TR NEWS

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PRICING STRATEGIES TO EASE ROADWAY CONGESTION

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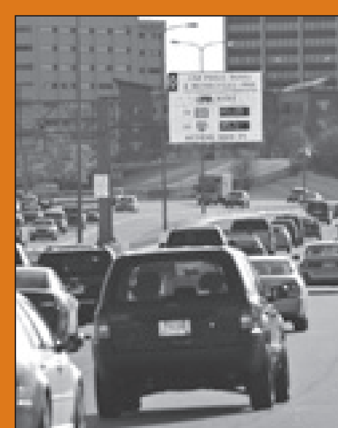

COVER: The MnPASS I-394 project in Minneapolis, started by the Minnesota Department of Transportation in 2005, converted high-occupancy vehicle lanes to high-occupancy toll lanes. Congestion pricing strategies are being studied and implemented across the nation. (Photo: David Gonzalez, Mn/DOT)

// TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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ALSO IN THIS ISSUE:

COMING NEXT ISSUE

Passengers disembark from a light rail transit vehicle. U.S. demographics are changing, and the transportation system will need to adapt.

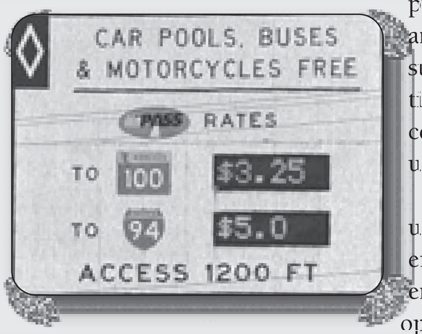
The impact of changing demographics on the transportation system—on the workforce, on system demand, and on safe mobility—is the focus of articles assembled for the September–October issue of *TR News*. Topics include key issues in transportation and aging, gender differences and transportation choices, and transportation demand in the context of growing diversity, as well as research and data needs. Other articles include an overview of entries in TRB's 2009 contest on communicating about transportation, energy, and climate change to the general public; applying service-life modeling to select repair and rehabilitation options for bridges; and more.

INTRODUCTION

Pricing Road Use to Address Congestion

Traffic congestion is one of the major—and most costly—problems in large urban areas of the United States and worldwide. Congestion interrupts the flow of traffic and delays the movement of passengers and freight. It wastes fuel, increases vehicle emissions, and boosts costs to highway users—including hours spent in frustration, stuck in traffic.

Many U.S. cities face significant congestion problems, with traffic delays choking off day-to-day economic and social activities. Valuable hours are lost to traffic congestion in urban areas of all sizes, with losses of time equivalent to more than one work week per person per year in the largest metropolitan regions. Aggregating the losses from traffic delays and wasted fuel for all travelers in 439 urban areas across the United States reveals total congestion costs of $87.2 billion, according to the Texas Transportation Institute. This estimate does not include the substantial costs of environmental degradation and productivity losses caused by traffic congestion.



Link to Costs

Transportation agencies therefore have been seeking new and better ways to deal with congestion. Adding highway capacity can alleviate peak-period travel demand, but capacity additions are not always possible, whether for economic or environmental reasons. Increases in travel demand often overwhelm newly added capacity or create new bottlenecks. Technological and operational approaches to improve system performance also show great promise in reducing congestion, as do strategies that advance more efficient and demand-responsive public transit systems or that promote telecommuting and more flexible work schedules. Yet these strategies, alone or in combination, are unlikely to be effective without linking the decision to travel on a congested road with the full costs of that travel. Congestion pricing provides this link.

Often referred to as value pricing—because travelers who pay expect to receive a value or benefit—congestion pricing comes in many forms, including variable pricing, peak-period pricing, market pricing, differential pricing, and dynamic tolling. In all cases, the strategy relies on the power of the market to reduce the waste from the delays associated with traffic congestion, by applying fees or tolls that vary with the level of demand and related congestion, often by time of day. This differs from conventional tolling in that the congestion charge is focused on managing system performance, instead of on raising revenue to pay for operations, maintenance, and infrastructure. Nevertheless, revenue enhancement is a potential outcome of congestion pricing.

Changing Travel Decisions

By incorporating into a driver's trip-making decision a consideration of the cost of the delay that the trip imposes on others, congestion pricing can reduce traffic congestion significantly and can sustain the reduction. The strategy encourages peak travelers to shift trips to off-peak times, to high-occupancy modes, or to less congested facilities—or even to eliminate some trips. Such changes in trip-making behavior have increased speeds and vehicle throughput; reduced delays and costs to automobile, truck, and transit users; enhanced productivity and reliability for goods movement and transit; decreased pollution and energy consumption; and contributed to economic productivity. By applying tolls that vary by level of congestion, congestion pricing rationalizes the use of limited road capacity.

In addition to incentives for more efficient use of road capacity, congestion pricing can generate revenues that can cover operating and enforcement costs and that can offer financing options for needed improvements in roads or other transportation services and infrastructure. Congestion-based tolls also indicate where capacity enhancements may be cost-beneficial, promoting the efficient investment of toll revenues.

Although congestion pricing offers many potential benefits, many questions and issues remain. These include equity, allocation and use of revenue, relationships to existing transportation revenue sources, and standards that make prices and choices transparent and easy to understand.

This issue of *TR News* provides an overview of various types of congestion pricing, major concerns and issues, potential benefits, and lessons learned from projects that are operating in the United States and in other countries. Challenges and hurdles to the deployment of pricing strategies are discussed, including equity, public acceptance, and operational issues. Outreach strategies to advance public and political understanding are described, and technological developments that may assist in deployment are explored. Finally, several new ideas that could help in gaining public acceptance are presented.

— Patrick T. DeCorla-Souza and Mark F. Muriello
Cochairs, TRB Congestion Pricing Committee

EDITOR'S NOTE: Appreciation is expressed to Jeffrey N. Buxbaum, Cambridge Systematics, Inc., and to TRB Senior Program Officers Martine A. Micozzi and Thomas R. Menzies, Jr., for their contributions in developing this issue of *TR News*.

No single set of articles on the congestion pricing of road use can seek to cover the varied perspectives on this timely topic. Readers are invited to share their views by submitting a letter or an article for possible publication in *TR News* (see guidelines on the inside back cover).

Pricing Road Use to Address Congestion

Congestion Pricing Basics

JEFFREY N. BUXBAUM

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Tolls have financed highway infrastructure since the Roman Empire. Although toll revenue often may be used for other purposes, many believe that financing highway infrastructure is the main function of tolls. Tolls for congestion pricing are different. They generate revenue, but with the intent of changing travel behavior to make more efficient use of the transportation system, by shifting some drivers to less congested periods, or to other modes, routes, or shared-ride vehicles, so that the traffic flows more freely.

Most products and services supplied in the marketplace rely on pricing to align demand with supply. If demand exceeds supply, prices will rise, and some customers will choose not to buy. Highways, however, are not priced this way, and the prices on the few facilities that are tolled are seldom allowed to vary according to changes in demand.

Motivations for Congestion Pricing

From the beginning of automobile travel, the U.S. system of paying for highways has relied largely on motor fuel taxes, excise taxes, sales taxes, and tolls. Motorists have grown accustomed to these methods of paying for the cost of building, maintaining, and operating highways. A system that sets a price for highway use as a way of reducing congestion would be a major change, potentially affecting where people live and work, locate businesses, and socialize.

Until recently, the congestion pricing of highways mostly had been an academic concept, because the necessary technology did not exist. Recent advances in electronic toll collection, however, have prompted greater interest in congestion pricing. Yet when the topic is discussed in public policy arenas—from state legislatures and governors' offices to the radio and blogs—the motivations often differ from the efficiency concerns that interest academics.

Reducing congestion during peak periods and improving travel time reliability are important moti-

PHOTO: DAVID GONZALEZ, MN/DOT

Minnesota's I-394 uses electronic toll collection on its high-occupancy toll (HOT) lanes.

vations, but so are encouraging transit use, reducing vehicle emissions and energy consumption, and especially providing a funding source for transportation programs and projects. Some may view a system of congestion pricing as a means of changing urban form and promoting regional economic development.

Pricing Signals and Congestion

According to basic microeconomic theory, the demand for a good is directly responsive to the price of the good. If the supply of a good is fixed, the prices can be raised when demand peaks. Examples of time-based pricing include airline tickets on holiday weekends, daytime cell phone use, and midday electricity use. In each case, customers who cause the peak congestion must pay a premium, while users who are willing to purchase at off-peak times—when the resource is less scarce—pay less.

Moreover, the higher prices signal that additional investment in production capacity may be profitable. An airline will raise prices on a popular route to manage demand for the limited number of seats, but at some point the airline may decide that adding another flight to the route would be profitable. Some proponents emphasize that a key advantage of congestion pricing is that it would identify places in the transportation system that warrant investments in more capacity.

But the mostly private users of roads and the mostly public suppliers of road capacity do not receive pricing signals. State and local governments largely have been responsible for the building and operation of roads in the United States, so that the highway system is perceived as a public good. In an economic sense, no one can be excluded from the use of a public good, and one person's use of the good does not diminish its value to others.

Under conditions of high volume, however; one additional vehicle entering a road system may cause the flow of traffic to slow, creating congestion and delay for others—so that highways are not strictly public goods. When there is no charge for entry, motorists do not consider that they are imposing a cost on others; the resulting market failure is known as congestion.

Pricing for Social Efficiency

Nobel Laureate William Vickrey advanced the idea of congestion pricing during the 1950s and 1960s. Implementation of his ideas was impractical, however, because of the primitive nature of toll collection. By the 1990s, tolls could be collected electronically without stopping vehicles, and several toll roads operated without tollbooths. These technological developments renewed interest in road congestion pricing.

Photo: Joe Pineiro, Columbia University Archives

William Vickrey, a Nobel Laureate, advanced the idea of congestion pricing.

Technology was not the only impediment to congestion pricing, however. Changing the status quo of highway funding and use would create winners and losers. Vickrey had recognized that this would need to be addressed if congestion pricing were to be implemented.

Although congestion pricing can produce an economically efficient solution to road congestion—so that society as a whole gets the most value out of its expenditures—travelers may be made worse off on average if the revenues are not used to increase mobility. Consider these examples:

- Some motorists will choose to pay the congestion charge and continue to use the same road at the same time as before. They will pay more as a consequence. These motorists place a high value on time, and some will be better off because of the travel time savings. Because all motorists pay the charge by choice, all presumably are better off doing this than taking advantage of other options, such as driving at a different time or on a different route, taking transit, or forgoing the trip altogether. On net, however, many still will be worse off than they were before congestion pricing.
- Those who choose an alternative road or mode or who cancel the trip are worse off, because they are not traveling when, where, or how they want.
- Those who were using other routes or modes before may be worse off, because new travelers now may be competing with them for the capacity. If congestion pricing increases the throughput of the priced highway, however, congestion on other routes and modes may be reduced. Only a detailed analysis can reveal the traffic impacts.

The distribution of winners and losers, and whether society as a whole is better off with congestion pricing, will depend on several factors, including who pays the tolls, the net effect on travel conditions, how the revenue is spent, and changes in other areas of concern, such as fuel consumption, emissions reduction, and safety.

The current system of financing highways through fuel taxes and vehicle fees creates its own winners and losers, but the social fabric has been

PHOTO: ILLINOIS TOLLWAY

Open road tolling lanes at the Irving Park Road Toll Plaza on the Tri-State Tollway (I-294) in Illinois.

built around this system. The transition from one system to another will be disruptive, with the outcomes dependent on how the revenues from congestion pricing are used.

Getting Prices Right

Congestion pricing can be carried out in many ways. One option is to price one or more lanes on a freeway, offering patrons a higher level of service on the tolled lanes. Another option is to price an entire road or collection of roads. A third approach is to establish prices for access to—or travel within—all roads in a specified zone, such as a cordoned central business district. A fourth is to price the entire roadway system.

Congestion pricing on a large scale requires extensive knowledge about congestion levels on all parts of the transportation system simultaneously and an understanding of how each driver's decision to embark on a trip will affect system congestion. Vickrey pointed out that the decision to travel is made at the beginning of a trip, but the impact of the travel was felt along the entire route and persisted after the trip because of the nature of bottlenecks.

In theory, under congestion pricing, a highway authority must anticipate economically efficient prices; communicate the prices to travelers, who then decide how to respond; and adjust the prices according to the responses—all in real time. Contemporary high-occupancy toll (HOT) lanes demonstrate how this works—prices are set dynamically, based on the traffic level in the priced lanes, and are changed frequently to maintain optimum traffic flow. Extending pricing beyond a single, limited highway corridor to a longer corridor or to a broader system of priced roadways introduces additional technical and political complexity.

Obtaining an economically efficient outcome is only part of the equation. Perceptions of fairness are another, evident in establishing urban transit fares. Transit systems often charge a flat rate, regardless of time of day or of distance traveled. Although some systems—like the Washington, D.C., Metro—charge per distance traveled, with higher prices during peak hours, most systems have constant rates all day. No system charges higher rates on more congested or more popular routes—although the higher rates may be economically efficient. Many travelers would consider this treatment to be unfair by a government-run system.

One option that perhaps is more practical than setting a different price for each minute of the day and each road on the system is a simplified system of user charges based on the time of day, type of road, and general location—for example, central business district, suburb, or rural area. After political compromises, however, the resulting system may not be the most economically efficient but, if done well, still would be more efficient than the status quo.

Effects on the System

Unless all roads are priced, motorists will have opportunities to shift travel to other parts of the system to avoid the charges. These motorists will incur the cost of using a less appealing route or mode. In addition, motorists who previously used the alternate route may experience the negative effects of higher traffic volumes and possibly more congestion. But because freeways carry so much traffic, pricing freeway use may instead have a positive impact on the system—a net win for society. Still, travelers on the priced freeway will be winning at the expense of those who no longer use the facility and of those who now must share the nonpriced roads with the displaced traffic.

The extent to which nonpriced roads will experience an increase, a decrease, or no change in congestion will depend in part on whether some of the revenue can be used to enhance the roads' capacity and whether improved operations on the priced facility allow higher throughput. The optimum flow on a highway occurs when vehicles travel at about 45 miles per hour. When demand exceeds a certain point, speeds drop precipitously, allowing less throughput despite higher demand. This paradox is borne out daily in stop-and-go conditions on freeways. Therefore if pricing can manage demand to maintain optimal travel speeds, throughput may increase in other parts of the system.

Distributing the Revenue

Distribution of public revenue is an age-old political issue. Concerns about equity and building political support for the congestion pricing concept may create a strong temptation to use revenues to compensate the losers and to spread benefits to favored groups. This may be the only practical way to build support for the concept and still yield a net positive contribution to society.

Examples of potential revenue uses include the following:

- Investing in transit improvements in the affected area;
- Subsidizing improvements to the nonpriced part of the highway system—for example, to parallel arterials;
- Rebating motor fuel taxes;
- Reducing general taxes, such as income or property taxes;
- Awarding grants to affected communities; and
- Allocating toll credits to all drivers, which some may use in full or trade-in any surplus for cash or tax rebates.

University of California planners King, Manville, and Shoup have suggested that using congestion pricing revenue to compensate groups may make good sense (*1*). They argue that those who perceive themselves to be losers from congestion pricing are likely to form a strong political resistance to the concept. The targeted distribution of revenue would allow these groups to perceive themselves as winners and give their support to congestion pricing.

Gaining Practical Experience

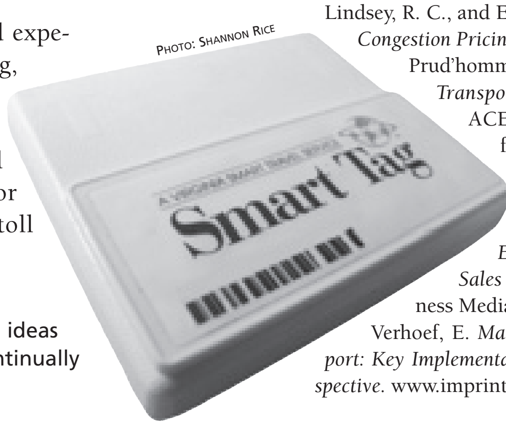
If the technology necessary for road pricing had been available at the beginning of the motor vehicle era, and if it had been used to capture the full marginal social cost of driving, communities might have developed differently. Urban areas perhaps would be more compact, with greater use of public transportation.

But with little real-world experience of congestion pricing, projecting the outcome is difficult. Most of the pricing experience in the United States has involved minor adjustments in tolls on toll facilities and HOT lanes. Lessons from these might not translate well to other types of pricing, such as the zone-based pricing that has been tried overseas in environments much different from those of the United States.

The complexity of the technical and political aspects of congestion pricing suggests the need to approach these new ideas with caution, by conducting tests and undertaking analyses that are transparent, comprehensive, and methodologically correct. Practitioners also must respect the concerns of the affected constituencies.

The testing of new congestion pricing ideas continues in the United States. The articles in the rest of this issue report on what has been learned so far and on new ideas and insights that are emerging from experiments.

PHOTO: SHANNON RICE



Smart Tag transponder. Technological and conceptual ideas for congestion pricing are continually being tested.

Acknowledgments

The author gratefully acknowledges David Williams of the Oregon Department of Transportation for identifying the need for a plain-language treatment of this topic, and for his review of an earlier version of this work, and the research assistance of Evan Enarson-Hering of Cambridge Systematics and Alexander Heil, formerly of Cambridge Systematics.

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Pricing Road Use to Address Congestion

U.S. and Worldwide Experience with Congestion Pricing

An Overview

KIRAN BHATT, THOMAS HIGGINS, AND JOHN T. BERG

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Only 15 years ago, congestion pricing was in its infancy in the United States. A private pricing project in Orange County, California, was in the planning and design phase, and several other projects were in planning stages with support from the Federal Congestion Pricing Pilot Program. Since then, the Orange County project started operations, and the federal program has supported more than 50 congestion pricing projects and studies in more than a dozen states, with more than 20 projects now operating. The projects implemented or under investigation include the pricing of high-occupancy vehicle (HOV) lanes and new express lanes, the conversion of toll or toll-free facilities to variable tolls, and application of congestion pricing within a region.

HOT Lane Conversions

The most common application of congestion pricing in the United States involves the conversion of HOV lanes into high-occupancy toll (HOT) lanes, which allow drivers of vehicles that do not meet the occupancy requirements to buy-in to the lanes by paying a toll that varies by time of day or by the level of congestion or demand. A rationale for converting to HOT lanes is that the HOV lanes are underused, despite increased congestion on the adjacent main lanes.

Electronic tolling ensures high-speed access to the restricted lanes and the setting of rates to maintain the free flow of traffic. In this way, HOT lanes provide travelers facing traffic congestion with new choices. Motorists can choose to continue on the main untolled lanes at the available speed, or pay a toll to gain access to a high-speed alternative, or meet the minimum occupancy requirements and use the high-speed lanes for free. Some major HOT lane conversion projects are summarized in Table 1 (page 9).

The earliest HOT lane conversion was the I-15 FasTrak facility, which opened in 1996 in San Diego, California. The FasTrak tolls vary with the level of demand to maintain free-flowing traffic. Fees can vary as often as every 6 minutes, typically in 25-cent increments. Message signs at the entrance inform motorists of the current fee. Tolls typically vary between $0.50 and $4.00, but can reach $8.00 during peak periods. The average toll rate is approximately $1.25 and seldom exceeds $4.00. Savings in travel time average 20 minutes per journey.

Another early example is I-10 in Houston, Texas. The freeway's HOV lane, which required a minimum of three occupants (HOV-3), was converted in 1998 to a HOT lane. Drivers of two-occupant vehicles can buy-in to the lanes during the times that three-occupant vehicles have access for free. This QuickRide program increased HOV-2 volume by 40 percent, while the HOV-3 volume decreased by less than 3 percent. The total volume on the HOT lane increased by 21 percent during the morning peak. The average speed on the general-purpose lanes was 25 miles per hour (mph) but exceeded 55 mph on the HOT lane, yielding a 17-minute time savings for the 13-mile trip.

More recent examples of HOT lane conversions include I-25/US-36 in Denver, Colorado, started in 2006; the MnPASS I-394 project in Minneapolis, Minnesota, begun in 2005; and two that opened in

The Capital Beltway HOT Lanes Project is currently under construction in Northern Virginia.

PHOTO: TREVOR WRAYTON, VIRGINIA DEPARTMENT OF TRANSPORTATION

TABLE 1 HOT Lane Conversion Projects in the United States

Project	Size and Characteristics	Use
San Diego, I-15	8 miles, 2 reversible lanes in median	25,172 transponders in use as of Nov. 30, 2008; approximately 15,000 HOV and 6,000 SOV vehicles/weekday
Denver, I-25/US-36	7 miles, 2 barrier-separated reversible lanes in freeway	95,091 vehicles paid to travel in September 2007 (10 months after opening)
Minneapolis, I-394	11 miles, including 2 reversible barrier-separated lanes for 3 miles; 1 lane, each direction for 8 miles, with double striping separation	More than 10,000 transponders leased by users since May 2005 opening
Houston, I-10, US-290	Single 13-mile reversible barrier-separated lane in I-10 median and 15-mile reversible lane on US-290	2,200 registered users by 2004, with access to both facilities
Seattle, SR-167	Single 9-mile nonbarrier separated (buffer) lane in each direction	Opened May 2008; in first 6 months of operation, more than 20,000 transponder users paid to use the HOT lanes
Miami, I-95 Express	21-mile HOT lanes (2 lanes in each direction)	First phase (8 miles) opened December 2008

HOV = high-occupancy vehicle; SOV = single-occupant vehicle; HOT = high-occupancy toll

2008—the SR-167 project in Seattle, Washington, and the I-95 Express Lanes project in Miami, Florida.

New Express Lanes

The key characteristic of these projects is the provision of new highway capacity in conjunction with variable pricing. The new capacity may be in the form of a new through-lane or lanes, a bypass lane or lanes around a congested point, or a new bridge or tunnel. Users must pay a toll to gain access to the new capacity, but HOVs may receive preference—for example, with free access or reduced tolls. As with other pricing projects, electronic tolling technology is necessary to ensure the effectiveness of time-of-day tolling.

Newly constructed express lanes with variable tolls have been implemented in only one location, SR-91 in Orange County, California, but other new express lane projects are under development in Baltimore, Maryland; San Diego, California; and Houston and Dallas–Ft. Worth, Texas. Selected projects are summarized in Table 2 (page 10). The goals are to reduce congestion, increase throughput, generate revenues, and provide a congestion-free travel option to motorists willing to pay the toll.

In addition to the projects shown in Table 2, several other new road projects are expected to implement variable tolls in the next few years, including:

- The SR-520 bridge in Seattle;
- The Inter-County Connector in Montgomery–Prince George's Counties, Maryland;
- The I-95 Managed Lanes, north of Baltimore; and
- The I-495 Beltway and I-395–I-95 Managed Lanes in Northern Virginia.

Converting Toll Facilities

The introduction of variable time-of-day tolls to facilities with fixed tolls is another common form of congestion pricing in the United States. Variable tolls are intended to encourage travelers to shift to off-peak times or to alternative modes or routes.

Off-peak toll discounts for transponder users have been applied to encourage the adoption of electronic tolling. Examples include the off-peak toll discount program in Lee County, Florida; time-of-day tolls on

The I-95 Express Lanes project in Miami, Florida, recently converted HOV lanes to HOT lanes.

Photo: Florida Department of Transportation

PHOTO: M6 TOLL PRESS OFFICE

A toll plaza at night on the M6 Toll road in Great Britain's West Midlands. Night and off-peak travel can be encouraged using variable toll rates.

the New Jersey Turnpike; the variable toll program of the Port Authority of New York and New Jersey; and the truck toll discount on the Illinois Tollway. Each program is summarized in Table 3 (page 11).

In most cases, the introduction of toll differentials for peak and off-peak travel has encouraged motorists to shift out of peak periods, has reduced peak-period congestion, has encouraged more efficient use of capacity, and has generated new revenues.

Other Pricing Initiatives

Various other pricing initiatives are under consideration in the United States. The most ambitious is areawide or regionwide congestion pricing, which would apply pricing at several locations within a city or region, including new and existing highways, lanes, or other facilities. In some cases, the proposals incorporate regional programs to promote carpooling or to improve transit service. Although adopted in other parts of the world, such broad applications of pricing have reached only the feasibility study phase in the United States.

Zonal and Regionwide Pricing

Officials in New York City recently considered a zonal pricing scheme similar to that adopted in London. Vehicles would have been charged for entering a priced zone encompassing most of Manhattan. Revenues would have been used to improve and expand mass transit.

The congestion pricing proposal failed to gain approval, however, and the federal funds that would have supported the program were shifted to other projects. Advocates of congestion pricing in New York City nevertheless believe that a pricing program will reemerge.

Another regionwide approach to congestion pricing has been under consideration in Maryland and Virginia for several years. The two states are studying the potential of regionwide priced networks of HOT and express lanes.

TABLE 2 New Express Lanes in the United States

Project	Size and Characteristics	Use
SR-91 Express Lanes, Orange County, California	10 miles, 4 new lanes in median; tolls vary by time of day according to fixed price schedule	Averaging nearly 40,000 vehicles per day in 2007; express lanes make up only one-third of SR-91 highway capacity but carry more than 40 percent of total traffic
Managed Lanes on I-15, San Diego	20 miles, 4 lanes, being built in the median with moveable barriers, multiple access points, and direct access ramps for transit; pricing will be dynamic	See article by Toups in this issue (page 23)
I-10 Managed Lanes, Houston	2 new lanes in each direction in the median; dynamic pricing; initially, new lanes open only to HOV and transit; by spring, toll rates will be established based on available capacity, to allow possible buy-in by SOVs during peak	Opened in 2008, to be fully operational in 2009
I-30 Managed Lanes, Dallas	2 reversible lanes operating in peak periods; initially only open to HOV and transit, but plans call for transition to SOV buy-in	Planned
San Joaquin Hills Transportation Corridor Toll Facility	Peak-period surcharge introduced in early 2000s	Results inconclusive, because price increment is relatively small

TABLE 3 Congestion Pricing on Toll Facilities in the United States

Project	Size and Characteristics	Use
Lee County, Florida, Off-Peak Toll Discounts	Toll discount provided during selected off-peak hours on two heavily used toll bridges	Public opinion on discount program positive; initial discount caused shift to off-peak and more efficient use of capacity
New Jersey Turnpike Authority Variable Tolls	Heavily used toll facility, with average daily trips exceeding 500,000 vehicles; toll schedule provides for peak–off-peak toll differential for E-ZPass users	Survey showed 7 percent of users altered travel behavior in response to toll differential in 2000; further changes made to toll differential in 2003 and 2006
Port Authority of New York and New Jersey Toll Differential Program	Peak–off-peak toll differentials on two tunnels and four bridges connecting New York and New Jersey	New toll program produced significant shifts from peak to off-peak
Illinois Tollway	Off-peak toll discounts for trucks introduced in 2005 as temporary measure to shift traffic out of peak during construction period	Some success with flexibility offered to truckers; other congestion pricing options under study

Alternative Fees

Other projects under investigation or experimentation seek to convert some of the fixed costs of owning and operating a vehicle into variable costs. The Oregon Department of Transportation (DOT), for example, has studied the feasibility of replacing the state gas tax with a mileage-based fee, including the imposition of variable, time-of-day fees in congested areas during peak travel times. The Puget Sound Regional Council has examined the practicality and travel effects of tolls based on distance, time of day, and location.

Minnesota DOT has evaluated the effects of converting lease costs and insurance premiums to a per-mile basis. In Atlanta, Georgia, households are being studied to determine responses to mileage-based insurance charges; subsequent tests are planned to evaluate the effects of fees varied by time and location. Initial findings from the studies and experimental data are supplying evidence that mileage-based fees influence driver behavior and that some forms of these fees could be used to reduce traffic congestion and generate revenues.

Carsharing and Parking Cash-Outs

In addition, carsharing and parking cash-out projects—intended to make the costs of owning, operating, and parking an automobile more apparent—provide incentives to reduce car ownership and driving. Carsharing programs that offer neighborhood car rentals are under way in San Francisco, California; Seattle; Boston, Massachusetts; and Washington, D.C.

By sharing a neighborhood car, drivers can eliminate the fixed costs of automobile ownership and instead incur a variable charge based on miles driven and hours of use. The first large carsharing program in the United States began in 1998, and approximately 20 metropolitan areas have programs.

Under a parking cash-out program, such as the ones in Los Angeles and Seattle, employees forgo their free or subsidized parking space in exchange for cash, which can be used for any purpose. Participants then must face market charges for parking and may shift to other commuting options.

International Experience

Although most congestion pricing programs implemented in the United States have focused on single

Congestion Pricing Benefits

- Reduces congestion
- Can increase throughput
- Can be a source of revenue
- Can be a fair and equitable part of a user charge program
- Promises positive environmental and energy benefits

Congestion Pricing Issues and Challenges

- Success calls for effective outreach, public support, and flexible management
- Pricing projects often require new policies and institutional arrangements
- Pricing and enforcement technologies are functioning, but some challenges remain
- High costs of new facilities and of pricing technologies are an issue
- Privacy concerns require close attention in areawide pricing proposals

facilities or lanes, pricing applications in other countries are more commonly areawide or regionwide. Since the implementation of areawide congestion pricing in Singapore in 1975, several pricing projects have gone into operation in other nations. Many of these projects involve fees for entering or traveling within a congested zone. Some programs charge vehicles for entering an urban region; others employ congestion pricing on expressway networks.

The United Kingdom, France, Norway, Sweden, Germany, Switzerland, Singapore, and Australia have implemented major road pricing projects. The London and Stockholm central area charge schemes have operated successfully since the mid-2000s. In addition, nearly all European Union member countries, as well as several Asian nations, Canada, Australia, and New Zealand, have conducted congestion pricing studies.

As in the United States, international projects are breaking new ground and providing important lessons about congestion pricing as a measure to improve the flow of traffic. Following are descriptions of three projects that highlight some of the broader approaches adopted by other nations. Several other international projects are summarized in Table 4 (below).

Singapore

At its inception in 1975, the congestion pricing scheme in the island nation of Singapore involved a simple, manually controlled area licensing procedure with toll booths. Since then, it has advanced to a fully automated electronic system, with a more extensive geographic scope.

The sophisticated system controls congestion on major roads, setting fees that vary by location, day of the week, and time of day. Charges are adjusted every calendar quarter to maintain free-flowing traffic within the central business district and to keep speeds at desired levels on principal expressways and arterials. The operating authority expands the number of charging points as traffic conditions warrant.

The effects of Singapore's road pricing system on traffic congestion have been significant, particularly when combined with policies designed to raise the cost of owning an automobile and to improve public transportation alternatives with the revenues from road pricing. According to the system's manager, electronic road pricing (ERP) has helped to "spread traffic flow evenly over the working day and eliminate short, sharp peak periods—although some localized congestion for short periods remains along alternative routes and on the priced route immediately after the ERP system stops operation."

London

London launched a cordon, or zonal, road pricing program in February 2003. The program entails a standard daily fee—initially £5, raised to £8 in 2005[1]—for vehicles crossing into, leaving, or traveling within the charging zone (see map, page 13).

[1] £1 = $1.62 in July 2009.

TABLE 4 Other Selected International Pricing Programs

Country and Program	Program Description and Characteristics
Norway: Toll rings	Oslo, Bergen, and Trondheim have toll cordons around the central cities; vehicles crossing the cordon are charged tolls depending on the time of day; the programs have reduced road use during the priced periods and generated new revenues to fund road improvements
France: Congestion pricing on intercity routes	Since the early 1990s, several autoroutes in France have adopted variable tolls to encourage shifts from peak to off-peak travel periods or from more to less congested routes
South Korea: Nam San Tunnel Congestion Pricing, Seoul	A peak-period surcharge has changed the composition of tunnel traffic and has reduced daily traffic through the tunnel
Germany: GPS-based truck tolls	GPS- and GSM-based tolling introduced for all trucks traveling on its major highways; tolls vary by distance traveled, number of axles, and vehicle emissions rating; tolls generate annual revenues of more than $4.0 billion; half of revenues are for highways and half for rail and inland waterways
Ireland, Israel, and others: Variable on-street parking pricing	Several cities have established location-, time-, and duration-specific parking rates for curb spaces within central cities; the programs have rationalized the use of curbside parking supply, reduced travel by automobile, and generated revenues

GPS = Global Positioning System; GSM = global system for mobile communications

THE CENTRAL LONDON CONGESTION CHARGING ZONE—The 2003 original charging zone in London (*dark shaded area, right*) was approximately 8 square miles. The expansion zone *(light shaded area, left*) was added in 2005, with North–South Edgware–Park–Vauxhall Roads as the dividing line (*bottom inset:* charge zone within Greater London).

The system allows for many exemptions and discounts, including substantial discounts for residents of the pricing zone. Designed to reduce weekday congestion in a central city zone bounded by a ring road, the charging zone was extended westward in February 2007.

Traffic adjusted rapidly to the introduction of pricing. After the first year, traffic circulating within the charging zone had declined by 15 percent during charging hours, and the number of vehicles entering the charging zone declined by 18 percent. Although traffic on the inner ring road—a possible diversionary route around the charging zone—was expected to increase, the increase was less than predicted, and no operational problems were observed.

Evidence showed no significant increases in traffic outside the charging hours or in the areas surrounding the charging zone. Traffic approaching the charging zone was reduced, and no significant change in traffic levels was observed on nearby local roads.

Stockholm

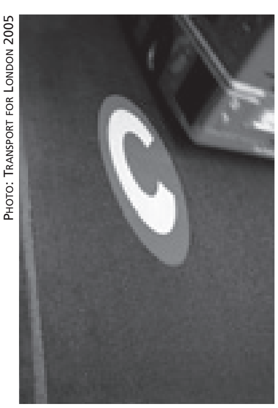
After more than three decades of study and debate, the government of Stockholm, Sweden, launched a 6-month pilot test of congestion pricing in 2006 and made the arrangement permanent in 2007. The goals of the cordon pricing program were to reduce congestion, improve the environment, and generate revenues for transportation improvements.

The priced area includes a central city zone of approximately 20 square miles that constitutes only a small part of the larger urbanized county. Vehicles are charged when entering or exiting the priced zone at 18 crossings that encircle the central city. Charges vary by time of day, with a maximum daily charge. Some exemptions are available, including an exemption for vehicles that travel through the priced zone without stopping.

Evaluations during the pilot test period showed that the charging program met or exceeded the goal of a 10 percent to 15 percent reduction in traffic. Congestion was reduced dramatically, and traffic speeds increased. The worst traffic queues in the city center were reduced by 30 percent or more. Traffic bypassing the city center did not increase significantly. Travel time reliability improved, and traffic volumes on the most heavily traveled routes dropped by 20 percent to 25 percent.

Public transit use increased by 6 percent to 9 percent, although not all of the change could be attributed solely to the charging program. Less than half of the auto users who gave up a trip during the charge period shifted to transit, and few commuters changed their time of departure.

PHOTO: TRANSPORT FOR LONDON 2005



Pavement marking in London's congestion charging zone.

Looking Forward

Experience in the United States and abroad suggests that the congestion pricing strategy holds promise as a tool to reduce congestion, improve environmental quality, and raise revenues to support transportation programs. With support from the federal government, states and localities have made important strides in the application of congestion pricing in the past 15 years. This progress is expected to continue, with congestion pricing becoming a more important component of U.S. urban transportation policy.

Interest in pricing is growing. Once a topic for a small cadre of academics, even areawide pricing is now front-page news around the world, discussed by transportation professionals, interest groups, and elected officials as an innovative way to cope with recurring congestion problems and to provide a source of funding and an effective complement to transportation improvement programs.

Although the primary rationale for variable pricing is to improve mobility, the revenue-generating effects have been equally important in attracting international interest. The revenues one day may serve as a partial or full substitute for fuel taxes.

Congestion pricing offers promise as transportation agencies struggle to find new and robust approaches to finance their programs. With proper attention to issues of project-specific acceptability, pricing can be a fair and equitable component of a road user charge program.

Much has been learned about the promise and potential of areawide and other types of pricing, yet much remains to be learned. The long-term impacts on land use, automobile ownership, businesses, and productivity need to be monitored.

Improving Models for Traveler Behavior Under Congestion Pricing

PETER VOVSHA

The growing variety of highway pricing forms and policies represents a challenge for travel modelers and decision makers. The Transportation Research Board recently initiated several large-scale research projects associated with understanding and forecasting traveler behavior under congestion and pricing, including two interrelated projects:

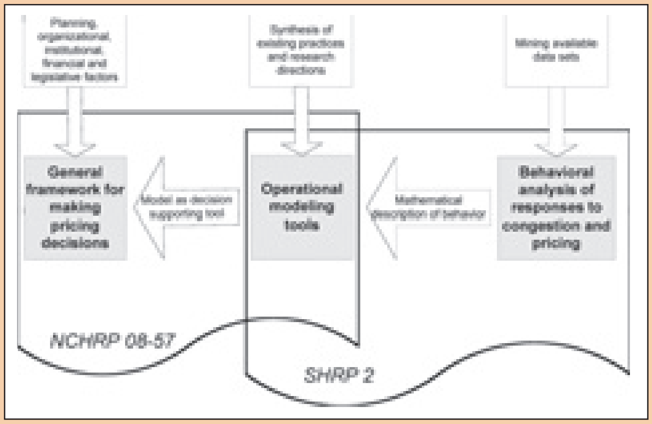
- National Cooperative Highway Research Program (NCHRP) Project 08-57, Improved Framework and Tools for Highway Pricing Decisions[1]; and
- Strategic Highway Research Program (SHRP) 2 Project C04, Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand.[2]

A team led by Parsons Brinckerhoff is conducting and coordinating both projects and has delineated common and exclusive areas for research (*see figure, at right*).

The NCHRP project focuses on improving the decision-making framework for highway pricing, recognizing that applied forecasting models are critical decision-support tools. The SHRP 2 project focuses on developing mathematical descriptions of the behavioral responses of highway users to congestion, travel time reliability, and pricing, and on incorporating the descriptions into travel demand modeling systems.

Both projects share a framework of applied models. This provides a link between the SHRP 2 investigation of the fundamentals of travel behavior and the NCHRP research into the practical aspects of decision making about pricing.

[1] www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=933.
[2] www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2163.



Common and Exclusive Areas of NCHRP Project 08-57 and SHRP 2 Project C04.

NCHRP Project Milestone

The NCHRP project has reached a milestone with the submission of an interim report, now in review, that includes a comprehensive overview of current practices. The interim report consists of two volumes:

- *Volume 1: Decision-Making Framework* relies on a synthesis of regional pricing studies in Washington, Colorado, Texas, and in the Atlanta, Georgia, and the San Francisco, California, regions, as well as case studies that document the decision-making process for five pricing projects. In addition

Implementing acceptable and effective pricing programs requires careful planning, coalition building, public education, and time and resources. Small steps taken in the United States and in other nations have led to significant strides toward the acceptance of congestion pricing as a key part of transportation policy.

Web Resources

For more information about the state of the art in congestion pricing, see the Value Pricing website of the Hubert H. Humphrey Institute of Public Affairs, University of Minnesota, www.valuepricing.org. Other notable web resources include the following:

Coordination of Urban Road User Charging Organisational Issues (CURACAO)
www.curacaoproject.eu/

Federal Highway Administration (FHWA) Highway Community Exchange Knowledge Sharing
http://knowledge.fhwa.dot.gov/
(Click on "Highway Community Exchange" and then on "Value Pricing")

FHWA Office of Operations, Value Pricing Program
http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/index.htm

K.T. Analytics and Cambridge Systematics, Inc., Value Pricing Pilot Program: Lessons Learned, Final Report, FHWA-HOP-08-023, 2008
http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/publications.htm

K.T. Analytics and Cambridge Systematics, Inc., Lessons Learned from International Experience in Congestion Pricing, Final Report, FHWA-HOP-08-047, 2008
http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/publications.htm

Transportation Research Board Congestion Pricing Committee website
www.trb-pricing.org

U.S. Department of Transportation, Congestion Initiative and Urban Partnership Agreement Program Information
www.fightgridlocknow.gov

to the models, the decision-making framework incorporates various pre- and post-modeling steps, including project screening, toll rate optimization, risk analysis, annualization of revenues, revenue stream interpolation and extrapolation, and estimation of revenue loss.

◆ *Volume 2: Forecasting Tools* presents findings from a survey of more than 30 travel models applied in pricing studies, including traditional four-step models and advanced activity-based microsimulation models. Travel model improvements are a key topic, because rating agencies and private investors are examining travel and revenue forecasts.

SHRP 2 Project

Three Levels

The research for the SHRP 2 project on road pricing, congestion, and travel demand is structured into three levels:

◆ The first level develops a fundamental understanding and a set of robust mathematical descriptions of travel behavior; no simplified analytical restrictions are applied.

◆ The second level presents advanced, yet operational, activity-based models that can incorporate various models of travel behavior.

◆ The third level examines the traditional four-step models used by most metropolitan planning organizations and state departments of transportation; these models can provide a more restricted framework for analysis.

Planning and modeling applications have not yet fully addressed congestion and pricing. In most applications, congestion is portrayed with longer average travel times, and the impacts of pricing are reduced to time equivalents of cost with a fixed value of time. Congestion and pricing, however, have many other specific impacts, including travel time reliability, which with average time and cost is a fundamental parameter of a highway's level of service; perceived highway time, determined by congestion levels and other attributes; and the different patterns of behavior in response to unpredictable travel times.

Improving Models

The SHRP 2 project is inventorying available data sets and has identified the most important directions for improving models:

◆ Measuring and including travel time reliability in travel demand models, along with average travel time and cost variables;

◆ Segmenting highway users according to their willingness to pay for improvements in travel time and reliability, as well as by their trip purpose, their income group, their personal characteristics, and their car occupancy;

◆ Improving modeling techniques for time-of-day choice and for mechanisms that spread out congestion peaks;

◆ Modeling of carpooling, including carpool formation and adaptability to improvements in travel time, cost, and reliability; and

◆ Identifying the model structures to incorporate different pricing forms and impacts for different travel choices, with an emphasis on integrating activity-based models and dynamic traffic assignment.

The next phase of these projects will include model development, estimation, and validation through several pilot applications.

The author is Principal, Parsons Brinckerhoff, Inc., New York.

Pricing Road Use to Address Congestion

Promoting Appropriate Congestion Pricing Solutions in Europe

Improving Access and Reducing Emissions

DAVID BLACKLEDGE

The author is Chairman and Director of European Affairs, Transport & Travel Research Ltd., Lichfield, United Kingdom.

In recent years, road congestion has ascended the policy agenda of many European governments. Traffic volumes in major European towns and cities continue to rise, causing more delays, air pollution, and noise. The European Commission estimates that €100 billion—equivalent to 1 percent of the European Union's gross domestic product—is lost to congestion each year.

Politicians and planners are recognizing that bold action must be taken to manage demand for scarce road space. Despite strong evidence from cities such as London, Rome, and Stockholm that road pricing can relieve congestion, many elected officials in Europe remain wary, fearing negative public reaction. The European Commission therefore supported a project to monitor congestion pricing developments, Coordination of Urban Road User Charging Organisational Issues (CURACAO), which ran from April 2006 to March 2009. During the span of CURACAO, the congestion pricing story has extended to whole countries.

Iterative Solutions

The CURACAO project is a consortium of 15 member organizations, coordinated by Transport & Travel Research Ltd, a transport consultancy in the United Kingdom. The consortium includes 10 expert partners—commercial consultancies, academic institutions, and government agencies—and representatives of five public authorities with experience in congestion pricing, either with fully implemented projects or as promoters of schemes not yet implemented (see Table 1, page 17).

CURACAO differs from other projects by approaching the implementation of congestion pricing not as a linear process but as an iterative process. The project developers recognized that no one-size-fits-all solution can ensure the success of demand management. Each European city has distinctive political, legal, and public acceptability issues, and therefore each requires a tailored solution. The CURACAO project therefore sought first to identify user needs through a User Needs Assessment questionnaire in July 2006.

Officials in cities that were considering congestion pricing received a list of possible barriers to implementation. The officials were asked to identify the five most significant barriers and to rank them from 1 to 5 by priority (see Figure 1, page 18). The top two barriers were the lack of a political champion and low public acceptability, followed by the difficulty of managing a large, complex project involving congestion pricing.

Established by the European Commission, the CURACAO consortium ran from April 2006 to March 2009 and conducted needs assessments, convened user groups, developed case studies, and produced reviews of congestion pricing projects.

TABLE 1 CURACAO Project Partners

Partner	Country	Website
ATAC, Rome	Italy	www.atac.roma.it
Bristol City Council	United Kingdom (UK)	www.bristol-city.gov.uk
CERTU	France	www.certu.fr
City of Stockholm	Sweden	www.stockholm.se
Goudappel Coffeng	The Netherlands	www.goudappel.nl
ITS, University of Leeds	UK	www.its.leeds.ac.uk
ISIS	Italy	www.isis-it.com
POLIS	Belgium	www.polis-online.org
Public Roads Administration	Norway	www.vegvesen.no
REC	Hungary	www.rec.org
SESTRAN	UK	www.sestran.gov.uk
SINTEF	Norway	www.sintef.no
Technical University of Dresden	Germany	www.tu-dresden.de
Transport & Travel Research Ltd.	UK	www.ttr-ltd.com
WSP	Sweden	www.wspgroup.se

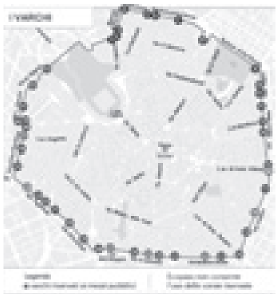
Respondents also identified several barriers that were not originally listed (the Other category in Figure 1), including legal barriers and uncertainty about the economic impacts. By recognizing these barriers, CURACAO was able to target its resources, offer solutions from cities that have experience overcoming similar problems, and provide assistance from industry and academic experts. The project conveyed this experience and expertise by convening user groups, developing case studies of best practices, and producing critical reviews of projects.

Moving Forward Together

In all, 20 cities or regions from nine countries joined the CURACAO User Group. The aim of the group was to provide a closed forum in which city representatives could comfortably discuss progress on congestion pricing planning and receive support and feedback from experts with technical or practical experience. The User Group met six times, learning about experiences in London, the Netherlands, Stockholm, Germany, and Milan, as well as holding a special discussion session for local politicians. In addition, representatives of other cities have presented draft plans for congestion pricing that emerged after CURACAO started and have received feedback from project experts.

Sharing Good Practice

CURACAO has developed case studies to provide local policy makers with detailed information about the impacts of introducing congestion pricing. The case studies build on evaluations of European cities that have implemented or sought to implement congestion pricing, such as Bristol, Edinburgh, The Hague, London, Oslo, Rome, and Stockholm. The case studies



Milan—as well as fellow Italian cities Rome and Bologna—has implemented a citywide congestion charge zone.

reveal each city's distinct contribution in the use of pricing to achieve particular policy objectives.

Ensuring Scientific Excellence

Through its network of experts, CURACAO monitored developments in congestion pricing experience and in the latest academic research. Syntheses of this information gave the project team, decision makers, and technical experts access to the state-of-the-art knowledge on congestion pricing practice. The project website contains a comprehensive state-of-the-art review incorporating developments up to December 2008.

Looking Ahead

Since the start of the CURACAO project, congestion charging has begun to enter the mainstream of political debate in Europe, as more cities have begun planning and introducing schemes. For example, the Netherlands has announced the first nationwide congestion pricing system.

Many issues and uncertainties remain for congestion pricing to make inroads, especially in smaller, provincial cities and towns. Public and business acceptability remain key barriers, but so does affordability for cities that have smaller economies of scale and that are reluctant to risk the possible displacement of commuters and shoppers. CURACAO concluded with a set of 17 policy recommendations aimed at governing authorities at the European, national, and local levels.

Milan's congestion charge scheme, EcoPass, was one of the initiatives studied by CURACAO.

For more details about CURACAO, visit the project website, which contains extensive information, including contacts.[1]

[1] www.curacaoproject.eu/.

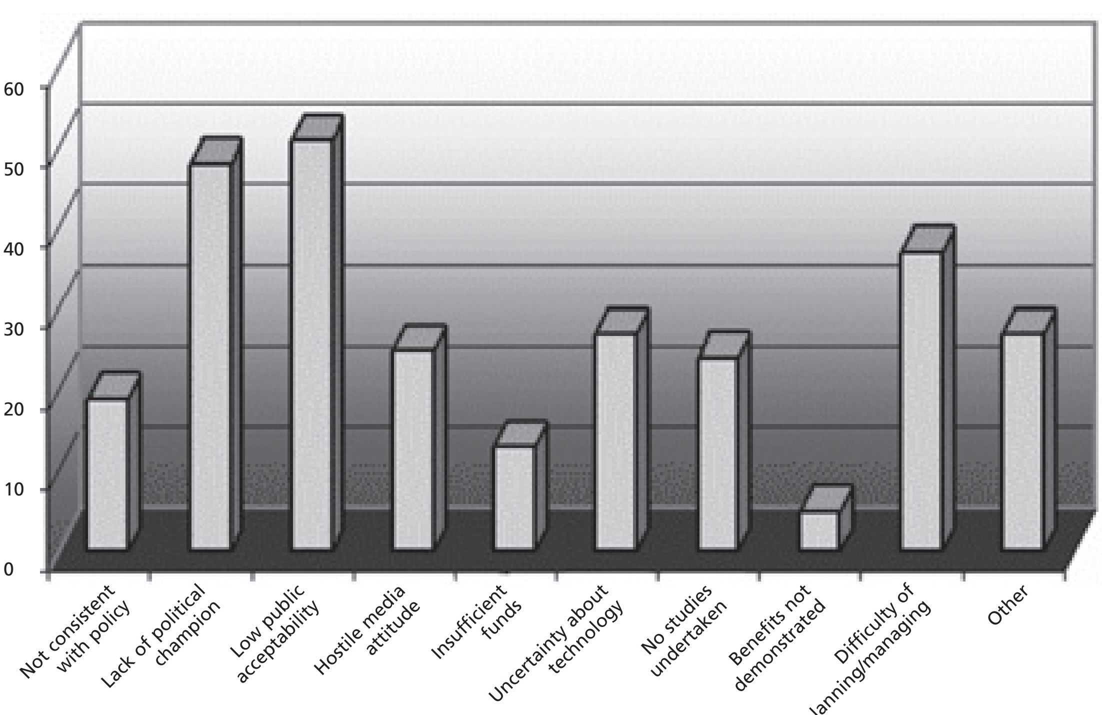


FIGURE 1 Barriers to Congestion Pricing Schemes

Spotlights on European Programs

United Kingdom: Varied Responses

All of the capital cities of the United Kingdom (UK) have considered congestion pricing.

The City of London introduced a congestion charge in 2003, and added the Western Extension in 2007. A proposal to expand the scheme in 2008 to include a charge for carbon emissions based on engine size was abandoned following the election of a new mayor, who is also reviewing the Western Extension.

In Edinburgh, a public referendum decisively rejected a transport improvement plan in 2005 that included a congestion charging scheme.

In Wales, the Cardiff Chamber of Commerce reported widespread support for a charging scheme among business leaders and transport professionals in late 2007, but no decision has yet been made to bring a scheme forward.

In England, the Department for Transport has supported 10 Transport Innovation Fund pilot areas to prepare bids for improvements, which may include congestion pricing. Successful councils will be awarded money to assist with the implementation of the plans. The UK government has shelved plans for a national congestion pricing scheme, announced in June 2005, in favor of local applications. The only city to propose a scheme, however, was Manchester, and a referendum comprehensively rejected the plans in December 2008.

Italy: Annual Passes

The City of Rome has operated Limited Traffic Zones (LTZs) since 2001. Access to particular areas of the city is restricted through an annual pass system, with a range of technologies for enforcement, including electronic gates, smart cards, and cameras that read vehicle number plates *(see photo)*. The system has helped to reduce car traffic in the LTZs by 15 percent to 20 percent, and the city is expanding the number of zones.

The cities of Bologna and Milan also have implemented congestion pricing with LTZs, with charges primarily based on the vehicle's engine size.

Rome's LTZ enforcement technologies include cameras that read vehicle number plates.

Sweden: Congestion Tax

Stockholm conducted a trial period of congestion charging from January through June 2006, with a September 2006 referendum showing majority support for the measure, known as a congestion tax. During the trial, traffic levels in the inner city were reduced by 20 percent to 25 percent, and the time spent in queues decreased by 30 percent to 50 percent. Emissions also were reduced.

Stockholm began the permanent scheme on August 1, 2007, operating from 7:30 a.m. to 6:30 p.m., Monday through Friday. The City of Gothenburg also is investigating the feasibility of a congestion pricing scheme.

The Netherlands: Going Nationwide

Amsterdam and Utrecht have developed plans for congestion pricing, although instead of levying a charge, the Utrecht plan offers incentives to commuters not to drive. The Hague has tested a similar approach. The cities' plans may be uncertain, however, because the Dutch government is committed to introducing congestion pricing nationwide in 2012 for trucks and in 2016 for cars.

Tolled Managed Lanes

Lessons Learned and Challenges to Meet

GINGER GOODIN AND CHUCK FUHS

Goodin is a Senior Research Engineer with the Texas Transportation Institute, College Station, and chairs the TRB High-Occupancy Vehicle, High-Occupancy Toll, and Managed Lanes Committee. Fuhs is Vice President of Parsons Brinckerhoff, Houston, Texas, and chairs the TRB Managed Lanes Joint Subcommittee.

High-occupancy vehicle (HOV) lanes have been in operation in the United States since the late 1960s. In 1970 three HOV projects were operating on mainline freeway corridors. Early HOV treatments allowed buses or carpools with three or more persons only (HOV-3) and were implemented in corridors with high bus transit ridership.

Over time, HOV lanes were implemented and operated to allow two-occupant vehicles (HOV-2) to promote ridesharing, meet growing demand, and utilize HOV lane capacity as traffic volumes outpaced expansion of adjacent general-purpose lanes. Today more than 120 HOV lanes—and countless arterial examples—operate throughout North America, with many more overseas.

Since the mid-1990s, congestion pricing has been added to HOV lanes, creating various forms of high-occupancy toll (HOT) lanes and median express toll lanes (ETL). Adapting HOV to HOT lanes with congestion pricing is a logical evolution. Pricing can provide more flexibility in maintaining free-flow conditions in HOV lanes, because it allows management in real time, with more fine-tuned operations than are available by restricting only eligibility and access.

Between 1995 and 2007, seven HOT or ETL projects were implemented, mostly on HOV lanes. One project, however—the SR-91 Express Lanes in Orange County, California—was implemented originally as a public–private venture, adding new ETLs to the median of the freeway.

Photo: David Sailors, Parsons Brinckerhoff

A three-person HOV lane, pictured in 2000, on the George Washington Bridge over the Hudson River in New York.

Lessons Learned

Experience with HOT and ETL projects has provided key lessons for the implementation of pricing:

High-occupancy toll (HOT) lanes can work without adversely affecting carpools and transit.

A common concern among HOV lane users is that the introduction of congestion pricing may adversely affect the viability of transit and carpooling. The increase in eligible vehicles may reduce service levels and lead to a shift from carpooling and transit to single-occupant vehicles (SOVs).

Congestion pricing, however, successfully has been demonstrated to maintain a premium level of service in the HOT lanes and to cause little adverse effect on service levels. Carpooling has not declined, and studies also have shown that shifts from transit to SOVs have been negligible.

HOT lanes are not necessarily big generators of revenue.

The net revenue generated through pricing depends on the number of lanes priced, the level of congestion in the corridor, and the proportion of vehicles that is allowed to use the lanes without charge during the periods of peak demand. The expectation that tolled lanes will pay for their capital outlay depends on the size of the implementation costs. Most projects—particularly HOV-to-HOT expansion projects—barely cover ongoing expenses for management and operations, much less offset the capital costs.

HOT and express toll lanes are not a panacea. Tolling on managed lanes does not work in all settings or projects, and requires a significant additional investment for operations and enforcement. Congestion pricing must be part of a broader, comprehensive approach to congestion management that includes expanded transit services, improvements in capacity and safety, the promotion of transportation demand reduction, and related measures.

Adding congestion pricing to HOV lanes requires many design and operational changes. To add congestion pricing to HOV lanes, more is required than the installation of tolling equipment and the administration of electronic transponders. An array of design, operation, and enforcement changes is needed for the HOV lane and the supporting infrastructure. For example, added traffic on the HOV lane may require weave or transition lanes at the points of access or longer merges as lanes end.

Designs originally developed for bus- or carpool-only HOV lanes may require upgrading, revamped signage, and some means of monitoring and enforcing the new restrictions. If transit services are expanded simultaneously, supporting investments may be needed for stations and park-and-ride lots.

Remaining Challenges

The growing number of implemented projects offers insights into the application of congestion pricing on HOT lane and ETL facilities. Nevertheless, several questions and challenges remain.

Enforcement

The enforcement of HOV lanes always has been difficult. The opportunity to avoid a toll stimulates a variety of tactics. Because of the different offenses that must be monitored, HOT-lane enforcement presents major institutional, safety, and technological challenges.

Toll evasion monitoring can be automated, but some functions still require on-site presence. For example, occupancy enforcement is labor-intensive, requiring the visual inspection of occupants in a fast-moving vehicle, often during periods of limited visibility.

GRAPHIC: TRANSURBAN

The Capital Beltway (I-495) HOT Lanes Project in the Washington, D.C. area, shown in this rendering, is currently under construction.

Maintaining Level of Service

As vehicle throughput increases, and as pricing is applied to meter the flow, the challenge is to maintain a reliable lane operation at higher traffic volumes. This requires knowledge about the most effective methods of lane separation and of operating the ingress and egress areas under high vehicle volumes, while providing the safest levels of operation.

Best Practices for Design

Most of the early projects were barrier-separated, with limited opportunities for access, which simplified pricing strategy, enforcement, and driver information requirements—and enhanced safety. Most projects implemented today are not physically separated and have many points of access. Identifying the best design, operation, and enforcement practices

Reliable lane operation at high traffic volumes requires knowledge about the most effective and safest methods of lane separation and of operating ingress and egress areas under high vehicle volumes.

Use of changeable message signs to assist motorists in making route choices was studied in the Los Angeles area in 2005 by the California Department of Transportation (Caltrans). Successful signage is integral to tolled managed lane operations.

PHOTO: CALTRANS

will require experience from more projects, especially from those with greater design and operational complexity.

Equity

Equity issues arise on every HOT project and play a role in HOV lanes, because the management tools restrict some users by mode and others by pathway—if they cannot freely enter the lane. The introduction of pricing therefore often includes various other approaches, such as expanding options for ridesharing and transit or offering transit credit programs. HOT lane experience will reveal more about the public's response to pricing and how to engender public support.

Demand Forecasting

Demand for tolled managed lanes is discretionary, because free options are available—and often visible on the adjacent roadway. The advent of sketch planning tools and the restructuring of regional models have provided a way to gauge the effects of pricing on the demand for HOT and express toll lanes. More project experience is needed to calibrate the pricing and demand forecasting tools effectively.

Communication with Drivers

Signage for tolled managed lanes can complicate an already difficult and constrained freeway design and operating environment. Drivers want to know the rules and regulations, which may change by time of day, as well as how much the lane costs, where the access points are located, and what travel time benefits will result. Further research, coupled with experience from the growing number of congestion-priced facilities, will improve understanding of the information that drivers need and of the most effective ways to communicate that information.

Environmental Benefits

Quantitative research on the air quality benefits of HOV facilities has been limited and inconclusive. With growing interest in mitigating climate change and in strategies to reduce greenhouse gas emissions from transportation sources, research is needed to examine the emissions benefits of HOT and ETL treatments.

Next-Generation Managed Lanes Projects to Watch

San Diego I-15
www.keepsandiegomoving.com/I-15-intro-ml.html

Houston I-10
https://www.hctra.org/katymanagedlanes/faq.html

Virginia I-495
http://virginiahotlanes.com/

Dallas I-635
www.newlbj.com/

Miami I-95
www.95express.com/

Los Angeles I-10
www.metro.net/projects_studies/fastlanes/index.htm

Minneapolis I-35W
www.dot.state.mn.us/upa/

What's in Store for Second-Generation Express Lanes in San Diego?

DEREK TOUPS

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Home to the nation's first high-occupancy toll (HOT) lanes, the congestion pricing demonstration on Interstate 15 (I-15) in San Diego, California, set the bar for the conversion of high-occupancy vehicle (HOV) to HOT lanes. An evolving, intelligent transportation systems project, the Express Lanes opened 20 years ago as an 8-mile reversible HOV expressway. In 1996, the congestion pricing element was added. The HOT lanes paved the way for similar projects nationwide.

Earlier this year, the California Department of Transportation (Caltrans) and the San Diego Association of Governments (SANDAG) unveiled a major expansion, doubling the length and width of the lanes, and setting new standards for managed lane projects worldwide. Caltrans and SANDAG are completing the next managed lanes extension on I-15 and are executing plans for additional congestion-priced facilities in the San Diego region.

History of I-15 Pricing

At the 1988 opening, the two reversible HOV lanes occupying the median of an 8-mile section of I-15 were expected to provide much-needed traffic relief to one of the region's busiest commuter routes—but that did not happen. After nearly a decade, demand for carpools and buses on the HOV lanes remained low, and many commuters were frustrated by the mounting traffic on the adjacent general-purpose lanes.

A local elected official proposed legislation to allow single-occupant vehicles (SOVs) to pay a toll for access to the underutilized HOV lanes; the surplus toll revenue could be channeled to accelerate transit development in the corridor. In response, SANDAG converted the roadway to the nation's first HOT facility in 1996.

PHOTO: CALTRANS DISTRICT 11

The San Diego Association of Governments (SANDAG) converted I-15 to the nation's first HOT facility in 1996.

SANDAG initially offered a monthly permit, branded as the Express Pass—a color-coded hang-tag affixed to the rearview mirror—issued to a limited number of drivers at a flat rate for unlimited use of the HOV lanes. SANDAG slowly increased the monthly permit fee to test the effect on motorists' willingness to pay. The findings influenced the pricing structure that SANDAG soon deployed under an all-electronic variable toll collection system.

SANDAG launched the I-15 FasTrak® program after only several months.[1] Under this scheme—

[1] FasTrak® is a registered trademark of the Transportation Corridor Agencies and is the de facto standard for electronic toll collection in California.

Photo: SANDAG

Under the FasTrak program, subscribers pay for each trip on San Diego's I-15 HOT lanes, with tolls that vary in real time.

which is compatible with other electronic tolling facilities throughout California—subscribers pay for each trip on the I-15 HOT lanes. The rate varies in real time, depending on the number of cars using the Express Lanes. Carpools, vanpools, certain clean air vehicles—such as hybrids—and motorcycles can use the I-15 Express Lanes without charge.

The statute authorizing the HOT lane program requires that the facility remain free-flowing, defined as Level of Service C—that is, stable flow, according to the terminology of the *Highway Capacity Manual*—or better. SANDAG instituted the world's first use of dynamic pricing in a road application—the price increases as the level of service within the lanes diminishes, so that fewer FasTrak customers enter the lanes.

The I-15 FasTrak program increased the use of the available capacity in the HOV lanes. By the end of 2008, SANDAG was processing more than 6,000 FasTrak transactions on a typical weekday, with an estimated 15,000-plus carpoolers traveling the Express Lanes every day. This represents a more than twofold increase over the preproject daily traffic of 9,200 vehicles when the lanes were for carpools only. The average toll rate is approximately $1.25 per trip.

With annual toll revenues totaling approximately $2 million, SANDAG's business model does not generate huge amounts of cash, but the revenues cover program operating costs, pay for the California Highway Patrol to enforce vehicle occupancy, and leave a small amount of funds to support I-15 transit operations.

Recently, the FasTrak program underwent a substantial evolution, by requiring all transponder holders to pay a small fee for the equipment. This change in policy induced some infrequent users to leave the program but had no effect on regular customers. As of late 2008, approximately 25,000 users were enrolled in FasTrak.

Typical traffic volumes in all lanes of the I-15 corridor range from 170,000 to 290,000 vehicles per day. Travelers in the general-purpose lanes regularly experience delays ranging from 30 to 45 minutes during peak times. Traffic in the corridor is projected to increase to approximately 380,000 vehicles daily by 2020. Without the improvements now under way, delays could be expected to reach as long as 90 minutes.

Recent Expansion

To solve the delay problem, SANDAG is partnering with Caltrans in the development and construction of roadway and structure projects, including the widening of facilities and the providing of new infrastructure, as well as adding new managed and HOT lanes, reversible lanes, and entry and exit points for bus rapid transit.

Photo: SANDAG

Variable toll message signs before every Express Lanes entrance display toll rates, as well as travel times, to major connectors.

Three Phases

Traffic and revenue studies were completed for the new Express Lanes in 2002. The pricing will be implemented through dynamic tolling, which will charge users a different per-mile rate depending on the level of congestion at the time for the segment at which the vehicle enters and for all segments downstream. The distance-based fares will fluctuate according to the value of travel time saved between the managed lanes and the adjacent general-purpose lanes for that trip, and according to the level of congestion in the managed lanes. The toll system will read vehicles at entry and exit to calculate the toll rate.

Caltrans and SANDAG are building the first of three phases of the 20-mile Express Lanes facility. The first phase—or middle section—opened to traffic last year, adding 8 miles of new Express Lanes to the original 8-mile reversible section, for a total of 16 miles in operation between State Route 163 and Centre City Parkway in the suburban city of Escondido. The northern section, comprising 4 miles from Centre City Parkway to State Route 78, is slated for completion by 2011, and the southern section, which entails the widening and retrofit of the original reversible HOV lanes, will be completed by 2012.

California law allows SANDAG to continue value pricing on I-15 indefinitely, subject to federal approval. In addition, SANDAG is authorized to implement similar programs on two additional corridors in the region.

New Technologies

In 2007, SANDAG celebrated 10 years of innovation in road pricing. In 2008, the authority opened the first phase in the expansion of the I-15 HOT lanes, launching the next generation of dynamic pricing technology.

A private contractor, TransCore, LP, operates the FasTrak system under contract to SANDAG and is constructing a new state-of-the-art toll collection system for the I-15 managed lanes. The new system will process vehicles entering at more than 25 locations; these include direct access ramps that allow Express Lane users to circumvent traffic queues at conventional freeway ramps and conventional weave lanes that allow vehicles to enter through openings in the concrete barriers and striping that separate the Express Lanes from the left-most general-purpose lane.

Striking a Balance

Since the inception of HOT lanes, program designers have sought to strike a balance among many demands, such as encouraging carpooling and transit, keeping the lanes flowing freely, and generating revenue to pay for operations. Despite declining transportation funding levels and pressure from state officials to redefine the minimum occupancy for carpools as three or more persons, SANDAG remains committed to exempting carpools of two or more persons from paying the toll. The agency is exploring other measures—such as credits for carpool and transit use—to add incentives for ridesharing, increase person throughput, and decrease vehicle miles traveled.

A forecast prepared in 2002 suggested that annual revenues from the I-15 FasTrak program would rise as high as $9 million after the expansion of the new managed lanes is completed in 2012. Although several years away, the excess revenue is expected to contribute to a robust bus rapid transit service that will operate throughout the day, with special peak-hour express service to rival the region's other mass transit services, the San Diego Trolley and COASTER commuter rail.

Innovative Funding

In 1987, San Diego County voters approved TransNet, a local half-cent sales tax, to fund a 20-year, $3.3 billion transportation improvement program for the county. In 2004, 67 percent of the region's voters supported a 40-year extension of TransNet, generating an additional $14 billion through 2048 to be distributed among highway, transit, and local road projects in approximately equal thirds.

The I-15 Express Lanes is perhaps the most visible of these projects. Despite California's fiscal crisis, SANDAG and Caltrans have a funding agreement to complete construction of the $1.3 billion managed lanes project by 2012. TransNet revenues are producing $241 million for the I-15 Express Lanes project.

In addition, the San Diego region was the first in

Photo: SANDAG

Excess revenue from the planned I-15 expansion is expected to contribute to a bus rapid transit service. The Metropolitan Transit System's I-15 corridor commuter bus service has received more than $8 million in subsidies in the past decade.

California to use Grant Anticipation Revenue Vehicle, or GARVEE, bonds. These transportation infrastructure bonds may be paid back with future federal transportation revenues. This funding strategy has allocated $197 million to the I-15 Express Lanes.

The San Diego region also was awarded approximately $450 million from the $4.5 billion statewide Corridor Mobility Improvement Account (CMIA) approved by California voters in 2006. The CMIA funds are for performance improvements on the state highway system or on major access routes to the state highway system; the I-15 Express Lanes project will receive $350 million of this funding.

Innovative Features

When the 8-mile section of new managed lanes on Interstate 15 opened to traffic earlier this year, a new era of integrated freeway management began, relying on the use of intelligent transportation systems and of advanced traffic management strategies. These include the following:

◆ *Dynamic value-based pricing.* SANDAG's new pricing system compares the value of time and the density of traffic to calculate the rate to charge SOVs for using the managed lanes.

◆ *State-of-the-art toll collection system.* An open-road tolling system tracks the entry of vehicles into the managed lanes, the number of tolling stations that the vehicles pass, and when the vehicles exit, and calculates each toll from the distance traveled and the rate displayed to the driver when the vehicle entered the lanes.

◆ *Integrated bus rapid transit.* Three new direct-access ramps now connect bus rapid transit centers directly into the managed lanes. Two more stations are planned, and last-mile–first-mile travel options under consideration include feeder bus, park-and-ride, and bikeways with dedicated lanes for bicycles to most of the stations.

◆ *Next-generation vehicle enforcement system.* San Diego will be the first site in the nation to test new automated vehicle occupancy verification technologies that can ensure that the HOT lanes are used fairly and perform at expected levels. Technologies that can detect and communicate the number of occupants in a vehicle may usher in a new generation of automated enforcement protocols to supplement the efforts of the California Highway Patrol.

◆ *Dynamic roadway expansion.* The middle two lanes of the four-lane I-15 facility are reversible, allowing expansion to serve the direction of the primary traffic flow and to provide additional capacity. At any given time, three lanes can flow in the peak direction, with the fourth lane traveling in the opposite direction.

◆ *Advanced toll signage.* New variable toll message signs before every Express Lanes entrance display toll rates and the travel times to major downstream freeway connectors. More than 20 of these sophisticated signs will be installed, allowing motorists to correlate the value of time with the cost of using the congestion-priced lanes.

Public Opinion

The combination of increased access, improved traveler choices, and shorter commuting times is attractive to area commuters. Public opinion polls taken by SANDAG in 2001 and 2004 revealed broad support for expanding the managed lanes, with more than 76 percent of respondents in favor of constructing new managed lanes; approximately 70 percent of those surveyed said they were likely to use the new managed lanes. Nearly every public opinion study about

TABLE 1 Public Opinion on I-15 HOT Lanes: SANDAG Survey Findings, 1996–2005

Survey Year	Percent of Respondents Supporting the Project	Percent of Respondents Opposing the Project
1996	66	**
1997, Wave 1*	56–95	**
1998, Wave 2*	64–94	**
1999, Wave 4*	58–88	**
1999, Wave 5*	70–88	**
2001	66	28
2002	58	14

* Survey by San Diego State University Foundation for SANDAG.
** Not reported.
Table excerpted from NCHRP Synthesis 377, *Compilation of Public Opinion Data on Tolls and Road Pricing.* Table 3, page 44. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_377.pdf.

Photo: SANDAG

A barrier transfer machine moves Jersey barriers to reallocate a traffic lane on I-15. The reversible lane segment of I-15 will be widened as part of the facility's expansion.

the I-15 Express Lanes between 1996 and 2005 has revealed broad support for the managed lanes concept and for expanded congestion pricing in the San Diego region (see Table 1, page 26).

Carpoolers on the I-15 managed toll lanes do not believe that the pricing program affects them adversely. Two key features appear to decrease the so-called Lexus Lanes stigma: first, intermediate access throughout the facility allows a diverse population to take advantage of the facility's time-saving benefit; and second, bus rapid transit is an integral component of the managed lanes strategy.

The integration of bus rapid transit is consistent with SANDAG's original proposal to apply the fees charged to drive-alone commuters on the HOV lanes to improve public transit in the I-15 corridor. In the past decade, SANDAG has provided more than $8 million in subsidies to the Metropolitan Transit System, which operates the evolving commuter bus service in the I-15 corridor.

Although managed toll lanes present an additional option for corridor travelers, some critics still argue that value pricing is unfair. Nonetheless, in a recent study, 88 percent of toll-paying I-15 FasTrak customers approved of the pricing policy, and 66 percent of other I-15 users—carpoolers, transit riders, and mainline users—gave it their approval.

Another survey found that 94 percent of transit riders and 92 percent of carpoolers believe the pricing component of the managed lanes is fair. Most of the respondents who approved noted that the project provides workable options for people in a variety of situations and that solo drivers help support transit and carpool alternatives. The lanes' effect of easing congestion for everyone on the main lanes was viewed as a balancing force in the "equity equation" (*1*).

Expanding Choices

In the next 4 years, SANDAG and Caltrans will complete the I-15 Express Lanes by adding 4 miles of HOT lanes, for a total of 20 miles, and by widening the reversible lane segment. The revamped Express Lanes will improve travel times and mobility and will connect to new bus rapid transit centers and park-and-ride lots.

These improvements will provide travelers with more reliable and convenient transportation choices. Work began in 2008 on the widening of the lanes and on the construction of the final portion. The entire $1.3 billion project will be complete by 2012.

Earlier this year, SANDAG completed its Regional Transportation Plan, which includes expansion of the managed lanes program into a network of more than 85 miles on Interstates 5, 15, and 805, as well as on State Route 52. As on I-15, the facilities will be limited-access lanes in which carpools, vanpools, and buses have priority and travel for free, and other vehicles pay a fee for access.

Plans also call for evaluating use of the managed lanes for goods movement during off-peak periods. This regional Express Lane Network will enhance transit and carpooling and will provide choice to travelers—and it will continue to serve as a model for improving mobility.

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Nontoll Forms of Pricing to Reduce Traffic Congestion and Pollution

Mileage, Insurance, Carsharing, and Parking Strategies

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One reason Americans drive as much as they do is that other modes of transportation rarely match the speed and convenience of driving. Driving is also relatively cheap on a per-mile basis. Although the fixed costs of driving can be high, the added cost of driving another mile is low. A person who has acquired, registered, and insured a car has little financial disincentive to drive.

According to Federal Highway Administration (FHWA) statistics, less than half of public expenditures associated with driving are covered through revenue sources that vary by road use, such as taxes on motor fuel (*1*). Much of the revenue derives from other sources, such as property taxes and vehicle registration fees.

In addition, the private cost of parking is bundled into the price of retail goods and services. The parking costs associated with each driving trip, therefore, are seldom considered in decisions to drive. Nevertheless, a retailer that does not charge for parking must recoup these costs through pricing, and customers cannot save these embedded parking costs by choosing to walk or by taking transit to go shopping.

Parking bundled with housing presents a similar situation. A 1961 Oakland, California, ordinance required one parking space per apartment building dwelling unit; a one-of-a-kind before-and-after study showed an 18 percent rise in construction cost per dwelling unit and a 30 percent reduction in housing density after the requirement. Reducing density increases the need for and ownership of automobiles, because destinations are spread out and the environment is less hospitable to walking and to alternative modes of transportation. Halving the residential density increases vehicle ownership by 32 percent to 40 percent, which also increases vehicle miles traveled (VMT) (*2*).

Making the costs of driving more evident and variable—for example, through mileage-based pricing and through variably priced parking—could influence the amount and timing of driving in ways that confer environmental, safety, and congestion-reduction benefits, while saving drivers money.

Alternatives to automobile ownership include using carsharing services, such as Zipcar, which offers automated car rentals by the hour in several cities and college campuses.

Per-Mile Road Use Fees

States are searching for alternatives to the motor fuel tax as a source of highway revenue. Raising fuel taxes is politically difficult. Moreover, a precipitous decline in tax revenue is likely because of new vehicle technologies and alternative energy sources, such as plug-in hybrid and all-electric cars.

Oregon established a Road User Fee Task Force in 2001 to consider options for replacing fuel tax revenue. The task force tested the feasibility of charging a fee per mile driven, tracked through in-vehicle Global Positioning System (GPS) units. In April 2006, 299 Portland-area motorists participated in a 1-year field experiment to test the technical and administrative feasibility of a fee per mile driven. In a second phase, the per-mile fee varied by location and traffic conditions—10 cents per mile within identified congestion zones and 0.43 cent per mile otherwise.

The system proved technically feasible, capable of protecting motorist privacy and effective in reducing driving when the charges were set high. The congestion charge of 10 cents per mile reduced VMT by 22 percent (*3*).

Pay-as-You-Drive Car Insurance

Motorists typically pay a periodic fee for car insurance. Insurance claims for liability and collision coverage—which represents most of the premium—result only when the insured vehicle is being driven. The crash risk goes up if a vehicle is driven more, yet the insurance premium does not necessarily change.

Pay-as-you-drive (PAYD) car insurance bills policyholders according to the crash risk associated with driving more miles and thereby discourages excess driving. PAYD premiums incorporate traditional risk factors, such as driving record and the vehicle's make and model, and reflect the selected coverage. Under PAYD, the expected reduction in claims for crashes and related incidents is disproportionate—1.34 times the reduction in mileage, because of fewer multicar collisions. Less congestion—also disproportionate to the reduction in mileage—and less pollution also would be expected.

PAYD Savings

A 2008 study by the Brookings Institution estimates that if all fixed costs of car insurance in the United States were converted to PAYD, the result would be an 8 percent reduction in annual VMT, plus $50 billion to $60 billion in net social benefits. The study estimates that 64 percent of all households would experience savings with PAYD insurance, amounting to an average of $270 saved per vehicle (*4*).

With PAYD pricing, low-income drivers would be expected to reduce their driving substantially more than others and would experience greater savings than the general population (*5*). By providing an affordable insurance option to low-income motorists who are willing to limit their mileage, PAYD insurance would reduce the number of uninsured motorists. Finally, PAYD insurance has been shown to be more effective than fuel taxes in reducing gasoline consumption and is cost-competitive with other government transportation programs to reduce air pollution and improve highway safety (*6, 7*).

Pilot Projects

From 1998 through 2001, Progressive Auto Insurance piloted PAYD insurance with 1,200 Texas drivers whose vehicles were equipped with GPS devices. Individualized premiums were based primarily on the number of minutes the motorists drove, as well as on when and where they drove. Progressive Auto Insurance now is offering a discount program based partly on mileage, but also on acceleration rates, braking force, and speed; in-vehicle units collect and store the data, which are transmitted by mobile communications.

Photo: AAA Foundation for Traffic Safety

Insurance claims for liability and collision coverage represent most of the premium in automobile insurance.

In 2004, GMAC Insurance began offering low-mileage discounts in four states to drivers with active OnStar accounts—which communicate vehicle mileage to GMAC Insurance. The insurance product is now available in most states to approximately 5 million drivers with OnStar and includes discounts of up to 54 percent for drivers with the lowest mileage.

Finally, MileMeter, a start-up insurance company, began to offer "insurance *buy* the mile" throughout Texas in 2008. Instead of purchasing coverage for 6 months or 1 year, a Texas motorist may purchase 1,000 to 6,000 miles of coverage, and make additional purchases as needed.

Carsharing

Neighborhood carsharing programs were introduced in Europe in the 1990s and are now widely available in European and U.S. cities. The automated hourly car rentals allow some households to meet their mobility needs without owning a car or by owning fewer cars.

The shared cars are conveniently placed throughout neighborhoods. Program members make reservations on the Internet and are given a smart card to access the reserved vehicle. The carsharing company pays all driving costs, including gas and insurance, in exchange for the member's hourly fee. Most lower-mileage households will save money by carsharing instead of owning a car.

San Francisco Bay Area's City CarShare is the most studied carsharing program in the United States. Extensive travel surveys and matched-pair analyses have shown that, independent of other factors, car-percent reduction in commuter VMT (*11*). Studies of parking cash-out in Seattle, Washington, and in metropolitan Minneapolis–St. Paul, Minnesota, have yielded similar results (*12, 13*).

Photo: Rikki Ward, City CarShare

San Francisco Bay Area's City CarShare program charges members $5 per hour and $.40 per mile—gas, insurance, and maintenance included.

sharing reduces member VMT by 7 miles per day, attributable to the reduction in car ownership (*8*).

VMT reductions in Europe have been even sharper. In Switzerland, for example, car owners who sold their vehicles and became carsharing members reduced their annual mileage driven by 72 percent, while new carsharers who had not previously owned cars did not drive any more than they did before, when they tended to borrow vehicles (*9*).

Carsharing is also an important strategy in addressing urban parking shortages. With approximately 20 member households typically sharing a vehicle, parking needs for office and housing developments can be reduced.

Parking Cash-Out

Most employers provide their workers with free parking as an untaxed benefit. In contrast, approximately 5 percent of employers offer transit or other commuter benefits (*10*), and these benefits often are capped at values lower than the uncharged parking. For these and other reasons, most employees choose to drive to work alone.

Parking cash-out is intended to realign commuter benefits by providing incentives for employees to use alternative modes of transportation. Parking cash-out offers the option of receiving taxable cash in lieu of uncharged or partly subsidized parking. This serves as an incentive to find alternatives to driving alone to work.

In most cases, employers offer the cash value of a monthly parking space. Employees may decline the cash and keep the tax-free parking space or accept tax-free transit, vanpooling, or bicycling benefits instead. The employee also may receive as taxable income any difference in the value of the parking and the alternative benefit.

A study of parking cash-out programs in eight firms in Southern California found an 11 percent reduction in drive-alone commuter trips and a 12

Photo: Progressive

Insurance company Progressive offers MyRate, a pay-as-you-drive automobile insurance program, in some states.

Variably Priced Parking

Free on-street parking encourages motorists to search—or cruise—for an open space instead of paying a commercial garage. This can add to congestion in urban streets. *The High Cost of Free Parking* summarizes findings from 16 studies of cruising in 11 cities (*14*). Drivers in search of on-street parking comprised 8 percent to 74 percent of city traffic, and averaged 30 percent; the average search time ranged from 3.5 minutes to 13.9 minutes.

One solution is to price on-street parking to achieve an occupancy standard that leaves at least a few spaces open at any time and location. New technologies to facilitate this arrangement include systems that allow payment by cell phone and mid-block machines that dispense parking tickets and accept credit cards.

Donald Shoup of the University of California, Los Angeles, who has long studied parking behavior and policy, has recommended that meter charges vary to achieve an 85 percent rate of curb-space occupancy. He also recommends that residents of an area with variable parking charges share in the revenues, to foster acceptance.

Redwood City, California, is implementing a law to set and adjust parking meter charges to achieve an 85 percent curb-space occupancy rate. The U.S. Department of Transportation (DOT) is funding projects in San Francisco, California, and New York City to vary meter charges to meet specific curb-space occupancy objectives.

Pricing Off-Street Parking

Employees who purchase monthly parking spaces have no financial incentive to use the privilege sparingly. Not using the parking space may cost them more, because taking transit would require payment of a fare, but driving would incur no additional cost for parking.

One strategy to change this incentive is to sell flexible parking passes. Instead of offering fixed monthly passes, parking operators would sell passes that provide a limited number of uses or a rebate for unused days above the average. Similarly, a monthly parking pass could include transit fares, if the parking operator can make an agreement to share some of the revenue with the transit agency.

The turnover of off-street parking spaces may not be desirable during rush hours, when driving should be discouraged to limit congestion. A city could charge a surtax for entering or leaving a parking facility at peak travel times, to encourage drivers to schedule trips outside of the heaviest traffic periods.

Making It Happen

Each of these strategies offers potential public and individual benefits, but each also has start-up challenges and costs that can inhibit implementation. Some of the options are gaining traction, but others may require additional incentives. For instance, carsharing programs are increasing, yet PAYD insurance is not widely available and may be difficult to bring about in some states without changes in insurance regulations and in other public policies.

Some state and local governments are leading the way by encouraging PAYD insurance, and assistance also is available from the federal government. King County, Washington, has engaged in an outreach to insurance companies and has launched a partnership with Unigard Insurance to pilot PAYD insurance with support from the Federal Value Pricing Pilot Program. The North Central Texas Council of Governments also has sought insurance company partners to implement PAYD insurance, and Oregon offers tax credits to companies that offer PAYD insurance.

The Brookings Institution has recommended a federal tax credit of $100 for each new mileage-based policy that an insurance company writes, phased out after the first 5 million vehicles are covered. Brookings also recommends dedicating $15 million in the next federal surface transportation reauthorization bill to support PAYD insurance pilot projects (*4*).

Employers can implement parking cash-out programs at any time, as well as incentives such as subsidized transit. Revising commuter benefits, however, requires some effort and initial employer costs—for example, the cost of alternative commuter benefits combined with also having to continue to pay for parking that is no longer being used, until it is shed. Employers looking to implement parking cash-out and complementary measures can find guidance at the Best Workplaces for Commuters Program website, launched by the U.S. Environmental Protection Agency and U.S. DOT and run by the Center for Urban Transportation Research at the University of South Florida.[1]

California has mandated parking cash-out for large employers that can recover the cost of the benefit by reducing their parking. Some states provide tax credits and other incentives to employers that offer commuter benefits, including parking cash-out. Maryland has the most generous incentive, allowing employers a 50 percent tax credit—up to $30 per employee per month—for the expenses of providing parking cash-out and other commuter benefits.

These public policy initiatives and experiences offer lessons and models for cities, states, and the federal government. Whatever specific incentives are implemented, PAYD and variable parking pricing strategies are garnering attention for their potential to reduce congestion, save money for consumers and commuters, and offer a myriad of additional benefits.

[1] www.bestworkplaces.org.

New technologies in on-street parking include machines that accept credit cards, such as this one in downtown Washington, D.C.

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The Acceptability of Road Pricing

Notable Findings—and Gaps for Research

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The implementation of road pricing plans often proceeds slowly and with difficulty. The London congestion pricing program came about only after many years of debate, rejected and modified proposals, and much stakeholder involvement and coalition building. A recent areawide plan for New York City came to naught after many months of planning and debate among an array of decision makers and interest groups. Plans for San Francisco have encountered "alarmist reactions" stemming from "unwarranted assumptions" (*1*). Even successful high-occupancy toll (HOT) lanes in the United States have involved long planning periods and intense public and political debate.

Because the path to adoption and implementation is demanding, those who are involved in planning for road pricing can benefit from research on its acceptability. The volume of domestic and international research on the acceptability of road pricing is now considerable, and the results provide valuable lessons to local, regional, and state planners.

PHOTO: FLORIDA DEPARTMENT OF TRANSPORTATION

Before the opening of the Florida 95 Express Lanes in December 2008, focus groups in Miami had characterized peak pricing as unfair to commuters; the number of HOV-3 carpools registered to use the lanes for free has increased steadily, according to the *South Florida Business Journal*.

Findings from U.S. Studies

Probably the most comprehensive and current research on road pricing acceptability is *NCHRP Synthesis 377: Compilation of Public Opinion Data on Tolls and Road Pricing*, which gathered results from public polls, focus groups, and surveys conducted since 2000 (2).

The first notable result is that acceptability varies with the party being surveyed and with the party conducting the survey. Aggregated across all the polls, 56 percent of respondents support pricing, and 31 percent oppose it; potential users offer the highest support (74 percent) and the least opposition (15 percent). In addition, tolling agency surveys recorded the highest support (70 percent), while media-sponsored polls found less support (54 percent), and universities or other organizations even less (47 percent). These varying results may reflect the typical sampling frames of the sponsors or the pricing concepts they tend to assess.

Another key finding is that the pricing scheme itself can make or break support. Aggregate support for HOT lanes was 73 percent and for express toll lanes separated from main lanes and variably priced, 62 percent. Only 32 percent supported cordon pricing, with virtually no support for the construction or the rehabilitation of a public toll facility by the private sector. General or hypothetical pricing concepts are less likely to attract support than those that apply to specific facilities.

Fairness is important to acceptability. According to the NCHRP Synthesis report, focus groups convened for the New York and Miami pricing plans characterized peak pricing as unfair to commuters. Focus groups assembled in San Diego raised concern about the fairness of having to pay twice for using a facility—once when it was financed by traditional taxes and a second time through the toll charges. The double-pay issue is thought to be one reason that public polls generally show more support for establishing tolls on new facilities than on existing facilities.

Photo: Caltrans District 11

San Diego's I-15 Express Lanes opened in 1988 and have since been converted to high-occupancy toll (HOT) lanes. Public opinion polls have shown consistent support for expansions of the facility.

Earlier research shows other fairness concerns about those who work in occupations that require day use of vehicles, fixed work schedules, and making long versus short trips (*3*). Finally, fairness to lower income groups is an issue often raised in the early planning stages, although public and traveler surveys increasingly show that income is not strongly related to a respondent's acceptance of a project.

These concerns typically have not stopped project development. For example, a recent review of Federal Highway Administration (FHWA) value pricing programs finds that "HOT lane conversions have encountered concerns in planning about catering to the rich, but usually these have not been sufficient to halt projects" (*4*).

Polling after implementation is not common, but evidence suggests that acceptability can grow as implementation proceeds. Reviewing surveys about three HOT lane projects—SR-91, I-15, and I-394—the authors of the NCHRP Synthesis found that "support remained high and even increased slightly" with time. The review of FHWA value pricing programs also finds acceptance over time with tests of fees for vehicle miles traveled, noting that "initial concern about security and technology can change to a favorable response after sufficient time and experience."

Findings from Abroad

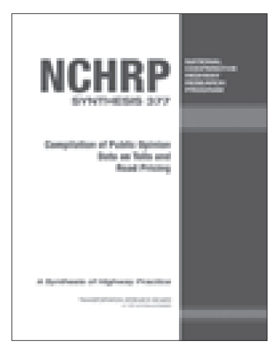
Overseas research points to the following keys to earning acceptability among the public and stakeholders:

◆ *A real problem.* The problem that pricing is intended to relieve—such as traffic congestion or air quality—must be obvious and severe. As Jones has pointed out, "The pain must be worth the gain" (*5*). Pricing proposals therefore need to find and target the most resonant problem or problems.

◆ *Plan for the revenues.* The intended use of the revenues must be clear and convincing. In early surveys in London, support for road pricing hinged in good part on revenues going to improve public transport. Other surveys—including polls of Swiss residents—suggested the importance of returning revenues to residents or offsetting other taxes. Arraying and assessing reactions to a broad set of options for revenue distribution is important in gaining acceptance.

◆ *Government trust, competence, and responsiveness.* How government is perceived and how planning is conducted—particularly the procedural fairness and openness of the planning process—are important to acceptance. Other keys are the government's history of effectively addressing congestion, providing public transit options, and making meaningful and sincere efforts to involve affected parties.

◆ *Growing experience.* Echoing U.S. research, overseas findings show that public and political acceptance tends to increase the longer the pricing programs are in existence. The reasons for the growing acceptance are not well explored. Proven effectiveness, minimal adverse consequences, or revenues devoted to promised transportation improvements



NCHRP Synthesis 377, published in 2008, gathered public opinion research on tolls and road pricing.

In Stockholm, Sweden, public support for congestion pricing increased after a trial period in 2006.

may contribute. Therefore highlighting successful program experience during planning and outreach—as well as keeping promises about revenue distribution plans as implementation proceeds—may enhance prospects for long-term acceptance.

Closing the Research Gaps

Most research on the acceptability of road pricing has focused on the response of the public. Less attention has been given to how decision makers and specific interest groups respond, and even less to the reactions of the public and decision makers after implementation. This gap in knowledge should be filled, because the perceptions of decision makers and of those who influence them are critical to the start-up and continuation of pricing programs.

Key issues for research include identifying the stakeholders who most influence the decisions of public officials; understanding how decision makers use and interpret surveys of travelers, voters, and the public at large; and discovering the program variables that are most important to decision makers. To gain these insights, standard surveys and focus groups may need to be supplemented with comprehensive case studies, including interviews with decision makers and stakeholders, reviews of public speeches and meeting minutes, and the tracking of media coverage, interest group reports, position papers, and newsletters.

More research is needed to assess how pricing programs are perceived over time; the changes that are made in response to user, stakeholder, public, and decision-maker reactions; and the most successful public relations efforts.

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Photo: Washington State Department of Transportation

By 2010, the SR-520 floating bridge in Washington State—shown here during a routine inspection—will become a tolled facility, with tolls that will vary to achieve performance targets. Revenue will help pay for bridge replacements and corridor improvements.

Pricing Road Use to Address Congestion

Bumps Along the Road

Lessons from Congestion Pricing Projects That Did and Did Not Make It

LEE MUNNICH AND JOHN DOAN

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Several U.S. cities have implemented successful congestion pricing projects, but in many areas, proposals have faced setbacks because of a lack of political and public acceptance. Case studies of projects in Edinburgh, Scotland; New York City; and Minneapolis, Minnesota—which faced serious bumps along the road to implementation—present valuable lessons learned.

Edinburgh: No Confidence

In 2002, the City Council of Edinburgh proposed a cordon-based road-pricing project, inspired by the success and public approval of the congestion pricing scheme in downtown London. The council saw similar opportunities to reduce congestion and improve transit service in Scotland's largest city.

Dual Cordon

The project proposed congestion pricing in two concentric circles—one around the Edinburgh city center and the other at the city bypass or beltway. Vehicles traveling in the city center between 7:00 a.m. and 7:00 p.m., Monday through Friday, would be subject to charges. Drivers would pay £2 to cross each cordon,[1] but only one charge to enter the city center, even if both cordons were passed or if the cordons were passed several times in one day. Automatic license plate recognition technology—similar to that used in London—would record the vehicles passing the cordon boundaries.

The dual cordon was expected to reduce congestion by up to 15 percent, with up to 85,000 fewer trips per day. Traffic volumes were projected to drop by 18 percent in the center city and by 15 percent in the west. A one-cordon scheme would remove 59,000 trips in the city center, with a small increase in the west. After additional consultation, discounts were added for residents, and the operating hours for the outer cordon were changed.

PHOTO: DAVID GONZALEZ, MINNESOTA DOT

The MnPASS I-394 project, which opened in 2005 in Minneapolis, Minnesota, has become an unlikely success, after two failed proposals in the 1990s.

Premature Referendum

Scotland's political parties were divided about the congestion-pricing scheme. The councils of surrounding cities opposed the plan. The Scottish Transport Minister announced government support in principle, if Edinburgh's residents supported the plan. In February 2005, the city council held a referendum; 75 percent of the voters rejected the proposal.

After the vote, Transport Initiatives Edinburgh identified two key reasons for the failure to achieve support for the congestion charge. First, much of the public believed that a main cause of congestion was that alternatives to car travel—such as transit—were not viable; yet the pricing proposal included no commitment to invest in alternatives before the startup of congestion pricing. Second, the popular referendum was held before any demonstration of the potential benefits of congestion pricing.

In London and Stockholm, both of which successfully introduced congestion pricing, the greatest

[1] £1 = $1.62 in July 2009.

Under the proposed congestion pricing plan for New York City, tolls paid to cross the Hudson River with E-ZPass (three center lanes in photo) would be applied to offset the congestion charge.

Photo: David Sailors, Parsons Brinckerhoff

opposition occurred immediately before the plan's implementation. Public support for the plans increased after implementation—that is, after travelers could witness and experience the benefits of congestion pricing firsthand. This indicates that a referendum should not be held until after the public has seen congestion pricing at work.[2]

New York City: Elephant in the Room

On Earth Day 2007, before a large audience in the Museum of Natural History, New York City Mayor Michael Bloomberg presented PlaNYC, a broad-based strategy to reduce air pollution and address climate change. After presenting a detailed list of environmental proposals, he shifted to a new topic: "You can't talk about reducing air pollution without talking about congestion; so as long as we are at the Museum of Natural History, let us talk about the elephant in the room—congestion pricing."

Bloomberg detailed an ambitious plan to introduce congestion pricing in Manhattan and to compete for federal funding for implementation, as well as to generate new funding for transit improvements. The proposed congestion-pricing zone was roughly defined as the island of Manhattan south of 60th Street, bordered by the East and Hudson Rivers. The plan included several vehicle exemptions and designated free routes that traversed the zone; in addition, tolls paid to cross the Hudson River with the E-ZPass® electronic toll collection system would be applied to offset the congestion charge.

[2] A referendum on congestion charging in Greater Manchester, England, also was soundly defeated in December 2008, despite extensive communications and outreach efforts by supporters.

Plan Details

The proposed fee would be in effect on weekdays from 6 a.m. to 6 p.m. at a rate of $8 for cars and commercial vehicles and $21 for heavy trucks entering from outside the zone. Transit buses, emergency vehicles, taxis, other for-hire vehicles, and vehicles with handicapped license plates would be exempt from the fee. Taxi and delivery trips that began in, ended in, or touched the zone would pay a $1 surcharge. Vehicles would be charged only once per day.

Operations for monitoring vehicles within the congestion zone were to be barrier-free and include E-ZPass readers for drivers already using toll transponders and a license plate recognition system employing video technology for vehicles without transponders. Drivers would be debited from their E-ZPass account or from a prepaid non-E-ZPass account linked to the vehicle's license plate number. Drivers without prearranged accounts would have 48 hours to pay by phone, the Internet, text messaging, or cash transaction at participating retailers.

An important feature of the proposal was a commitment to dedicate net revenues from the congestion pricing program to fund vital capital improvements to the Metropolitan Transportation Authority's transit system.

Deadline Pressures

In January 2008, the New York City Traffic Congestion Mitigation Commission approved the plan for congestion pricing, with some changes—such as reducing the size of the zone, eliminating charges for vehicles that remained exclusively within the zone, eliminating charges for vehicles leaving the zone, and a discount for low-emission trucks. The New York City Council approved the proposal two months later. The New York State Legislature, however, refused to take up the bill that would have authorized the plan.

The simplest explanation for the failure of the New York City plan is that the project was overly ambitious, and the proponents ran out of time within a tight timetable. A U.S. Department of Transportation (DOT) deadline for federal funding assistance was an incentive for early action and galvanized the advancement of the plan; nevertheless, the deadline became an insurmountable hurdle in satisfactorily addressing questions raised by the state assembly. Local experts also speculated that a lack of confidence in the city's ability to deliver the promised transit improvements contributed to the proposal's demise.

The New York City plan nevertheless generated political support and advanced public awareness and understanding of congestion pricing. As a result, congestion pricing remains a possibility as New York City works to address congestion challenges and the need for transit system funding. In contrast, in Edinburgh, where voters overwhelmingly rejected the proposal, the congestion pricing scheme will be difficult to resurrect.

Photo: Edward Reed, Office of the Mayor

In March 2008, New York Mayor Michael R. Bloomberg announced a new express bus route from Throgs Neck in the Bronx to lower Manhattan as part of the proposed congestion pricing package for the city.

Photo: David Gonzalez, Minnesota DOT

Surveys about three HOT lane projects, including Minnesota's I-394, revealed broad—even increasing—support.

Minnesota: If at First You Don't Succeed…

Minnesota may have been one of the least likely places in the United States to adopt congestion pricing. The state had no toll roads in the 1990s, and congestion in the Minneapolis–St. Paul metropolitan area was not at a point of crisis, compared with other major U.S. cities. In the 1990s, however, Minnesota DOT and the Twin Cities Metropolitan Council, in collaboration with researchers at the University of Minnesota's Humphrey Institute of Public Affairs, began to study the possibility of congestion pricing and of privately financed toll roads in the region.

Early Attempts

Minnesota DOT made two attempts to implement congestion pricing projects in the 1990s. The first, in 1996, was a privately financed toll road in the State Highway 212 corridor. Political leaders, frustrated by the long wait for public tax dollars to build the project, wanted to move the project forward and supported tolling. The second was a proposal to charge solo drivers for use of the carpool lanes in the I-394 corridor west of Minneapolis. Political support for both proposals failed to materialize.

Although many Minnesota transportation and political leaders were prepared to give up on congestion pricing, Minnesota DOT, with funding from the Federal Highway Administration's (FHWA) Value Pricing Pilot Program, continued to support research, outreach, and education about congestion pricing through the Humphrey Institute of Public Affairs. The

Minnesota Department of Transportation's MNPass website serves as a communication tool with the public.

Institute organized a Pricing Task Force of state and local political leaders, transportation association leaders, and business and environmental interests.

A "Good Idea"

In 2003, the task force recommended the reconsideration of a high-occupancy toll (HOT) lane on I-394. The goal was to improve the efficiency of the high-occupancy vehicle (HOV) lanes by increasing their person- and vehicle-carrying capacity while maintaining high service levels for carpools and transit. Newly elected Governor Tim Pawlenty supported the HOT lanes as an innovative way to make better use of roadways without increasing taxes and as a demonstration that could lead to pricing arrangements to fund new lanes.

Approved by the state legislature, the I-394 HOT lanes—named MnPASS—converted the HOV lanes into optional toll lanes in May 2005. Buses, carpools, and motorcycles use the lanes for free. Most consider the I-394 MnPASS lanes a success. Transit and carpool service levels maintain the target speed of 55 mph. A survey shows that 65 percent of respondents in the corridor think MnPASS is a "good idea."

In 2007, Minnesota won a $133 million federal Urban Partnership Agreement grant to expand the MnPASS system to I-35W south of Minneapolis.[3]

[3] Although the Minneapolis congestion pricing projects are moving forward, the implementation of HOT lanes, which provide drivers a priced choice, is less contentious an issue than areawide or cordon pricing, represented in the Edinburgh and New York City proposals. The authors do not intend to compare the three case studies, but to develop common lessons from each for other implementers to apply.

Lessons Learned

Clearly the successes or failures of these congestion pricing projects occurred within unique contexts, but broader lessons can be gleaned for the implementation of future projects.

◆ *Define the public purpose and the project objectives.* Minnesota generated legislative support for its congestion pricing plan by focusing on more efficient use of the HOV lanes and on providing commuters with a new choice to bypass congestion.

◆ *Demonstrate the potential benefits.* Most people are skeptical of change. When given the choice between the status quo and an unknown scheme, citizens will favor the status quo, even if the status quo does not provide the greatest social benefit. The overwhelming lack of support for the Edinburgh referendum is an example. Minnesota DOT and its partners demonstrated to legislators and stakeholders how HOT lanes work through videos of projects in California, seminars, briefings, and scanning tours of successful projects.

◆ *Take a holistic approach that includes investments in roadways and transit.* Public support for congestion pricing is more likely if the revenue generated can be linked directly to transit and roadway improvements. The Minnesota experience and the public and local political support garnered for the New York City proposal are examples.

◆ *Finally, if at first you don't succeed, try again.* Minnesota's early failures laid the groundwork for the education and outreach effort that led to the I-394 HOT lane project and to the expansion of the system to I-35W. Reintroducing a project decisively voted down in a referendum, as in Edinburgh, is difficult. New York City, however, has built a base of support and interest in congestion pricing that may yet reemerge.

Acknowledgments

Anthony May of the Institute of Transport Studies at the University of Leeds provided background and details on the Edinburgh case study. Mark Muriello, Assistant Director, Port Authority of New York and New Jersey, provided context and information on the New York City congestion pricing effort. The authors drew on personal knowledge and experience with the Minnesota HOT lane project.

Resources

http://en.wikipedia.org/wiki/Edinburgh_congestion_charge.

http://en.wikipedia.org/wiki/New_York_congestion_pricing.

New Ideas for Congestion Pricing

PATRICK DeCORLA-SOUZA AND MATTHEW E. MacGREGOR

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The four general types of congestion pricing approaches are

- *Priced lanes*—one or more lanes on a roadway facility are priced;
- *Priced highways*—all lanes are priced;
- *Priced zones*—all roads in an area, such as a central business district, are priced; and
- *Priced road networks*—prices are established for some or all of the lanes of a larger road network in a region.

Hurdles must be overcome for the wider deployment of each type, and innovative ideas are showing the way. Innovative ideas also are being applied to address stakeholder concerns about involving the private sector in the implementation of pricing projects.

Priced Lanes

Experience with the pricing of new lanes raises two important issues that stem from the relatively high costs of construction and rights-of-way in urban areas. First, even if all vehicles in the new lanes are to be tolled, the project usually needs additional direct financial support to be feasible. Second, some believe that public transit will be disadvantaged if resources are not made available to improve transit services concurrently with the implementation of priced lanes. The flexible and efficient express (FEE) lanes concept attempts to address both financial feasibility and modal equity.

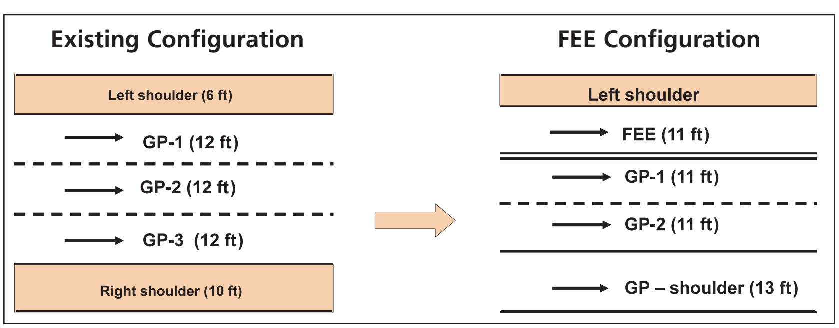

FIGURE 1 Creating flexible lanes on a six-lane highway.

Overhead lane controls for active traffic management.

FEE Lanes

FEE lanes (see Figure 1, below left) use existing pavement and rights-of-way to create flexible highway lanes on the shoulder to serve as travel lanes when needed (*1*). The freeway would be restriped to convert the far left general-purpose lane into a variably priced lane that would be tolled during peak periods. The right-side shoulder then becomes a dynamic travel lane for general-purpose traffic. Active traffic management (AcTM) techniques—such as speed harmonization and overhead lane controls—would indicate which lanes are open, as well as the safe operating speed (see photograph, above).

Although this approach reduces the costs of implementation—and thereby improves the financial feasibility—FEE lanes introduce significant safety and operational concerns. For example, converting the shoulder to a general-purpose travel lane will impede incident management activities, and the intermittent use of the shoulder for general-purpose travel may increase crashes if drivers fail to obey the overhead instructions about lane use.

Complications also may arise in freeway operations with vehicles entering and exiting at interchanges. Mitigating strategies are available to address some of the safety and operational concerns—for example, installing emergency pull-off areas adjacent to the shoulder travel lane, and ensuring appropriate

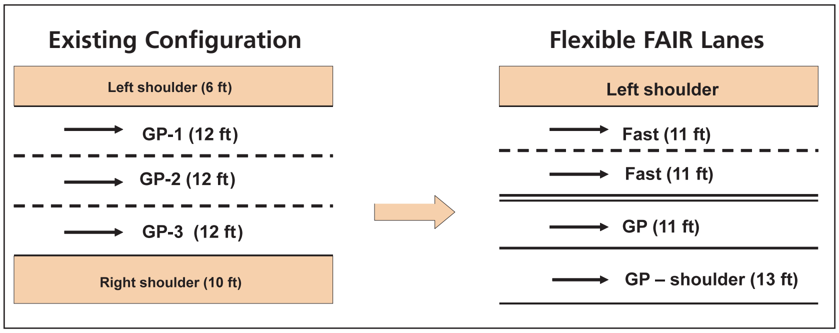

FIGURE 2 Creating flexible FAIR lanes using dynamic shoulder travel lanes.

design features and motorist guidance at freeway entries and exits.

The FEE idea builds on emerging AcTM strategies now being explored to increase highway capacity during peak periods and to manage freeway travel dynamically. FEE also could address modal equity, because it increases the potential for investing surplus revenue in new transportation infrastructure and rolling stock, to encourage carpooling and transit.

Because the new capacity would be created from existing rights-of-way, FEE lanes could be implemented more quickly than conventional capacity expansions. If the safety and operational issues can be addressed, the FEE lane approach may be an attractive way to introduce priced lanes. The construction costs would be lower and the financial feasibility would be improved in comparison with the construction of new lanes.

Revenues from the new priced lane may be sufficient to pay for the tolling and AcTM infrastructure, as well as for improvements to strengthen the shoulder lane and implement emergency pull-off areas and other strategies in response to the safety and operational issues.

Flexible Fast and Intertwined Regular Lanes

Flexible fast and intertwined regular (FAIR) lanes involve the separation of freeway lanes into two sections: fast lanes and regular lanes (*2*). The fast lanes would toll all users—except buses—to ensure the free flow of traffic and to provide improved transit and new paratransit services.

In the regular lanes, constricted flow would continue, but drivers with electronic toll tags who opt to remain in the regular lanes would receive credits. The credits could be applied for toll payments in the fast lanes or for payment for transit and paratransit services. The credits would compensate motorists for giving up their right to use the fast lanes and could reduce concerns about double taxation.

On a 6-lane freeway, the right shoulder could be converted to a travel lane during rush hours (see Figure 2, above), creating two fast lanes in each direction. Congestion would be reduced on the free lanes, because the highway's rush-hour capacity would increase by one lane in each direction. The safety and operational issues for FEE lanes, however, also apply to FAIR lanes, and these need to be resolved.

Priced Queue Jumps and Tolled Bypass Lanes

Lee County, Florida, has proposed priced queue jumps and tolled bypass lanes (*3*), allowing toll-payers to bypass at-grade congestion at the intersection of two major arterials via a flyover or an underpass. Another version of this concept allows toll-paying motorists to bypass congested traffic at freeway entrance ramps.

Tolled bypass lanes could be constructed at congested locations. For example, a toll road, SH-161, will be constructed in North Texas, 2 miles from SH-360, a parallel, nonpriced facility. The regional mobility plan includes priced lane connections—called Fast Connections—between the two facilities, as shown in Figure 3 (page 41). In the figure, the bold lines with arrows indicate the directional priced lanes that would be constructed adjacent to the regular lanes; the dashed lines indicate grade separations.

Priced Highways

Many highways and water crossings will require reconstruction as their service lives come to an end. If the public is educated about the high costs of reconstruction and rehabilitation and is reassured of the geographic equity in sharing the toll burdens across the region, congestion pricing may be acceptable as a way to help pay for reconstruction and rehabilitation while improving mobility.

By 2010, the SR-520 floating bridge in the Seattle, Washington, metropolitan area will become the first toll-free facility in the United States to charge new tolls that will vary to achieve performance targets. The willingness of the public to pay for new infrastructure could be leveraged with the FEE highway concept.

FEE Highway

As with the FEE lane approach, the shoulders on the right side of limited-access highways could be used as dynamic rush-hour travel lanes—but instead of charging variable tolls in only one lane, all lanes would be priced to create a high-performing highway, as shown in Figure 4, page 42 (*1*). Variable fees and ramp metering would hold traffic volumes within the capacity of the roadway and would prevent the breakdown of traffic flow. Surplus revenues could be used for new transportation infrastructure and transit rolling stock.

As with the FEE lane concept, significant safety and operational concerns are inherent in the FEE highway proposal, and these must be resolved.

Priced Zones and Networks

The United States has no operating examples of congestion-priced zones or road networks, but Seattle has studied congestion pricing for all lanes of its roadway system. New York City and San Francisco have undertaken studies of zone-based pricing for their central business districts. Two approaches can make these strategies more acceptable to the public.

FEE Highway Network

The FEE highway approach for full pricing of a highway facility could be expanded to create a FEE highway network. With all lanes on the network priced, the operational issues of access and egress between priced and regular lanes would be avoided. Also avoided would be the costs of barriers separating the priced lanes and the free lanes and of connectors between priced lanes at intersecting freeways. In addition, the approach eliminates the highway capacity penalty associated with lane separation.

Fast Miles

FEE highway networks could be established in conjunction with Fast Miles (*4*). Each licensed motorist in a metropolitan area with a priced network would be credited with the dollar value of a monthly allocation of free miles, calculated by multiplying the average per-mile peak-period charges by the peak-period lane capacity and the number of lane miles priced during the peak periods on the highway system.

Other New Ideas

Several approaches could be deployed to address concerns of transportation stakeholders or to make congestion pricing easier or simpler for the traveler. Most of these ideas are still preliminary and require much more discussion and development; some may face insurmountable technical challenges.

Network Pricing with a Transportation–Housing Benefit Program

Metropolitan highways could be congestion-priced during peak periods, and all employees in the area would be eligible for a tax-free transportation–housing benefit. The benefit could be applied to congestion tolls, transit fares, or housing costs. Those who do not choose to pay congestion tolls for long commutes by automobile could use the benefits to pay for transit fares, or they could bike or walk and use their benefits to pay for the higher costs of urban housing near employment centers. Tax incentives would encourage employers to provide these benefits. Any loss of tax revenue would be reimbursed to the taxing agency from congestion toll revenues.

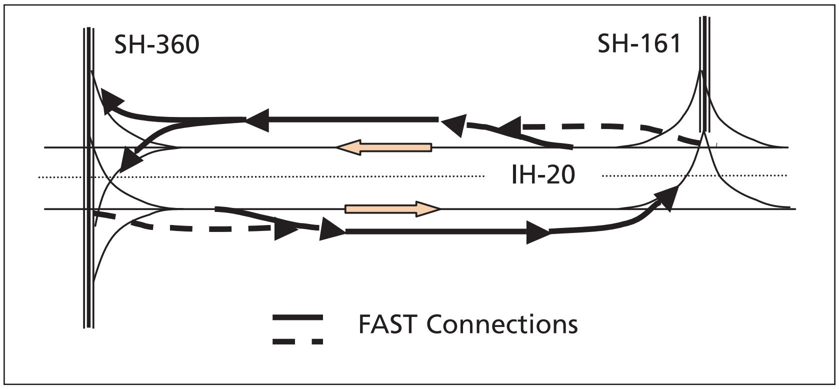

FIGURE 3 Proposed tolled bypass lanes on IH-20 in North Texas.

In the long term, exurban residents would be encouraged to move closer to urban areas with good transit service. Those who already live in denser urban environments would be encouraged to stay and not move to exurbs for larger homes. This approach encourages residents of metropolitan areas to live in transit-friendly locations within urban areas, reducing dependence on automobiles for peak-period commuting.

Network Pricing with an Opt-In Transition Strategy

Another strategy focuses on the transition from the current financing system to a system of full network pricing (*5*). Drivers could opt into a system that charges by vehicle miles traveled, facility type, and time of day and provides credits for fuel taxes and for other vehicle taxes paid. Drivers could choose to remain in the current system and pay fuel and other taxes.

Network Pricing with a Mobility Investment Fund

Texas DOT has proposed a different voluntary pricing strategy, network pricing with a mobility investment fund. Motorists who are employed could choose to make an annual deposit into a mobility account and would earn credits for using transit or noncongested roads. Conversely, the mobility accounts would be debited for the use of designated congested roads during rush hours.

Toll Credits or Toll Discounts

Low-income commuters could receive toll credits or toll discounts through adjustments or rebates to their transponder-based toll accounts.

Carpool Occupancy Enforcement

The preregistration of eligible carpools and vanpools with an employer or ridesharing agency could reduce enforcement difficulties. Vehicle occupancy could be audited at the site of employment. Reliable methods of auditing to ensure that registered carpools remain in operation, however, have yet to be developed (*6*).

Toll road SH-161 in Texas will be constructed 2 miles from SH-360 (pictured), a parallel, nonpriced road.

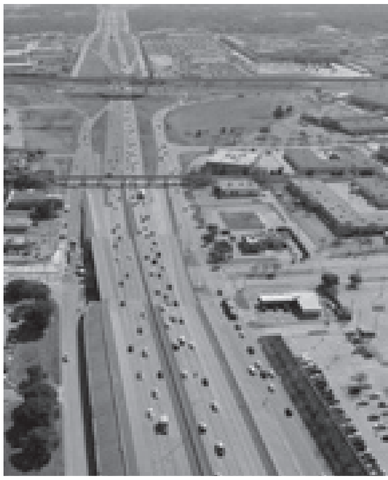

PHOTO: TEXAS DEPARTMENT OF TRANSPORTATION

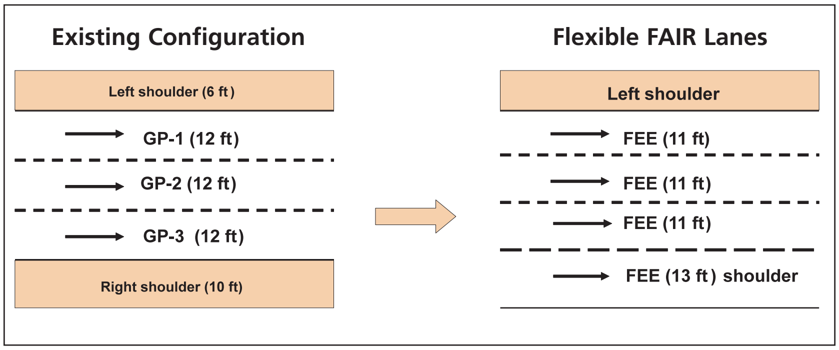

FIGURE 4 Conversion of six-lane highway to FEE highway.

Other Strategies

◆ Employers concerned that new tolls during rush hours may increase costs for employees or may interfere with on-time arrivals could provide subsidies for toll payment. The subsidies would be similar to the tax-free parking and transit benefits that many employers already provide each month to their employees.

◆ Retailers could provide toll reimbursements, similar to parking validations, to rush-hour shoppers who make purchases above a certain amount. Retailers would need a way to verify the toll amount paid.

◆ Transit operators could offer discounts to commuters who drive to park-and-ride lots via a tolled facility. Similar programs already provide discounts for parking costs incurred in association with a transit trip.

◆ Because of the unpredictability of toll rates during rush hours, trucking companies could opt into a program that would charge prescheduled rates for one year. The companies then could include the rates in contracts with shippers.

◆ A money-back guarantee could be established for motorists and truckers concerned about the congestion-reduction benefits they receive for the tolls paid. Credits, rebates, or partial rebates could be offered to highway users who do not receive the promised levels of service.

Private-Sector Participation

Transportation agencies could consider public–private partnerships (PPP) to reconstruct, finance, and operate priced highways, such as FEE highways—although this may require new PPP approaches. A key difference from normal toll roads is that system operators need flexibility to set toll rates high enough to ensure the free flow of traffic.

An approach used for the express toll lanes on I-595 in Florida is to have all toll revenue go to the public sector and to compensate the private partner with availability payments, which pay for the number of hours the facility is open for service at a specified performance level. Although this transfers the traffic and toll-revenue risks to the public sector, it provides the public sector with flexibility to manage the traffic flow between the free and the priced lanes, with the emphasis on maximizing traffic throughput instead of revenue.

An alternative to availability payments is shadow tolls—flat fees paid to a private partner for each vehicle served at the desired level of service. Under this approach, the private partner would set the *real* tolls to optimize use of the priced facility while ensuring the desired level of performance.

Creative Solutions

Congestion pricing can improve the efficiency of the highway system and reduce congestion, fuel consumption, and environmental impacts, while generating new revenue for transportation investment. Moving forward with this promising approach, however, requires the exploration and development of creative solutions that are acceptable to the public and that meet political, safety, and operational challenges. Exploring the new ideas for congestion pricing approaches could help the strategy gain use in metropolitan areas clogged with roadway traffic.

Acknowledgments

The authors acknowledge valuable comments from members of the TRB Congestion Pricing Committee on a draft of this article. The authors are responsible for any errors, and the views expressed are those of the authors and not necessarily those of the U.S. Department of Transportation, the Federal Highway Administration, or the Texas Department of Transportation.

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CALENDAR

TRB Meetings

September

6–9 4th International Congress of Smart Rivers: The Future of Inland Navigation*
Vienna, Austria

14–15 Integrated Corridor System Management Modeling Best Practices Workshop
Irvine, California

16–17 North American Freight Flows Conference 2009
Irvine, California

17–18 Research on the Transmission of Disease in Airports and on Aircraft: A Symposium
Washington, D.C.

28 Long-Term Performance of Geotechnical Infrastructure
Buffalo, New York
G. P. Jayaprakash

October

5–7 European Transport Conference*
Leiden, Netherlands

13–14 Infrastructure Security Workshop*
Rutgers, New Jersey
Joedy Cambridge

19–22 8th National Conference on Asset Management
Portland, Oregon

27–30 4th International Conference on Women's Issues in Transportation
Irvine, California

28–29 Workshop on Innovations in Traffic Congestion Monitoring* (*by invitation*)
Beijing, China

29 EMS (Emergency Medical Services) Workshop and Midyear Meeting
Washington, D.C.
Richard Pain

November

12–13 Developing a Research Agenda for Transportation Infrastructure Preservation and Renewal
Washington, D.C.

16–18 5th National Transit GIS Conference*
St. Petersburg, Florida
Thomas Palmerlee

December

13–18 12th International Conference on Travel Behavior Research*
Jaipur, India
Kimberly Fisher

2010

January

10–14 TRB 89th Annual Meeting
Washington, D.C.
www.TRB.org/meeting

April

12–16 1st International Conference on Pavement Preservation*
Newport Beach, California

27–29 High-Speed and Intercity Passenger Rail Systems and Strategies Joint Rail Conference*
Urbana, Illinois
Elaine King

May

5–7 1st International Conference on Nanotechnology in Cement and Concrete
Irvine, California

9–12 Innovations in Travel Demand Forecasting: 2010
Tempe, Arizona

30–June 2 Safety and Mobility of Vulnerable Road Users: Pedestrians, Motorcyclists, and Bicyclists*
Jerusalem, Israel
Richard Pain

June

2–4 TRANSED 2010: 12th International Conference on Mobility and Transport for Elderly and Disabled People*
Hong Kong, China

2–5 4th International Symposium on Highway Geometric Design*
Valencia, Spain

3–5 GeoShanghai 2010 International Conference*
Shanghai, China

21 Workshop on Benefits and Requirements for a Cooperative National Traffic Speed Data System (*by invitation*)
Seattle, Washington
Thomas Palmerlee

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar). To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail lkarson@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

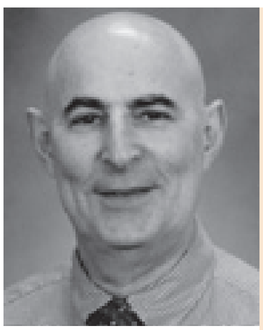
*TRB is cosponsor of the meeting.

Frank S. Koppelman

Northwestern University

A pioneer of research in travel behavior analysis, Frank S. Koppelman notes that an essential part of his work as a consultant and academic is to help clients, practitioners, and students cultivate the skills necessary to conceptualize and design transportation-related decision models that are both realistic and relevant to the decision at hand. Koppelman is a principal consultant with Midwest System Sciences, Inc.; a managing partner of ELM-Works, LLC; and professor emeritus at Northwestern University, in Evanston, Illinois.

Koppelman earned a bachelor's degree in civil engineering and a doctorate in transportation systems from Massachusetts Institute of Technology, and a master's degree in business administration specializing in economic analysis and marketing from Harvard University's Graduate School of Business Administration. In 1975, he joined the Civil Engineering Department and Transportation Center at Northwestern University, where he now advises doctoral students and provides support to a research group studying preferences in vehicle design features.



"Models are not a tool unto themselves, but part of a system of complex tools designed to support decisions by senior management, whether in the public or private sector."

An early contributor to development of activity-based travel demand modeling, Koppelman focuses his research on travel demand choice and forecasting, traveler behavior, and traveler behavior models. He works with Cambridge Systematics, Inc., to provide policy guidance on ways to attract riders to public transportation. He also has consulted for Boeing Commercial Aircraft, Nissan Motors, and many state and local transportation agencies.

Koppelman observes that in creating policies for products and services, it is essential to understand manufacturing and development processes, as well as the factors that influence policy adoption at the personal and corporate levels. Studies of travel behavior have become more crucial than ever, he notes: "This work is particularly important in transportation analysis now, when the United States is faced with environmental degradation and serious balance of payment deficits due, in large part, to the role of petroleum consumption for transportation."

Koppelman's work has led the way in aggregation approaches: he has formulated typology using individual models to predict population travel flows, and his extensive work on aggregation approaches is often cited in texts and other research. He furthered awareness of multivariate statistical techniques in travel behavior research and expanded understanding of models, creating new structures for generalized extreme value models, as well as developing and using conceptual models that emphasize subjective and objective traits in travel behavior.

Working with the late Eric Pas of Duke University, Koppelman introduced the use of statistical pattern recognition techniques in the analysis of daily and multiday activity travel patterns. He was an early contributor to activity-based travel demand modeling, and with colleague Chandra Bhat designed a widely used course in mode choice modeling for graduate and undergraduate students.

"Models are not a tool unto themselves, but part of a system of complex tools designed to support decisions by senior management, whether in the public or private sector," Koppelman notes. Other models he has developed or implemented address vehicle transaction choice, intercity air itinerary choice, and household vehicle ownership and use.

Public decision making about patterns of growth will be aided by the implementation of disaggregate choice models, as well as by the formulation of models for activity and household-based travel choice, Koppleman observes. "In the field of person travel demand analysis, the objective is to understand how changes in policies, infrastructure changes, operating changes, and costs influence the decisions of individuals and the households to which they belong," he explains.

Koppelman often advises students and practitioners of travel behavior and analysis, "The choice of a preferred model is as much a matter of judgment as statistics," adding, "You have the responsibility to your client and the public to make your judgments as transparent as possible, providing the basis for your choice of model structure and specification and the arguments that might be made against your recommendation."

The Transportation Research Board named Koppelman an emeritus member of the Transportation Demand Forecasting Committee, which he had joined in 1982. He also has served on the Intercity Passenger Rail Committee (1992–1998), the Traveler Behavior and Values Committee (1973–1984), and the Statewide Multimodal Transportation Planning Committee (1973–1975), and on several other standing technical committees. He is a founding member of the International Association for Travel Behavior Research (IATBR) and was Associate Editor of and now serves on the editorial board of *Transportation Research, Part B.*

Koppelman received the Burlington Northern Foundation Faculty Achievement Award in 1986 and IATBR's first Lifetime Achievement Award in 2003. He is the author of more than 150 publications.

Michael H. Belzer

Wayne State University

Professor and consultant Michael H. Belzer's commitment to trucking industry operations and labor issues has brought national recognition to his research on motor carrier safety, union–management relations, regulation, and industrial organization. An associate professor in the Department of Economics at Wayne State University, Belzer also is associate director of the Alfred P. Sloan Foundation's Trucking Industry Program, director of the Trucking Industry Benchmarking Program, and a consultant specializing in trucking issues.

His book, *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation*, published by Oxford University Press in 2000, made a strong case for motor carrier regulatory reform. While the book was a product of Belzer's research, it also was grounded in personal experience—he drove a tractor-trailer for 10 years after graduating from college, including 8 years driving R-Model Mack trucks in tank operations. He saw firsthand the difference in the industry before and after interstate trucking deregulation in 1980.

"My experience in the industry has given me a greater appreciation of the challenges faced by drivers and by trucking companies."

"I experienced the work pressure and the fatigue and then the lower compensation that has become the norm," Belzer states, noting that as a Teamster, he was better off than his nonunion colleagues. In 1981, however, his compensation was cut by 35 percent and remained frozen at that level for the next 5 years. Spurred by the conditions under which he and his colleagues worked, Belzer became involved in helping reform the International Brotherhood of Teamsters and preserving drivers' wages and benefits.

The fatigue Belzer experienced as a truck driver led directly to one of his research subjects—truck driver occupational safety and health. His other areas of expertise include industrial and labor relations, labor market analysis, freight regulation issues and regulatory evaluation, risk analysis, economic analysis of transportation issues, trucking industry issues, and motor carrier safety. An interest in freight distribution and concern about Michigan's economy has led him to launch a research agenda studying the feasibility of transforming southeast Michigan into a global freight hub through a partnership with the Port of Halifax.

He also has developed an interest in Asia and in Chinese culture. The future of the American worker depends in part on the wages and labor conditions of the Chinese workers who represent 25 percent of the world's workforce, notes Belzer. He spent a sabbatical studying Chinese industrial relations through visiting scholar appointments at Academia Sinica and Cheng Chi University in Taiwan, and he serves as a visiting scholar at Jilin University Business School in Changchun, China.

A southern California native, Belzer earned a bachelor's degree at the College of Arts and Sciences at Cornell University in Ithaca, New York; he then studied industrial relations in the trucking industry, earning master's and doctoral degrees from Cornell. He moved from there to the University of Michigan, where he developed his research agenda on truck driver safety. At Wayne State University, he served initially as academic director of the Master of Arts in Industrial Relations Program and associate professor of Urban and Labor Studies. He recently moved to the Department of Economics.

"My experience in the industry has given me a greater appreciation of the challenges faced by drivers and by trucking companies," Belzer comments. One of Belzer's latest research projects is a report analyzing organization, regulation, and industrial relations in North America's motorcoach bus industry. He also has completed a report examining economic factors that may contribute to large commercial vehicle crashes, using data from the Large Truck Crash Causation Study, and has coauthored a paper published by the Brookings Institution on the effects of trucking industry deregulation on urban sprawl and distribution networks.

"My major interest right now is trying to make sure that public policy analysis incorporates the full costs and benefits of transportation in their analyses," Belzer notes. These costs may include not only the safety and health impact of transportation operations, he observes, but also the carbon footprints and environmental impacts on supply chains, domestic manufacturing and distribution, and both urban development and suburban sprawl. "This may indeed result in reduced freight operations—that is, shorter supply chains—but the corresponding gain in local production will more than offset the cost, resulting in greater economic efficiency."

Belzer chairs the Transportation Research Board's Trucking Industry Research Committee, having served as chair of the predecessor task force from 2001 to 2006, and he is a member of the Freight Systems Group Executive Board, the Freight Transportation Economics and Regulation Committee, and the Truck and Bus Safety Committee. From 2000 to 2003, he was a member of the National Research Council–appointed Committee for Review of the Federal Motor Carrier Safety Administration's Truck Crash Causation Study.

Photo: Eric Shen, Port of Long Beach

Participants in the Ports, Waterways, Freight, and International Trade Conference visit the rail trench of the Alameda Corridor.

Meetings Focus on Marine Activities

The 34th Annual TRB Ports, Waterways, Freight, and International Trade (PWFIT) Conference focused on Critical Research Issues in Freight and Marine Transportation: Meeting the Challenges at the Beckman Center of the National Academies in Irvine, California, May 4–6. Prominent public- and private-sector speakers outlined critical research issues and needs. In working group sessions, attendees reviewed research problem statements for consideration by TRB's Cooperative Research Programs and topics to be considered for policy studies. The Ports of Los Angeles and Long Beach sponsored a waterside and landside tour of the San Pedro Bay facilities, the rail trench of the Alameda Corridor, and the Pacer distribution facility.

The Marine Board held its 2009 Spring Meeting at the Aquarium of the Pacific, Long Beach, California, May 11–12. Members and guests heard presentations and engaged in discussions about pressing issues in marine transportation: naval engineering in the 21st century; vessel incident investigations; integrated ocean observing systems; maritime domain awareness; offshore facilities inspection programs; piracy; and risk assessment frameworks.

At a special dinner event May 11, Board members presented Keith W. Tantlinger with the National Academy of Sciences' Gibbs Brothers Medal. Tantlinger was recognized for his outstanding achievements in naval architecture and marine engineering—most notably, his visionary and innovative design of the cellular containership and supporting systems that transformed the world's shipping fleet and facilitated the rapid expansion of global trade.

Photo: Nancy Simms, The Propeller Club of the United States

Congressman Elijah Cummings (D-Maryland), keynote speaker at the Harbor Safety Committee Conference, with Captain Allen Thompson of the Tampa Bay Pilots (*right*) and Rear Admiral Steve Branham, U.S. Coast Guard (*left*).

The Tampa Bay Harbor Safety and Security Committee hosted the 11th Annual Harbor Safety Committee Conference in Tampa, Florida, May 27–29. Cosponsored by the U.S. Coast Guard and the National Oceanic and Atmospheric Administration, the conference examined the Critical Path to Safe and Secure Harbors: Communication, Collaboration, and Coordination. Congressman Elijah Cummings (D-Maryland), Chair of the House Subcommittee on Coast Guard and Marine Transportation, delivered the keynote address. Admiral Thad Allen, Commandant, U.S. Coast Guard, delivered the closing address and presented the Harbor Safety Committee of the Year award to the South East Texas Waterways Advisory Council.

STATISTICS INFORMATION EXCHANGE—Transportation professionals from the United States, Canada, and Mexico gathered at the Keck Center for the 23rd North America Transportation Statistics Interchange, Monday, June 22, 2009. Chairing the meeting were Deborah Johnson, Research and Innovative Technology Administration (*far right*), and Mark Wallace, U.S. Bureau of the Census (*second from right*). Established in 1991, the Interchange furthers collaboration and the exchange of information among transportation and related statistical federal agencies in Canada, Mexico, and the United States. Primary participating agencies include Statistics Canada, Transport Canada, the Ministry of Communications and Transportation of Mexico, the National Institute of Statistics and Geography of Mexico, the Mexican Institute of Transportation, the U.S. Department of Transportation Bureau of Transportation Statistics, and the U.S. Census Bureau.

Characterizing Cementitiously Stabilized Layers for Pavement Design and Analysis

In subgrade, subbase, and base layers of flexible and rigid pavement structures, many state highway agencies use cementiously stabilized materials such as lean concrete; cement-stabilized aggregate; and soil stabilized with cement, lime, and fly ash, sometimes in various combinations. Limited research has linked the properties of these materials—such as shrinkage—to the performance of the pavements.

Although the American Association of State Highway and Transportation Officials' (AASHTO) *Interim Mechanistic–Empirical Pavement Design Guide Manual of Practice* (MEPDG) provides a methodology for analyzing and predicting the performance of pavements with stabilized layers, the short- and long-term properties of the materials may differ substantially, depending on the type and quantity of stabilizing agent, the pavement structure, the environmental conditions during and after construction, the loading, and other factors.

The MEPDG has not adequately addressed the characterization of the materials, the changes in their properties over time, and their distress models; in addition, other properties may need to be considered. Research is needed to identify the properties of cementitiously stabilized materials that influence highway pavement design, constructability, and performance and to recommend methods for measuring these properties. This information can be incorporated into the MEPDG to provide rational analysis and design procedures of pavements constructed with stabilized layers.

Washington State University has been awarded a $500,000, 36-month contract [National Cooperative Highway Research Program (NCHRP) Project 4-36, FY 2009] to recommend performance-related procedures for characterizing cementitiously stabilized pavement layers for use in pavement design and analysis, which can be incorporated into the MEPDG.

For further information, contact Amir N. Hanna, TRB, 202-334-1432, ahanna@nas.edu.

Guidelines for Quality-Related Pay Adjustments for Pavements

Highway agencies generally use quality measures for pavement construction, but pavement characteristics—such as material properties and smoothness—often vary from the specifications. The variation will affect pavement quality and performance, as well as the highway agencies and road users. To account for value lost or gained by this variation, many highway agencies incorporate quality-related pay adjustments—incentives and disincentives—into the construction contracts for flexible and rigid pavements.

Many of the approaches used by highway agencies to deal with construction variation and assigning pay adjustment factors have been developed empirically, without an understanding of actual relationship to performance. In addition, the procedures used to determine the amount and method of the pay adjustment do not consider such relevant issues as highway classification, constructability, multiple pay factors, impacts on highway users, risk sharing, contractor motivation, and legal ramifications. Rational guidelines are needed to determine quality-related pay adjustment factors for flexible and rigid pavements, to assist highway agencies in incorporating into construction contracts pay adjustment factors commensurate with the expected gain or loss in pavement performance.

Photo: Texas Transportation Institute, 2004

A new NCHRP project will help develop guidelines for quality-related pay adjustment factors for pavement construction.

Fugro Consultants, Inc., of Austin, Texas, has been awarded a $249,793, 24-month contract [NCHRP Project 10-79, FY 2009] to develop guidelines for determining quality-related pay adjustment factors for flexible and rigid pavements. The guidelines will be recommended for adoption by AASHTO.

For further information, contact Amir N. Hanna, TRB, 202-334-1432, ahanna@nas.edu.

Design Requirements for Culvert Joints

Traditional methods for the structural design of buried culverts and storm drains ignore longitudinal stresses, transverse stresses, and circumferential stresses at the joint. The joint's structural design assumes only in-plane loading of the pipe's cross section—in-plane bending and in-plane thrust. Current practice does not consider the longitudinal bending moments and shear from nonuniform loading or from variations in the bedding support along the pipe's length.

Field observations show that longitudinal effects, such as variation in bedding stiffness, may cause many culvert failures. Failure of the joint may allow water and soil to seep through, resulting in loss of soil support, the collapse of the pipe, and pavement damage.

Tighter standards for construction and installation may alleviate longitudinal distress from poor bedding alignment and stiffness. Most pipe installations, however, are less than perfect; a structural design process that considers longitudinal effects will improve joint performance.

Queen's University of Canada has been awarded a $369,998, 30-month contract to develop structural design requirements for joints in flexible and rigid culverts to withstand variations in construction, support, and loading conditions, for consideration by the AASHTO Highway Subcommittee on Bridges and Structures. The project is scheduled for completion in November 2011.

For further information, contact Waseem Dekelbab, TRB, 202-334-4109, wdekelbab@nas.edu.

PHOTO: TEXAS TRANSPORTATION INSTITUTE

Urban Mobility Report Finds "Lull" in Traffic

The economic downturn has eased traffic congestion on the nation's roads—somewhat. According to the Texas Transportation Institute's (TTI) *Urban Mobility Report 2009*, released in July, the decrease in traffic congestion is not a downward trend but a "temporary lull" that will likely pick up when the economy does.

The TTI data show that each traveler spent 1 hour less sitting in traffic, and wasted 1 less gallon of gasoline in 2007 than in 2006. The difference is minimal, but represents a change from ever-increasing traffic congestion levels in previous years. The report also calculates the cost of traffic congestion in 2007 as $87.2 billion, representing 2.8 billion gallons of wasted fuel and 4.2 billion hours of wasted time.

The report examines traffic congestion levels for American cities. Metropolitan Los Angeles has the nation's worst traffic congestion for urban areas with a population of more than 3 million. For cities with 1 million to 3 million residents, San Jose, California, had the worst traffic. Tucson, Arizona, led the way in traffic congestion for urban areas with populations between 500,000 and 1 million; and the Charleston area of South Carolina had the worst traffic for cities with fewer than 500,000 residents.

For more information or to see the report, visit http://mobility.tamu.edu/ums/.

Construction Begins on Rail Tunnel Project

An 8-year, $8.7 billion project to build a rail tunnel under the Hudson River broke ground in June, marking the start of the largest mass-transit construction project in the country. The first new link between New Jersey and Manhattan since the lower deck of the George Washington Bridge in 1962, the project is designed to alleviate the heavy traffic crossing the Hudson. New Jersey Transit trains running through the 8.78-mile tunnel—which will extend from Kearny Yards, New Jersey, to 34th Street in Manhattan, at depths of 100 to 200 feet—potentially will remove 22,000 vehicles per day from the road.

In 2001, Penn Station at 34th Street in Manhattan reached capacity at 42,500 passengers during the morning peak period. This caused a bottleneck, stifling travel and delaying commuters. The tunnel project will more than double the number of peak-hour trains to and from Manhattan, from 23 to 48, and will bring morning peak capacity from 45,000 to 90,000 trips.

Funded by The Port Authority of New York and New Jersey, New Jersey Transit, New Jersey toll revenues, and the federal government, the project will add a large station under 34th Street with 6 tracks, 72 high-speed escalators, and 15 elevators, with connections to 14 subway lines, Port Authority Trans-Hudson trains, Amtrak, and the Long Island Rail Road.

"Dump the Pump" Day Promotes Public Transit

The American Public Transportation Association (APTA) sponsored its fourth annual "Dump the Pump" Day on Thursday, June 18. Public transportation agencies across the country encouraged commuters to skip their drive to work and ride public transportation instead, raising awareness about public transportation's role in helping individuals save money and reduce the environmental impact of automobile travel.

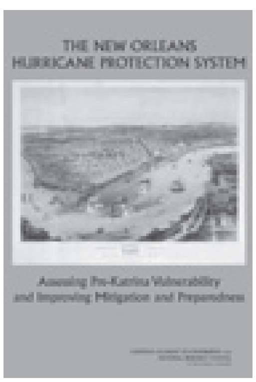
According to APTA statistics, riding public transportation to work saves the average American commuter $9,068 per year, taking into account the costs of owning, insuring, maintaining, and fueling a car, as well as paying for parking.

"With gas prices increasing 33 percent since December, coupled with uncertain economic times, people have been looking for ways to save, and riding public transportation is a great choice to make," noted APTA President William Millar.

Public transportation systems celebrated Dump the Pump Day in various ways: offering free or reduced rides, holding giveaway contests, and placing ads on screens at gasoline stations.

Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 29th Edition; AASHTO Provisional Standards, 13th Edition
American Association of State Highway and Transportation Officials (AASHTO), 2009. 4,392 pp.; $720; 1-56051-432-9.

This set incorporates two foundational books in transportation planning and construction. The 29th edition of *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* contains 421 materials specifications and test methods commonly used in highway facilities construction, developed and maintained by transportation departments in AASHTO's Subcommittee on Materials, as well as pertinent American Society of Testing and Materials specifications approved by member states. The set also includes the 13th edition of *AASHTO Provisional Standards* (pictured), which contains 42 provisional materials specifications and test methods, with 8 updated and 10 new standards.



New Orleans Hurricane Protection System: Assessing Pre-Katrina Vulnerability and Improving Mitigation and Preparedness
National Academies Press, 2009. 58 pp; $21; 0-309-13833-7.

Hurricane Katrina, which struck New Orleans and surrounding areas in 2005, was one of the nation's most devastating natural disasters. Shortly after the storm, the U.S. Army Corps of Engineers established a task force to assess the performance of the levees, floodwalls, and other structures comprising the area's hurricane protection system. Released by the National Academy of Engineering and the National Research Council, this book provides an independent review of the task force's final draft report, identifying key lessons from the Katrina experience and their implications for future hurricane preparedness and planning in the region.

The Interagency Performance Evaluation Task Force draft final report is reviewed, and advice is offered on how to improve the hurricane-protection system in the New Orleans area. Levees and floodwalls surrounding New Orleans cannot provide absolute protection against overtopping or failure in extreme events, the report states. Policy options include the voluntary relocation of people and neighborhoods from areas that are vulnerable to flooding, as well as the elevation of the first floors of buildings to the 100-year flood level, at minimum.

Safety Management Systems in Aviation
John J. Goglia, Alan J. Stolzer, and Carl D. Halford. Ashgate, 2008. 322 pp.; £57; 978-0754673040.

Aviation is one of the safest modes of transportation. To encourage further safety improvements—as well as a proactive approach within the aviation community—the International Civil Aviation Organization has mandated that all member states implement Safety Management System (SMS) programs in their aviation industries. Although some countries have applied the SMS for several years, the United States is only beginning to participate, and many other countries are not yet involved.

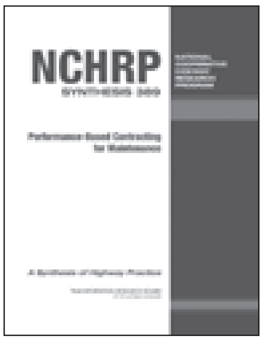
This book covers the essential points of the SMS, presenting its quality management underpinnings and its four pillars: risk management, reliability engineering, SMS implementation, and scientific rigor. Designed as a textbook for the aviation safety student, the book also features several commentaries on SMS in practice by experts in aviation safety.

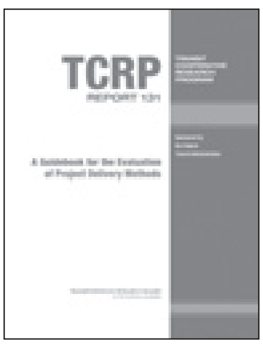
Places of Refuge
Eric Van Hooydonk. Informa Law, 2009. $531; 978-184311-841-1.

The need for specific legal arrangements governing ships in distress and places of refuge is one of the most topical problems in public and private maritime law. Shipping disasters involving the loss of the *Erika* in 1999 and of the *Prestige* in 2002 had environmental consequences and attracted the attention of the International Maritime Organization, the Comité Maritime International, the European Union, and national maritime authorities.

This book serves as an authoritative source of international law on this topic. It provides clarity on the scope of the right of access, the conditions under which coastal authorities may deny access, the liability of authorities granting or denying access, the basis and the conditions of financial securities, and the obligation to establish contingency plans.

The books in this section are not TRB publications. To order, contact the publisher listed.





TRB PUBLICATIONS

Communication Matters: Communicating the Value of Transportation Research—Guidebook
NCHRP Report 610
This report studies the integration of communications throughout the research process and introduces new ways to think about communicating the value of research. Authors examine the signs of good communications practices, the communication process, planning and evaluating communications efforts, communicating with specific audiences, and case studies on good communication practices within the transportation community and outside it.

2009; 61 pp.; TRB affiliates, $37.50; nonaffiliates, $50. Subscriber category: planning and administration (IA).

NDT Technology for Quality Assurance of HMA Pavement Construction
NCHRP Report 626
The results and analyses of research to investigate the application of nondestructive testing (NDT) technologies in the quality assurance of hot-mix asphalt (HMA) pavement construction are presented, along with several key products, such as a recommended manual of practice with guidelines for implementing selected quality assurance testing technologies and detailed test methods for the recommended technologies.

2009; 112 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber category: materials and construction (IIIB).

Ruggedness Testing of the Dynamic Modulus and Flow Number Tests with the Simple Performance Tester
NCHRP Report 629
This report outlines part of a multiphase effort to develop a practical, economical simple performance tester (SPT) for use in routine HMA mix design and in the characterization of HMA materials for pavement structure design according to the Mechanistic–Empirical Pavement Design Guide. Ruggedness testing was conducted with the SPT for the dynamic modulus and flow number tests developed in NCHRP Project 9-19 as simple performance tests for permanent deformation.

2008; 124 pp.; TRB affiliates, $39; nonaffiliates, $52. Subscriber category: materials and construction (IIIB).

Performance-Based Contracting for Maintenance
NCHRP Synthesis 389
Performance-based maintenance contracting (PBMC) provides incentives to achieve desired results from maintenance contractors. This differs from the more usual practice for highway maintenance contracting—low bid combined with method specification. Surveys, interviews, and a literature review of domestic and international experience explore the potential of PBMC to reduce costs and improve maintenance levels of service.

2009; 106 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber category: maintenance (IIIC).

Public Sector Decision Making for Public–Private Partnerships
NCHRP Synthesis 391
The benefits and risks of allowing the private sector to have a greater role in financing and developing highway infrastructure are presented through findings from a literature review, interviews, and surveys of U.S. state departments of transportation, Canadian ministries of transportation, and stakeholders.

2009; 130 pp.; TRB affiliates, $40.50; nonaffiliates, $54. Subscriber category: planning and administration (IA).

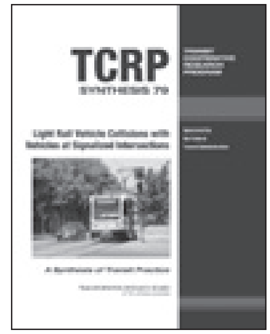
Transportation's Role in Emergency Evacuation and Reentry
NCHRP Synthesis 392
Transportation's role in emergency situation planning, control, and research, as well as effective and innovative practices, are summarized in this synthesis. Most transportation agencies surveyed indicated they had adequate communication capabilities to carry out their role; the survey responses suggested, however, that the greatest needs were for more financial and workforce resources dedicated to planning and managing evacuations.

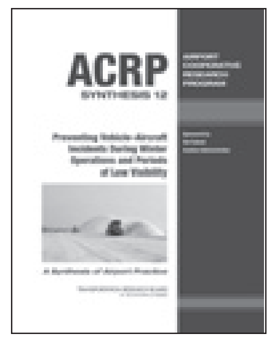
2009; 129 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber categories: planning and administration (IA); highway operations, capacity, and traffic control (IVA); and security (X).

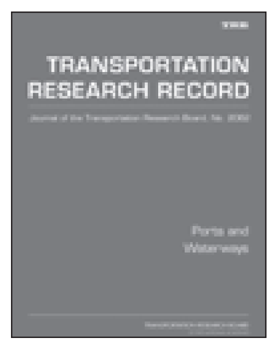
A Guidebook for the Evaluation of Project Delivery Methods
TCRP Report 131
Studies of various project delivery methods for major transit capital projects are presented. Also investigated are the impacts, advantages, and disadvantages of including operations and maintenance as a component of a contract for project delivery.

2009; 101 pp.; TRB affiliates, $38.25; nonaffiliates, $51. Subscriber category: public transit (VI).

TRB PUBLICATIONS *(continued)*







Light Rail Vehicle Collisions with Vehicles at Signalized Intersections
TCRP Synthesis 79
This synthesis explores methods tested and used by transit agencies to reduce collisions between light rail vehicles and motor vehicles at highway intersections controlled by traffic signals. Issues addressed include a range of light rail transit (LRT) operations and environments, such as median-running, side-running, contraflow, and mixed-use LRT alignments; urban and suburban settings; and a variety of U.S. geographic regions.

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Transit Security Update
TCRP Synthesis 80
Using interviews with industry experts and a review of the National Transit Database, this synthesis studies transit-related counterterrorism and anticrime security measures and practices, crime and security incident trends, and major obstacles to security and policing management.

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An Airport Guide for Regional Emergency Planning for CBRNE Events
ACRP Report 12
The details that airports should consider in their hazard and threat assessments, airport emergency plans, and annexes are outlined in this report. Also examined are issues involving terrorist use of CBRNEs—chemical, biological, radiological, nuclear, or explosive materials—targeted at airports.

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Integrating Airport Information Systems
ACRP Report 13
This report provides information to help airport managers and information technology professionals address the issues that arise in integrating airport information systems. The report reviews information sources and strategies to capture business-critical information for use in synergistic ways, as well as new technologies, such as facial recognition kiosks, smart board passes, intelligent wireless sensors, and more.

2009; 87 pp.; TRB affiliates, $38.25; nonaffiliates, $51. Subscriber categories: planning and administration (IA) and aviation (V).

Preventing Vehicle–Aircraft Incidents During Winter Operations and Periods of Low Visibility
ACRP Synthesis 12
Intended to help airport operators engaged in snow and ice removal to promote a safer winter runway, this synthesis examines the factors affecting safe winter operations, and offers practical approaches to prevent runway incursions by airport snow-removal equipment operators.

2008; 70 pp.; TRB affiliates, $33.75; nonaffiliates, $45. Subscriber category: aviation (V).

Effective Practices for Preparing Airport Improvement Program Benefit–Cost Analysis
ACRP Synthesis 13
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Ports and Waterways
Transportation Research Record 2062
Public–private partnerships for port infrastructures, productive efficiency of world container ports, productivity improvement at a seaport coal terminal, critical infrastructure at West Coast intermodal terminals, and an equilibrium model to evaluate maritime infrastructure investments are explored in this volume, among other topics.

2008; 73 pp.; TRB affiliates, $37.50; nonaffiliates, $50. Subscriber categories: freight transportation, multimodal (VIII); marine transportation (IX).

Transit: Management, Technology, and Planning 2008
Transportation Research Record 2063
Authors examine the use of smart card data to define public transit use, innovative public–private cooperation for urban transportation, transit operator fleet size impact models, a fleet-size model for light rail and bus rapid transit systems, a data archiving

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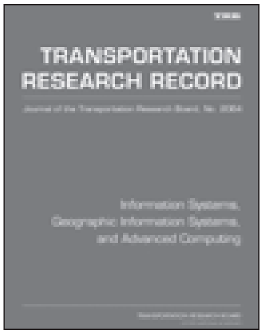

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and mining system for transit service improvements, planning and financing strategies for a downtown circulator bus route, links between transit ridership and gasoline prices, land use–based transit planning, and other subjects.

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Information Systems, Geographic Information Systems, and Advanced Computing
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Regional Transportation Systems Management and Operations; Managed Lanes 2008
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Transportation Research Record 2066
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2008; 121 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber categories: freight transportation, multimodal (VIII); marine (IX).

Societal and Economic Factors
Transportation Research Record 2067
Authors research the effects of socioeconomic status on hurricane disaster relief plans, inadequate transportation as a barrier to community involvement, geographic and demographic profiles of morning peak-hour highway commuters, environmental justice for low-income and minority communities adjacent to ports, the impact of urban road pricing on low-income car drivers, driver frustration with bicyclists and pedestrians, climate change impacts on transportation and the economy, highway-induced development in metropolitan areas, and more. Also included are papers on enacting cultural change within a state department of transportation, sustainable urban transportation policies for developing countries, and indicators for sustainable transportation planning.

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Pavement Monitoring, Evaluation, and Data Storage; Strength and Deformation Characteristics; and Surface Properties–Vehicle Interaction 2008
Transportation Research Record 2068
Included in this volume are papers on subjects such as truck hydroplaning, pavement condition sampling for life-cycle management, a finite element analysis tool for pavement crack propagation, innovation in automated analysis of cross-slope data, a neural network for analysis of rigid pavement deflection data, rut accumulation and power law models, identifying the cause of premature distresses, the effect of rubber deposits on runway friction, and a targeted program to improve skid resistance.

2008; 140 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber category: pavement design, management, and performance (IIB).

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