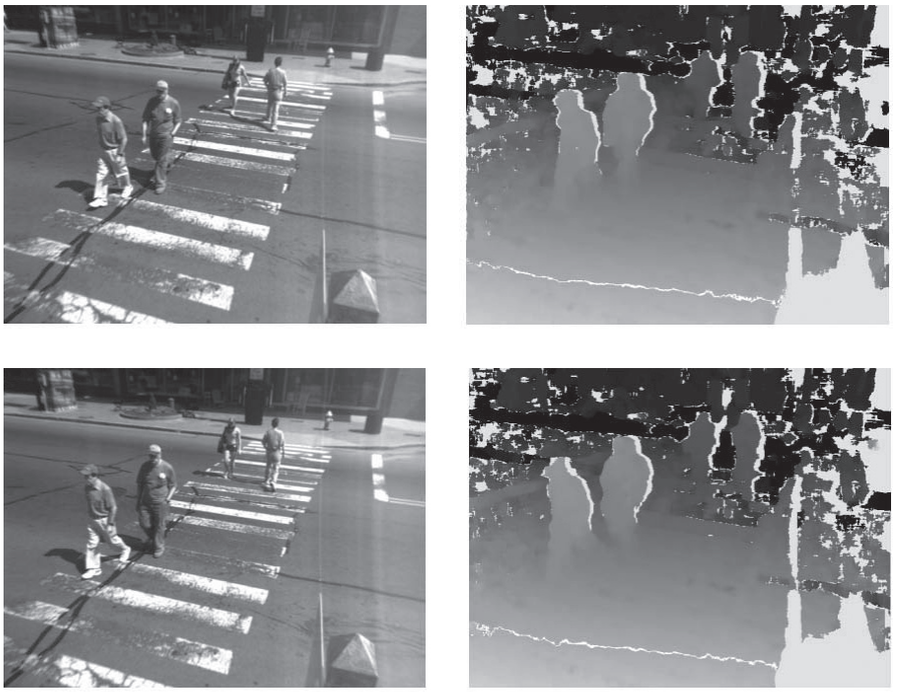


Y-projection intensities for the selected pedestrians, frame k_1.



Y-projection intensities for the selected pedestrians, frame k_2.

This figure illustrates the principle of continuous pedestrian tracking. The two frames of video image (top left, k_1, and top right, k_2) were shot with a time difference of 1.2 seconds. Red and blue windows indicate corresponding pedestrians in the two frames. Both the pedestrian images and the corresponding windows appear different in these frames. The projection intensity curves, however, shown in the plots below, remain quite similar, which makes it possible to use the projection intensity as a distinctive pattern feature. In addition, the pixel distance between the same pedestrians on the different frames is usually smaller than the distance between different pedestrians, though this may not always be true. The simultaneous use of these two features permits both continuous tracking of the detected pedestrians and elimination of background objects that were accidentally classified as pedestrians. *Source: Migma Systems, Inc.*



Migma Systems, Inc.

This figure shows two consecutive images (left, top and bottom), and their respective disparity maps (right, top and bottom), taken at a sampling time of 200 milliseconds.

used in image processing to analyze structured objects, to fill small holes and convert the resulting disparity layer into a binary image. In the binary image, they used a linear regression model to construct a background boundary line that was used to window out all potential pedestrians in the layered disparity map. With this approach, the potential pedestrian was gradually extracted from the image. The number of disparity layers depended on the original map. In other words, the researchers did not fix the number of disparity layers.

Detecting Pedestrians Using 3–D Convex Curvature

A common problem associated with the template-matching approach is the selection of a template library general enough to account for the changes in rotation, scale, brightness, and viewpoints found in the real world. To overcome this problem, the researchers developed a new method for pedestrian detection based on the disparity map. Instead of applying existing templates, they used a 3–D convex curvature feature to detect pedestrians in each layer of the map.

The researchers developed an algorithm to extract "chips," or parts, of the pedestrian's body (head or upper body, for example) and the background at various disparity layers. Without being able to match the templates with the various body parts, it is almost impossible to know whether a particular chip contains only the head or head and upper body. As noted earlier, pedestrians in a disparity map do not have regular shapes. In other words, the researchers concluded that it would be impossible to build a library of templates for all possible shapes of pedestrian body parts, and therefore they decided that a different approach would have to be taken to detect the pedestrian in the disparity map.

The approach the FHWA researchers took was to extract 3–D features. In particular, they looked for curvatures in the disparity chips. Unlike street signs and other background objects in the roadway environment, the human body has distinctive 3–D curvatures similar to a sphere (head), plane (body), and cylinder (legs). The researchers therefore used the 3–D convex feature to detect the pedestrian in a disparity chip. In particular, for each row of chips, a parabolic curve was used to fit the row's disparity values. The researchers then checked whether the fitting curve was convex or concave. They applied this discrimination rule to the disparity chip extracted at each layer. If a pedestrian body part (such as the head or upper body) was detected, it could be extracted out, with the window size estimate based on the chip size. Once the entire frame was processed, all the small windows were combined to form a large window that contains the pedestrian.

Continuous Pedestrian Tracking

The detection method described above neither guarantees that the pedestrians will be detected in the same order in each video frame nor that the resulting analysis will be free of false alarms (false detection). The ultimate goal of the entire system is to continuously track pedestrians and predict their location. The researchers therefore had to ensure continuous tracking of detected pedestrians and eliminate false alarms. In identifying the pedestrians and discerning their images from false alarms, the research team used two independent features: the geometric location and the average projection intensities of the images along either the rows (x intensity) or columns (y intensity).

Many researchers have used the geometric location of the image window center on the image frame in pattern recognition. Others have developed and implemented studies using projection intensities.

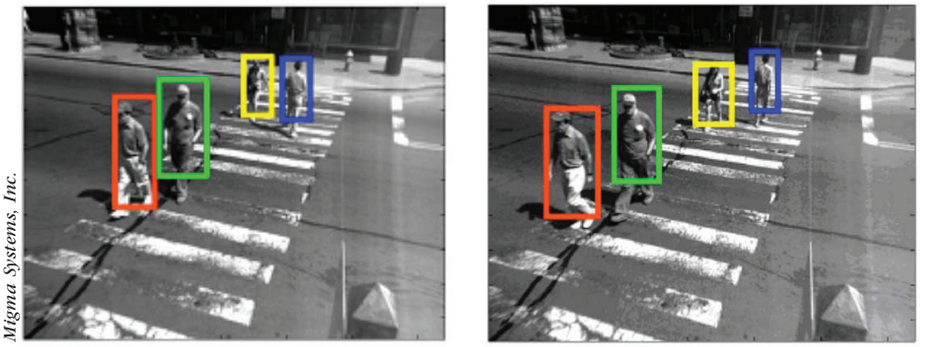
System Test Results

The researchers tested their pedestrian detection method with a large number of images taken with the stereovision system. The images were captured at actual street intersections during sunny, partly cloudy, and cloudy days. Both single and multiple pedestrians were recorded.

The researchers then examined and analyzed the images and their respective disparity maps. For example, they looked at two images that were taken at an intersection on a sunny day, each showing four pedestrians crossing the street in a crosswalk. From the disparity maps they found that it was easy to identify the first two pedestrians, those closest to the camera. The other two

pedestrians, although visible in the disparity maps, are not so clear. The researchers expected this to be the case because the latter pedestrians were about 6.4 meters (21 feet) away from the camera, while the former pedestrians are about 2.7 meters (9 feet) from the camera.

To detect the four pedestrians, the researchers first used the disparity thresholding algorithms to obtain a set of disparity layers. They then detected the potential pedestrians in each layer by checking the 3-D convex curvature features. If they detected a pedestrian in a particular layer, he or she was windowed out, signifying detection. At the end, all windows were combined to extract the entire pedestrian. The researchers then applied the Bayesian classifier, a statistical method for object classification, to associate the pedestrians detected over consecutive image frames. The approach successfully detected all four pedestrians, and the researchers windowed each with a different color coding to facilitate correlating the pedestrian association in consecutive frames.



Migma Systems, Inc.

The approach successfully detected all four pedestrians. Each is windowed with a different color coding, indicating the pedestrian association in consecutive frames.

Conclusion

In summary, the new multipedestrian detection system comprises several key modules: (1) a disparity-layered thresholding method that can be used to extract potential pedestrians layer by layer, (2) pedestrian detection with a 3-D convex curvature feature that can be used to window out pedestrians in each disparity layer, (3) continuous pedestrian association that correlates the same pedestrian in subsequent frames, and (4) estimation of pedestrian speed and location.

The initial focus of the data collection for this research was limited to collecting data on pedestrians in the crosswalk in order to validate the research approach. Phase II will extend this to detecting and tracking pedestrians both in the crosswalk and on the curb.

After testing the system using actual images taken with a stereo-vision system at street intersections, the research team concluded that the results show that the system has significant potential for use in Intelligent Vehicle Initiative (IVI) applications.

Eventually, the researchers will incorporate the software algorithms into selected hardware platforms deployed at intersections, using wireless communications to traffic controllers. FHWA also needs to further improve the technologies to increase the detection accuracy and reduce the system cost.

Once the detection system developed in this research is refined, State departments of transportation will be able to use it in their pedestrian safety programs. As South Carolina's Dodds says, "Systems that better enable pedestrians and motorists to share the pavement safely at the same time would be worthy of consideration."

David R. P. Gibson is a highway research engineer on the Enabling Technologies Team in FHWA's Office of Operations Research and Development. He is a registered professional traffic engineer with bachelor's and master's degrees in civil engineering from Virginia Polytechnic Institute and State University. His areas of interest include traffic sensor technology, traffic control hardware, traffic modeling, and traffic engineering education.

Bo Ling received his M.S. in applied mathematics in 1990 and a Ph.D. in electrical engineering in 1993 from Michigan State University. Ling has served as a principal investigator for numerous government-funded research projects. He is a cofounder and president and chief executive officer of Migma Systems, Inc. He became a senior member of the Institute of Electrical and Electronics Engineers, Inc., in 1998 and is a part-time faculty member of the Department of Electrical and Computer Engineering at Northeastern University in Boston.

Michael Zeifman has a degree in materials science and metallurgy from Leningrad Polytechnic Institute (now St. Petersburg State Polytechnic University) in Russia (1987), an M.Sc. in quality assurance from Technion-Israel Institute of Technology in Israel (1997), and a Ph.D. in physical reliability, also from Technion-Israel Institute of Technology (2000). After years of industry and university research, he joined Migma Systems, Inc., as a senior research engineer in 2005.

Shaoqiang Dong received his Ph.D. from the University of Massachusetts at Amherst in 2004. He received his M.S. (1997) and B.S. (1994) degrees, both in mechanical engineering, from Xi'an Jiaotong University in China. He joined Migma Systems, Inc., as a research engineer in 2004.

Uma Venkataraman received her M.S. in computer science from Madras University in India (1996), and she has several years of software development experience. She joined Migma Systems, Inc., as a senior software engineer in 2003. She focuses on software development.

Authors' note: The system reported in this article was developed under USDOT SBIR Phase I funding (Contract No.: DTRT57-05-C-10105). For more information, contact Dr. Bo Ling, 508-660-0328 or bling@migmasys.com.

Along the Road

Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation (USDOT) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Technical News

FHWA Hosts One-Stop Shop For Pavement Information

A wealth of pavement information is now available with one click at www.fhwa.dot.gov/pavement. The Federal Highway Administration's (FHWA) new topic-based Web site is the one-stop destination for information on topics from pavement design and construction to maintenance and rehabilitation.

Site users can select a specific topic, such as design, or choose from focus areas, such as optimized pavement performance, advanced quality systems, pavement surface characteristics, or environmental stewardship. Also featured are lists of publications, software, upcoming conferences and events, and workshops and training, including courses available from the National Highway Institute. Technical guidance, technology transfer resources, and information on pavement research also are available.

In addition, site visitors can find links to pavement-related communities of practice, such as one based on the *Mechanistic-Empirical Pavement Design Guide.* A list of links offers related sites in the categories of asphalt, concrete, recycling, and the Long-Term Pavement Performance program. The site's comprehensive list of contacts includes FHWA staff from across the country as well as key personnel and contacts from State highway agencies and various industry associations.

For information on specific pavement subjects, please contact the individuals listed by topic on the Web site. For more information on FHWA's topic-based Web sites, contact Bob Hayes at 202-366-4970 or robert.hayes@fhwa.dot.gov. A topic-based site for hydraulics engineering is available at www.fhwa.dot.gov/engineering/hydraulics, and additional sites for other program areas are under development.

Anti-Icing Overlay Helps Prepare Highways For Winter Precipitation

Researchers at the Keweenaw Research Center, a research institute at Michigan Technological University, are developing technology to reduce the treacherous effects of ice formation on highways and bridges.

Russ Alger, director of the Institute for Snow Research at the center, has invented an anti-icing epoxy pavement overlay to prevent vehicles from sliding on ice. The overlay is a sheet of epoxy covered with an aggregate to create a sponge-like surface that soaks in a certain amount of ice-melting chemicals that crews deposit on roadways. By holding the chemicals in place on the roadway—protecting them from premature removal by snowplows or other disturbances—the product is said to help prevent ice buildup.

Use of the overlay on several notoriously treacherous roadways in Wisconsin proved successful in preventing crashes, according to test results from the Wisconsin Department of Transportation.

Alger and others involved with producing the overlay are refining the marketing of the product with a pricing goal that is comparable to other overlays but with the additional anti-icing capability. Alger says the epoxy overlay also can protect pavements from corrosion.

For more information, visit the Keweenaw Research Center at www.mtukrc.org.

American Concrete Pavement Association

Next Generation Simulation Program

A team of traffic simulation and modeling experts managed by Cambridge Systematics, Inc., and supported by senior advisors from major research institutions and consultants are serving as key contributors to FHWA's Next Generation Simulation (NGSIM) program. NGSIM is a multiyear project for improving the quality, trustworthiness, and usability of simulation tools for better decisionmaking. Other goals are fostering an environment of public-private cooperation and influencing and stimulating the commercial modeling market.

Traffic simulation models offer significant potential for evaluating existing operating conditions on freeways and other transportation facilities. They also can help decisionmakers analyze alternative operational and management strategies. The objective of NGSIM is to develop behavioral algorithms in support of microscopic traffic simulation, with supporting documentation and validation datasets that describe the movement and interaction of multimodal travelers and vehicles on the roadway system and their interactions with traffic control devices, delineation, congestion, and other features of the environment that continually change. All NGSIM products will be available to simulation model developers and the transportation community at large. Current study products are posted on the NGSIM Web site.

In addition to the research consortium of FHWA, private consulting firms, and universities, three stakeholder groups (traffic modelers, software developers, and model users) oversee the work and review the results.

For more information, visit the NGSIM Web site at www.ngsim.fhwa.dot.gov.

UC Berkeley Institute of Transportation Studies

Public Information and Information Exchange

FHWA Wins "Historic Preservation" Award

The Advisory Council on Historic Preservation (ACHP) recently presented its highest award to FHWA for its efforts to protect historic transportation facilities around the country.

Since 1992, FHWA's transportation enhancement program has supported more than 2,500 historic

preservation and rehabilitation projects, such as restoration of lighthouses, train depots, and ferry terminals, many of them converted to economic uses for local communities. FHWA is the largest single source of Federal funding available to States for historic preservation.

"We are committed to preserving our historic treasures and supporting the heritage of our communities," says FHWA Acting Administrator J. Richard Capka.

Surface transportation legislation signed in August 2005 by President George W. Bush provides additional resources for transportation enhancement and historic preservation projects.

"This is truly a program where Federal undertakings directly benefit local, regional, and State historic preservation efforts while improving the national infrastructure," says John L. Nau III, ACHP chairman, referring to FHWA's transportation enhancement program.

For more information, contact Doug Hecox at 202-366-0660 or doug.hecox@fhwa.dot.gov.

Work Zone Training for Law Enforcement Officers

FHWA's Office of Safety coordinated the development of a stakeholder-produced, model training course for law enforcement officers who are assigned work zone duties.

Following the investigation of a fatal work zone crash that resulted in the death of a Tennessee Highway Patrol trooper on July 26, 2000, the National Transportation Safety Board (NTSB) recommended developing a model training program for law enforcement personnel to address traffic control strategies used at highway work zones. With the goal of improving communications among law enforcement officials, contractors, and the engineering community engaged in work zone duties, the partners include FHWA, the National Highway Traffic Safety Administration, the International Association of Chiefs of Police, the National Sheriffs' Association, and the American Association of State Highway and Transportation Officials.

The FHWA Office of Safety assumed the leadership role for producing the materials for the course, which will be distributed broadly throughout law enforcement agencies and organizations across the country.

For more information, contact Guan Xu at 202-366-5892, guan.xu@fhwa.dot.gov or John Balser at 202-366-9212, john.balser@fhwa.dot.gov.

FHWA Launches "ITS Lessons Learned Knowledge Resource" Web Site

USDOT's Intelligent Transportation Systems (ITS) Joint Program Office recently developed a Web site containing lessons learned on planning, designing, deploying, operating, maintaining, and evaluating ITS technologies. Available at www.itslessons.its.dot.gov/its/benecost.nsf/LessonHome, the "ITS Lessons Learned Knowledge Resource" Web site enables members of the ITS community to access the latest knowledge and contribute their own lessons learned.

Each lesson description includes a title in the form of a recommendation, a narrative to provide the context and explain the lesson learned, and identifying information such as the date, location, source, and a contact for more information.

Lesson categories include management and operations, policy and planning, design and deployment, leadership and partnerships, funding, technical integration, procurement, legal issues, and human resources. Within the lesson categories, site visitors also can select application areas, goals, and geographic locations. Previous lessons have discussed the challenges in planning and deploying smart card technology in rural environments, how to develop a formal ITS data-sharing policy for agencies, and the use of task order contracts to develop, deploy, and maintain traffic signal control systems.

For more information, visit www.itslessons.its.dot.gov/its/benecost.nsf/LessonHome.

U.S. Transportation Secretary Mineta Announces New Byways

U.S. Transportation Secretary Norman Y. Mineta recently announced the addition of 45 roads in 27 States to America's system of scenic byways. The designation helps local communities promote tourism and makes the roads eligible for grants that fund educational signs, restrooms, recreational amenities, and other improvements. The National Scenic Byways Program, administered by FHWA, recognizes and enhances roads based on their archaeological, cultural, historical, natural, recreational, or scenic qualities.

FHWA Acting Administrator J. Richard Capka speaks at the National Scenic Byways designation event on September 22, 2005.

Several members of Congress and officials from FHWA spoke at the designation event at Union Station in Washington, DC. Deputy Assistant Secretary for Transportation Policy George Schoener, FHWA Acting Administrator J. Richard Capka, and Associate Administrator for Planning, Environment, and Realty Cynthia J. Burbank were present for the ceremony on September 22, 2005.

For more information, visit www.byways.org.

These students are working in the ATREL Traffic Operations Laboratory. *Photo: University of Illinois at Urbana-Champaign College of Engineering.*

ConnDOT

ConnDOT staff members monitor highway conditions in one of the agency's operations centers.

IDOT and University of Illinois Create New Transportation Center

The Illinois Department of Transportation (IDOT) recently announced the creation a state-of-the-art research program at the University of Illinois that will conduct studies aimed at producing safer, less congested highways; more environmentally friendly transportation solutions; and longer lasting roads. The State is providing $6.6 million over the first 3 years to build the Illinois Center for Transportation (ICT).

The ICT will be headquartered at the Advanced Transportation Research and Engineering Laboratory (ATREL), part of the University's Department of Civil and Environmental Engineering. Under the cooperative agreement, the center will be administered by the university and will provide state-of-the-art facilities for research and training transportation professionals in both the private and public sectors, as well as providing research opportunities for students.

The ICT will focus on outreach, education, and research to solve transportation problems, reduce congestion, and improve safety and efficiency. The research activities will play a major role in maintaining and operating a premier transportation system to help economic development.

A unique feature is that although administered by the University of Illinois, a portion of the ICT funding will be outsourced to develop cooperative relationships with other Illinois universities and to expose more students to transportation research.

The total funding for the first 3 years is $8.8 million, with IDOT providing a majority of its $6.6 million share through Federal highway dollars specifically earmarked for research purposes. The University of Illinois is providing the local match of $2.2 million to get the program underway.

For more information, visit www.dot.il.gov.

University of Illinois

Connecticut Receives "2005 Innovative Traveler" Award

FHWA recently presented Connecticut with an award for the innovative design of its traveler information Web site. FHWA Acting Administrator J. Richard Capka presented the award to Connecticut Department of Transportation (ConnDOT) Commissioner Stephen E. Korta II at the AASHTO annual meeting.

In March 2005, ConnDOT launched its "e-alert" system, a statewide electronic incident notification system covering rail and highway traffic for the State of Connecticut. The service is available at no cost, 24 hours a day, 7 days a week to subscribers who have access to e-mail. The system received more than 6,500 registrations in its first 6 months.

Notices of significant highway incidents expected to last at least an hour are e-mailed to subscribers. Incident updates and notification when an incident has been cleared also are provided. The highway e-alerts are generated from ConnDOT's highway operations centers in Newington and Bridgeport, which monitor approximately 240 highway cameras at key locations around the State. The rail e-alerts, which indicate route and delay information, are generated from ConnDOT's New Haven Rail Operations Center.

For more information or to sign up to receive e-alerts, visit www.ct.gov/dot.

ConnDOT

GDOT's IT Department Receives National Recognition

The Georgia Department of Transportation's (GDOT) Information Technology (IT) department has proven itself one of the best in the Nation, receiving an honorable mention award from the Urban and Regional Information Systems Association (URISA). URISA selected GDOT's Transportation Explorer application (TREX) for an award for "Exemplary Systems in Government," a category that recognizes improvement in the quality and delivery of government services.

"This award symbolizes the accomplishments we have made in the field of information technology as a department," says Teague Buchanan, geographic information systems manager.

TREX is a Web portal system that serves as an internal information clearinghouse and also enables the public to search GDOT maps, reports, and plans about all transportation projects in Georgia. Users can run real-time queries

by city, State, or project number, and the reports can be saved and printed.

For more information, contact Jerrice Boyd at 404-657-6955 or visit www.dot.state.ga.us.

GDOT

Iowa Department of Transportation

Successfully launching the deck on the U.S. 20 Iowa River Bridge near Steamboat Rock was key to building this structure in an environmentally sensitive area.

State Highway and Bridge Teams Earn Awards for Quality

Teams from a dozen States, representing a range of road and bridge projects in every region of the country, recently earned top quality awards from the National Partnership for Highway Quality (NPHQ).

The highest honor, the 2005 National Achievement Award, went to the Iowa Department of Transportation. According to Bob Templeton, executive director of NPHQ, the Iowa team was recognized for the innovative and environmentally sensitive design and construction of the first incrementally "launched" steel bridge of its kind and magnitude in the United States, the U.S. 20 Iowa River Bridge in north-central Iowa.

Lauding the "innovative thinking, quality design and performance, and cost-effective practices" of the States singled out for honors, Templeton said, "These accomplishments not only reflect the widest possible range of activity but mirror the distinctiveness of every region of our country, North, South, East, and West. We know that our winners this year will continue to set quality standards and lead the pack for years to come. What's more, their achievements will continue to improve the quality of life for the driving public."

For more information on the Iowa team's accomplishments, visit www.nphq.org/press_2005_ia.cfm. For more information about the winning project teams from Arizona, Colorado, Georgia, New Jersey, North Carolina, Oregon, Pennsylvania, South Dakota, Texas, and Virginia, visit www.nphq.org/press_allWinners2005.cfm.

NPHQ

Personnel

FHWA's Jorge Pagan-Ortiz Recognized as 2005 HENAAC Luminary

Jorge Pagan-Ortiz, principal bridge engineer in the FHWA Office of Bridge Technology, was recently honored for his significant contributions to the Hispanic technical community at the 2005 Hispanic Engineers National Achievement Awards Conference (HENAAC).

The HENAAC Luminary Honor is an award given for leading, collaborating, and initiating key programs and research and demonstrating noteworthy milestones in carrying the torch of promoting success through education. Pagan received the award on October 7, 2005, in Anaheim, CA.

NATIONAL HIGHWAY INSTITUTE

Training Update

New NHI Course Promotes Context Sensitive Solutions

Due to increasing awareness of the impact of highways on the surrounding environment and communities, transportation agencies are exploring context sensitive solutions (CSS) when building and renovating roadways. The Federal Highway Administration (FHWA) defines CSS as "a collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic, and environmental resources, while maintaining safety and mobility."

Formerly known as "context sensitive design," CSS stresses the importance of working with community representatives to balance local, regional, and national transportation needs with the historic and natural environment and the needs of the community. This collaborative approach benefits agencies because it results in effective and timely decisions, attainment of public trust and support, positive relationships with resource agencies, delivery of safe and financially feasible project solutions, and improvement to the overall project delivery process.

The RBA Group

New Jersey Transit used CSS at its Rutherford train station at Station Square (shown here) to reconnect the main street with the station, improve bicycle access, and make the station a focal point for new infill development. The hub of the project is a new roundabout in front of the station, combined with pedestrian improvements along streets that act as "spokes" leading from the station throughout the downtown.

Through a new course, Context Sensitive Solutions (#142050), the National Highway Institute (NHI) aims to further increase awareness of how to apply CSS in transportation planning, design, construction, and maintenance. The goal is to educate the transportation community about the human/social, natural/cultural, technical, and organizational contexts that should be considered when developing and implementing transportation solutions.

The course provides participants with the tools and techniques necessary to employ the CSS approach effectively to deliver timely and successful transportation projects. The format includes lectures, group and individual problem-solving exercises, interactive discussions, and references to publications and software.

Upon completing the course, participants will be able to do the following:

- Understand the collaborative, interdisciplinary CSS approach as it applies to transportation projects (planning through construction stages) and the associated benefits
- Recognize the value of early and continuous stakeholder involvement in ensuring effective and timely decisionmaking
- Describe the flexibility afforded in applying industry design standards (such as the American Association of State Highway and Transportation Officials' *A Policy on Geometric Design of Highways and Streets* or "Green Book") while maintaining or improving roadway safety performance
- Explain the importance of achieving environmental sensitivity
- Discuss how incorporating aesthetics and community values and themes is an integral component of an effective design
- Understand the best practices developed by FHWA's Federal Lands Highway Division and the CSS pilot States
- Apply CSS in highway and bridge design without compromising safety
- Identify the tools and techniques available to generate consensus among project stakeholders
- Apply the course materials and related tools to deliver timely and successful CSS projects

The course targets a broad audience that includes transportation planners; environmental specialists; highway, bridge, construction, and design engineers; and managers of Federal, State, and local highway transportation agencies.

For course scheduling, contact Sherron Monts at 703-235-0534. For more information, visit NHI's Web site at www.nhi.fhwa.dot.gov. To learn more about other NHI courses, consult the course catalog available on the NHI Web site or contact NHI at 703-235-0500 (phone) or 703-235-0593 (fax). For more information on CSS, please visit www.fhwa.dot.gov/csd.

Internet Watch

By Joanne Sedor

New Freight Site Tackles a Weighty Issue

The United States has long relied on the fast and reliable delivery of freight to fuel the Nation's economy, and this trend shows no signs of stopping. Economic forecasts indicate, for example, that by 2020, freight volumes will be 70 percent greater than they were in 1998. Although this type of growth in freight shipments benefits the economy, it also places increasing stress on the U.S. transportation system.

To meet the Nation's needs for moving freight in the coming years, government agencies and the transportation industry need to plan for and invest in infrastructure and operational improvements. Federal, State, and local transportation practitioners need accurate forecasts of commodity and traffic flows and access to the latest forecasting models and analysis tools to ensure that appropriate investments and improvements are made.

A new Web site managed by the Federal Highway Administration's (FHWA) Office of Freight Management and Operations aims to provide exactly this type of information. Sponsored by the U.S. Departments of Transportation, Agriculture, and Energy and the U.S. Army Corps of Engineers, the new "Freight Model Improvement Program" (FMIP) Web site (www.fmip.gov) provides comprehensive information on state-of-the-art freight forecasting and analysis models and assists in applying these models to transportation planning and policy at all levels of Government.

"The 'FMIP' Web site provides a unique opportunity for the transportation community to share methods for monitoring and forecasting freight activity, identify needed improvements, and mobilize vendors, consultants, and government agencies to improve upon today's state-of-the-art freight modeling practices," says Tianjia Tang, project manager for FHWA's Freight Analysis Framework, which is one of the many modeling tools used today by freight specialists.

News and Events

FHWA divided the site into several sections, all of which are easily accessible from links at the top of the homepage. In the news section, users will find the latest information on the freight industry and upcoming training sessions, courses, workshops, and conferences. This section also includes announcements and updates on freight projects and publications. Further, users can submit their own news items for posting through the Web site's discussion board.

A Model Section

Site users can gain a better understanding of the state of modeling practices by clicking on links to various studies about freight models. The models evaluated vary in scale and cover a range of geographies, from local and regional to statewide and national. For example, a link to metropolitan and local modeling studies, enables users to download reports about freight models used in Sarasota, FL, Baltimore, MD, and Portland, OR.

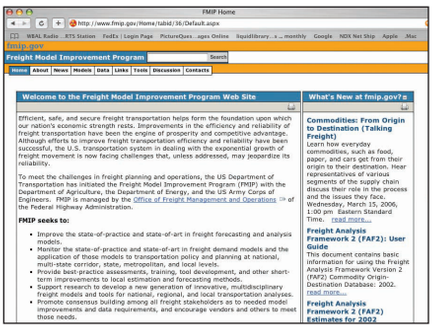
A Data Depository

Models are no better than the data upon which they are based, making the availability and quality of freight data an especially important issue among freight specialists. The data section of the "FMIP" site features an array of existing freight data, such as commodity movements, classifications, origins, and destinations. Economic activity data also are accessible, including data from the U.S. Census Bureau and the U.S. Department of Commerce's Bureau of Economic Analysis.

A Complete Toolbox

The tools section of the Web site houses information about various modeling techniques and tools used in forecasting freight and passenger movements. Links direct users to a number of resources, including FHWA's Freight Analysis Framework (FAF), a tool for estimating commodity flows and related freight transportation activities. Another link takes users to the State version of the Highway Economic Requirements System (HERS) model, which FHWA created to help State departments of transportation develop highway investment programs and policies that maximize economic benefits relative to costs. In addition to the FAF and HERS models, the site offers links to the Geofreight Intermodal Freight Display Tool and the Center for Transportation Analysis' Transportation Network.

People Are Talking



The "Freight Model Improvement Program" Web site.

While much of the "FMIP" Web site serves as a location for users to download data, the discussion board is a dynamic feature that enables users to post comments or questions about freight modeling. Because many hot topics often are vetted through the discussion board, users can post items and participate in discussions anonymously, although FHWA encourages everyone to register and log into the site to help foster collaboration and information sharing.

"The discussion board is open to everyone interested in freight modeling, including members of both the public and private sectors," says Tony Furst, director of FHWA's Office of Freight Management and Operations. "We hope that the board will not only be a place where users can engage in intelligent discussions, but also a place where users can explore new ideas, create new partnerships, and discover new opportunities."

For more information, visit www.fmip.gov or contact Tianjia Tang at 202-366-2217 or tianjia.tang @fhwa.dot.gov.

Joanne Sedor is a transportation specialist at FHWA.

Communication Product Updates

Compiled by Zac Ellis of FHWA's Office of Research and Technology Services

Below are brief descriptions of products recently published online by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. Some of the publications also may be available from the National Technical Information Service (NTIS). In some cases, limited copies are available from the Research and Technology (R&T) Product Distribution Center.

When ordering from NTIS, include the NTIS publication number (PB number) and the publication title. You also may visit the NTIS Web site at www.ntis.gov to order publications online. Call NTIS for current prices. For customers outside the United States, Canada, and Mexico, the cost is usually double the listed price. Address requests to:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703–605–6000
Toll-free number: 800–553–NTIS (6847)

Address requests for items available from the R&T Product Distribution Center to:

R&T Product Distribution Center, HRTS-03
Federal Highway Administration
9701 Philadelphia Court, Unit Q
Lanham, MD 20706
Telephone: 301–577–0818
Fax: 301–577–1421

For more information on research and technology publications from FHWA, visit the Turner-Fairbank Highway Research Center's (TFHRC) Web site at www.tfhrc.gov, FHWA's Web site at www.fhwa.dot.gov, the National Transportation Library's Web site at http://ntl.bts.gov, or the OneDOT information network at http://dotlibrary.dot.gov.

QuickZone Case Study Snapshot #1, I–40 Full Closure Feasibility Assessment Publication No. FHWA-HRT-05-142

The Tennessee Department of Transportation (TDOT) identified a section of I–40 east of downtown Knoxville as a candidate for major rehabilitation. In 2004, TDOT considered various strategies to perform the needed roadwork, keeping in mind construction costs, project duration, and potential impacts on road users. Using QuickZone, TDOT officials studied the likelihood of significant congestion under the proposed full closure option by presenting a quick prediction based on current traffic volumes.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #2, I–95 Operational Analysis for Lane Closures at Night Publication No. FHWA-HRT-05-143

Maintaining roadway capacity is an important aspect in the ongoing project to replace the Woodrow Wilson Bridge in the Washington, DC, metropolitan area. Project engineers used QuickZone to analyze multiple scenarios for extending the duration of lane closures and the number of lanes closed.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #3, Responding to Public Concern About Delays During Bridge Repairs Publication No. FHWA-HRT-05-144

In the spring of 2001, a major structural rehabilitation project started on the Little Bras d'Or Bridge in Nova Scotia, Canada. Public concern and political pressure advocated rescheduling the work for November of that year. Transportation officials used QuickZone to analyze various staging scenarios and ultimately demonstrated that delaying the work until November, using the same traffic control strategies, would still result in unacceptable motorist delays.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #4, Justifying the Additional Cost of Night Work in Nova Scotia Publication No. FHWA-HRT-05-145

In 2001, the intersection of Reeves Street and Trunk 4 in Port Hawkesbury, Nova Scotia—along a key access route to the Trans-Canada Highway—was slated to be upgraded. Under the original traffic control plan, the intersection operated 24 hours a day, 7 days a week. Under these conditions, QuickZone predicted a queue up to a 6.5 kilometers (4.1 miles) long and 70 minutes of delay.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #5, Cost-Effective Construction Phasing in Yosemite Valley Publication No. FHWA-HRT-05-146

Yosemite National Park in California is one of the most popular national park destinations in the Nation, averaging more than 9,000 visitors each day throughout the year. Because of the shape of Yosemite Valley, public access to the park is quite limited. As of August 2004, officials had not come to a final decision about the timing or phasing of the work. However, the time and effort invested in data collection and QuickZone analysis had a marked impact on shaping the planned work to minimize impacts on park visitors while finding effective ways to reduce project duration and costs.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #6, Preparing For Peak Tourist Season During Repaving Operations, Zion National Park
Publication No. FHWA-HRT-05-147

In 2004, a major rehabilitation of the main road through Zion National Park in Utah was scheduled to take place. Transportation officials used QuickZone to estimate the length of the anticipated queue and the number of vehicles in the queue during the peak tourist months of June, July, August, September, and October.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #7, Cumulative Delay Analysis for Successive Work Zones on Beartooth Highway
Publication No. FHWA-HRT-05-148

The Central Federal Lands Highway Division (CFLHD) has been working with the U.S. Department of Agriculture's Forest Service and the National Park Service to reconstruct a 30-kilometer (18.6-mile) section of the scenic Beartooth Highway in Montana. In planning the work, CFLHD officials relied on QuickZone's capability to estimate the cumulative delay a motorist would likely encounter from a series of work zones, including localized bottlenecks, flagging operations, and periodic full closures.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

QuickZone Case Study Snapshot #8, Economic Impact of Work Zones With Lengthy Detours in Wyoming
Publication No. FHWA-HRT-05-149

Louis Lake Road is located in Fremont County, WY, and links the town of Lander and the Shoshone National Forest. The one-lane gravel road with turnouts was deemed narrow, unsafe, and inadequate for expected increases in traffic as more visitors are drawn to the area. Transportation officials used QuickZone to estimate the delay a traveler would face during flagging operations of different lengths and capacities.

The document is available online at www.tfhrc.gov /its/quickzon.htm. Free printed copies are available from the R&T Product Distribution Center.

Laboratory Assessment Process Handbook for Expert/Peer Reviews at the Turner-Fairbank Highway Research Center, Version 2.1
Publication No. FHWA-HRT-05-033

The purpose of the *Handbook for Expert/Peer Reviews* is to provide guidance for participants in the TFHRC Laboratory Assessment Process. The primary audience for the handbook is members of the panels serving to review a laboratory. The handbook acquaints panel members with the process and expectations associated with their involvement in the review. The handbook also is a useful source of information about the reviews for laboratory managers and staff as well as the customers and stakeholders of the laboratories being reviewed.

The document is available online at www.tfhrc.gov /services/pubs/05033/index.htm. Free printed copies are available from the R&T Product Distribution Center.

In-Vehicle Display Icons and Other Information Elements, Volume I: Guidelines
Publication No. FHWA-RD-03-065

Because of the speed with which in-vehicle information system (IVIS) devices are entering the automotive marketplace, many research issues associated with the design of in-vehicle visual symbols and other information elements have not been adequately addressed. The overall goal of the project was to provide the designers of in-vehicle technologies with a set of guidelines for display icons and other information elements. Specific objectives included the following:

- Design and perform experimentation to select appropriate symbols for in-vehicle use and use the resulting data to write final guidelines for in-vehicle symbol usage, encompassing both current and future symbols
- Write preliminary and empirically based final guidelines

The key product is a set of clear, concise, and user-centered, human-factor guidelines for designing in-vehicle icons. The 42 guidelines address issues such as the legibility, recognition, interpretation, and evaluation of graphical and text-based icons and symbols. Further, they provide IVIS developers with key information regarding the use and integration of existing and new visual symbols. In addition, guidelines are provided for the design of in-vehicle auditory information.

The document is available online at www.tfhrc.gov /safety/pubs/03065/index.htm. Free printed copies are available from the R&T Product Distribution Center. Printed copies also may be purchased from NTIS. The NTIS number is PB2005-105411.

Validation of Accident Models for Intersections
Publication No. FHWA-RD-03-037

This report describes the results of an effort to validate and calibrate motor vehicle crash models for rural intersections. Both the validation and recalibration activities were conducted in pursuit of one primary research objective, which was to improve an existing set of statistical models for predicting crashes at two- and four-lane intersections, with the intent to facilitate use in the Interactive Highway Safety Design Model.

The researchers drew conclusions and made recommendations for five types of intersection models: (1) three-legged, stop-controlled intersections of two-lane roads; (2) four-legged, stop-controlled intersections of two-lane roads; (3) three-legged, stop-controlled intersections with two lanes on a minor road and four lanes on a major road; (4) four-legged, stop-controlled intersections with two lanes on a minor road and four lanes on a major road; and (5) signalized intersections of two-lane roads.

The document is available online at www.tfhrc.gov /safety/pubs/03065/index.htm. Free printed copies are available from the R&T Product Distribution Center.

Conferences/Special Events Calendar

Date	Conference	Sponsor	Location	Contact
May 7–10, 2006	2006 Concrete Bridge Conference	Federal Highway Administration (FHWA), National Concrete Bridge Council, Nevada Department of Transportation, and American Concrete Institute	Reno, NV	Shri Bhidè 847-972-9100 sbhide@cement.org www.nationalconcretebridge.org/cbc
May 14–20, 2006	National Transportation Week	U.S. Department of Transportation and other organizations	Nationwide	Joe Toole 703-235-0500 joe.toole@fhwa.dot.gov www.ntweek.org
June 4–7, 2006	North American Travel Monitoring Exhibition and Conference	Transportation Research Board (TRB), FHWA, American Association of State Highway and Transportation Officials, Minnesota DOT, City Engineers Association of Minnesota, Minnesota County Engineers Association, Institute of Transportation Engineers (ITE), and ITS/Management and Operations Council	Minneapolis, MN	Tom Palmerlee 202-334-2907 tpalmerlee@nas.edu www.natmec.org
July 16–19, 2006	3rd International Conference on Bridge Maintenance, Safety, and Management (IABMAS 2006)	International Association for Bridge Maintenance and Safety (IAMBAS)	Porto, Portugal	Sandra Pereira (+351) 253-51-0489 secretariat@iabmas06.com www.iabmas06.com
July 23–26, 2006	45th Annual Workshop on Transportation Law	TRB	Chicago, IL	James McDaniel 202-334-3209 jmcdaniel@nas.edu www.trb.org/conferences/law
July 25–29, 2006	5th International Symposium on Highway Capacity	TRB Committee on Highway Capacity and Quality of Service, Nagoya University, University of Tokyo, Tottori University, Toyo University, Yokohama National University, Tokyo Metropolitan University, and Kyoto University	Yokohama, Japan	Richard Cunard 202-334-2965 rcunard@nas.edu www.itr.genv.nagoya-u.ac.jp
July 30–August 2, 2006	2006 Pipelines Conference	American Society of Civil Engineers	Chicago, IL	Leonore Jordan 703-295-6110 ljordan@asce.org www.asce.org/conferences/pipelines2006
July 30–August 3, 2006	Second International Symposium on Transportation Technology Transfer	FHWA	St. Petersburg, FL	Roger Dean 703-235-0550 roger.dean@fhwa.dot.gov www.t2symposium.org
August 6–9, 2006	First International Conference on Fatigue and Fracture in the Infrastructure—Bridges and Structures of the 21st Century	Pennsylvania Infrastructure Technology Alliance, FHWA, TRB, The Port Authority of New York & New Jersey, and New Jersey DOT	Philadelphia, PA	Alyssa Clapp 610-758-3535 alcb@lehigh.edu http://ffconf.atlss.lehigh.edu
August 6–9, 2006	ITE 2006 Annual Meeting & Exhibit	ITE	Milwaukee, WI	Lisa Petty 202-289-0222, ext. 136 lpetty@ite.org Christina Denekas 202-289-0222, ext. 128 cdenekas@ite.org www.ite.org

Do you have a handle on freight demand in your area?

Freight Demand Modeling:
A Conference on Tools For Public Sector Decisionmaking

September 25—27, 2006
National Academies' Keck Center
Washington, DC

The conference focuses on forecasting freight transportation demand. See http://trb.org/calendar for registration information and more details about the conference program or contact Elaine King at eking@nas.edu or Brie Schwartz at bschwartz@nas.edu, 202—334—3206.

Sponsors:

Federal Highway Administration

Federal Railroad Administration

Research and Innovative Technology Administration

U.S. Army Corps of Engineers

Transportation Research Board

The National Academies

The conference will achieve the following objectives:

- Examine current modeling practices and emerging technologies
- Review current and future data sources that support freight transportation modeling
- Review state of the art and new directions in freight modeling
- Identify areas ripe for research and improvement

U.S. Department
of Transportation
Federal Highway Administration
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