HOUSTON'S TRAVEL RATE IMPROVEMENT PROGRAM

"TOOLBOX" OF IMPROVEMENT STRATEGIES

ADD CAPACITY

Prepared for
Greater Houston Partnership

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April 2001

ADD CAPACITY

The best known, and probably most frequently used, improvement option is to add capacity to the transportation system. That can mean more traffic lanes, additional buses or new bus routes, new roadways or improved design components.

The strategies listed in this section seek to increase mobility by increasing the capacity of the transportation network. The benefits associated with these improvements include reduced congestion, delay, and travel time. Emissions may be reduced due to the reduction in congestion or may be increased due to the effect of increased demand from new development. The strategies include:

- New Lanes
- New Highways
- Improve Street Continuity
- New Lanes Without Widening the Roadway
- New Toll Roads
- Grade Separation
- Geometric Design
- Managed Lanes/Truck Lanes
- New Streets in New Developments
- HOV Lanes
- Multimodal Transportation Corridor
- Freight Rail Improvements
- Bus Rapid Transit
- Heavy Rail
- Commuter Rail

New Lanes

Implementation

Hurdles:	All
Level:	Areawide
Sector:	Public
Locations:	Routes

Description

Adding new lanes to existing roads has historically been the most common approach used to alleviate urban congestion. In recent years, some regions have shifted away from capacity increases as a sole strategy for relieving congestion, as it has become apparent that this cannot be the only way to address congestion. In many urban areas, right-of-way is no longer available to widen existing streets or freeways. In other areas, a limited amount of right-of-way is available, but the benefit of additional lanes diminishes as the number of existing lanes on the facility increases. For example, adding one lane to a two lane directional facility provides a 50 percent increase in capacity, while increasing the number of lanes from five to six results in a capacity increase of only 20 percent.

Target Market

While the focus of relieving congestion has broadened to include better management and more efficient use of existing facilities, adding new lanes to existing roads does remain one of the available tools. The addition of new lanes to existing freeways and principal arterials serves to reduce congestion on those routes or alleviate congestion within the surrounding roadway network. Motorist safety may also be improved through the construction of additional capacity in problematic areas. Increases in freeway and arterial capacity, however, may be accompanied by increases in volumes due to vehicles shifting from other routes or times of day to the improved routes.

Benefits and Costs

The costs associated with constructing additional lanes on existing roads vary widely due to right-of-way costs, types of construction materials, roadway design, amount of bridge construction and many other factors. In general, however, the costs associated with freeway expansion are approximately $2 to $4 million per mile per lane. The costs associated with principal arterial street expansion are approximately $0.5 to $1 million per mile per lane. The addition of a lane to expand freeway capacity provides benefit/cost ratios in the range of 3:1, although this can vary significantly. The addition of a lane to expand principal arterial capacity provides benefit/cost ratios near 10:1 (1).

Implementation Issues

Legislation from the Clean Air Act, Intermodal Surface Transportation Efficiency Act and Transportation Efficiency Act for the 21st Century has imposed procedures through which construction projects must be evaluated during the planning phases. Major capital investments are analyzed for a range of alternatives: factors including operation, persons served, mode share, travel costs, and construction and operating costs. This process provides information for public input and participation. An environmental assessment may be required for projects that could have considerable impacts on the environment. For metropolitan areas with air quality problems, projects to widen roadways are subject to an analysis to determine whether the project will result in further degradation of air quality in the region.

1. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991

New Highways

Implementation
Hurdles: All
Level: Areawide
Sector: Public
Locations: Routes

Description

The construction of new highways typically involves construction on newly acquired rights-of-way where no prior roadway existed. The purpose of the new facility may be to reduce congestion on nearby roads, improve safety in the corridor, or provide access to new or future development. New highway construction may also provide the benefit of diverting truck traffic from local streets. In addition to the planning and design of a new highway, issues of acquiring right-of-way and mitigating the negative impacts on the environment and local businesses and residents must be addressed. While building new roads cannot be the only strategy to mitigate congestion, new construction can serve a role in the overall plan to reduce urban congestion.

Target Market

Obtaining local consensus to build a new urban highway can often be difficult. In some areas, groups that feel new highways are not in the best interest of the community may oppose new construction. New highways may be seen to redistribute regional development and encourage single occupant vehicle (SOV) travel. The draw of traffic from other facilities can often leave a new facility congested within a short time after completion. In many areas, new highway construction is occurring in suburban areas as these areas attempt to address congestion problems. There may be less opposition to building new suburban roads where right-of-way is more available at a lower cost, and there are fewer impacts on neighboring development.

Benefits and Costs

The costs associated with constructing new roadways vary widely due to right-of-way costs, types of construction materials, roadway design, amount of bridge construction and many other factors. In general, however, representative costs can be provided. The construction of principal arterials is approximately $1.5 million per mile per lane (1). The construction of "super arterials"—streets with grade-separation at major intersections (see regional thoroughfares)—is approximately $3 to $4 million per mile per lane (2). Finally, the costs associated with new freeway construction are approximately $4.5 million per mile per lane. All of these types of roadway improvements have been shown to produce benefit/cost ratios of 2:1 to 4:1, although the costs and benefits can vary significantly (1).

Implementation Issues

Legislation from the Clean Air Act, Intermodal Surface Transportation Efficiency Act and Transportation Efficiency Act for the 21st Century has imposed procedures through which construction projects must be evaluated during the planning phases. A major investment study may be required in the early planning stages for projects involving federal funding that have substantial costs and a significant impact on capacity, level of service, or mode share within the corridor. This process allows for public input and participation. An environmental assessment may be required for projects that could potentially have considerable impacts on the environment. For areas in non-conformance with air quality standards, projects to build new roadways will be subject to conformity analysis to determine whether the project will result in any further degradation of air quality in the region.

1. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.
2. 2. Urbanik. T., et al. Considerations in Developing a Strategic Arterial Street System, Research Report 1107-5F, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1990.

Improve Street Continuity

Implementation
Hurdles: Public
Level: Target Markets
Sector: Public
Locations: Routes

Description

The mobility provided by a roadway system is affected by its street continuity. A lack of continuous streets results from changes in the number of lanes or from inadequate planning for street location between neighboring developments.

Capacity reducing changes in cross section may include reduction in the number of lanes, reduction in lane width, reduction in lateral clearance to obstructions, reduction in median width, reduction in pavement quality, etc. Changes in alignment that affect street continuity include sharp horizontal or vertical curves. These types of curves can limit operating speeds in the vicinity of the facility. Discontinuity can also occur with secondary facilities within the right-of-way, such as bicycle and pedestrian facilities. Bicycle and pedestrian facilities may be disjointed in locations where facilities start and stop without connections to other bicycle/sidewalk facilities in the area.

Target Market

Relatively minor reconstruction projects to upgrade “weak links” of facilities may result in significant increases in mobility for large portions of the facility. A two-lane bridge serving four lanes on either side could be upgraded to a four-lane bridge. Limiting sections of roadway may be upgraded to match the number of lanes of adjoining sections. Sections of roadway that have gaps in bicycle and pedestrian facility networks can be retrofitted to link with existing bicycle/pedestrian facilities. Locations with substandard vertical and/or horizontal alignment for prevailing volumes and speeds can be redesigned. Roadways with reverse curves (a curve in one direction followed immediately by a curve in the reverse direction) can be redesigned with a longer single curve to provide a smoother flow through transitions in roadway alignment. Reconstruction to lengthen existing curves should provide for higher operating speeds, greater sight distance, improved safety, and greater driver comfort, which are important on major urban roadways but may not be as important on minor roadways where speed and capacity are less critical elements.

Implementation Issues

Improvement efforts by METRO, the cities and counties and TxDOT over the last two decades have targeted this problem and completed many of the discontinuous major streets.

New Lanes Without Widening the Roadway

Description

Additional travel lanes may be provided on a road by using one or more shoulders as travel lanes, reducing lane widths, or a combination of the two. Although this practice is typically not seen as a long-term improvement, it may be used as a short-term improvement where bottlenecks exist. Freeway shoulder lanes have been used to provide both general-purpose lanes and high-occupancy vehicle (HOV) lanes. And additional turn lanes have been created at street intersections to improve capacity. Capacity increases of up to 30 percent have been seen on facilities with redesigned lanes (1). One concern associated with converting a shoulder to a travel lane is the impact on safety. Results of studies to assess the safety of converting shoulder lanes to travel lanes have been mixed. Some studies have shown slight increases in accident rates, while other studies have shown either no increase in accident frequency or severity or a slight reduction in accident rates, presumably due to decreased congestion (2,3).

Implementation

Hurdles:	All
Level:	Areawide
Sector:	Public
Locations:	Routes

Target Market

In most cases, the removal of the left shoulder for conversion to a travel lane is preferable from both safety and operations standpoints. Left shoulders are not used as frequently for emergency stops and enforcement as the right shoulder. Regardless of which shoulder is converted, shoulders are often not designed to accommodate traffic loads and the structural integrity of most shoulders may need to be upgraded prior to conversion. In areas with truck restrictions for the left lane, left shoulder lanes will be subject to lower traffic loadings.

While the conversion of a right shoulder to a travel lane is often the easiest to implement, there are several safety and operational disadvantages to converting right shoulders. Right shoulders are commonly used for vehicle refuge during emergency stops or breakdowns and by law enforcement personnel. Other concerns involve entrance ramps, where conversion of a right shoulder would reduce sight distance and potentially adversely affect merging operations. The conversion of both shoulders to travel lanes is not recommended.

Benefits and Costs

The costs associated with implementing shoulder lanes vary depending on the condition of the existing shoulder, however, conversion of a shoulder to a shoulder lane is approximately $1.5 million for construction and engineering and $12,000 per year for maintenance. Shoulder lanes can provide benefit/cost ratios near 7:1, depending on the level of congestion relief and the construction costs (1).

Implementation Issues

Careful planning and design should accompany any consideration of converting a shoulder lane to a travel lane to avoid any potential safety problems such as substandard sight distances. If the facility is on the federal aid system, federal approval will be required in advance of conversion.

Measures that have been taken to mitigate the impacts of shoulder conversion on safety and operations include: advisory and regulatory signing, constructing frequent short parking areas, dynamic message signs, continuous lighting, truck lane-use restrictions, freeway service patrols, and heightened enforcement.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.
2. Chen, C. Evaluation of HOV and Shoulder Lane Travel Strategy for I-95, ITE Journal, Institute of Transportation Engineers, Washington D.C., 1995.
3. 3. Curren, J. Use of Shoulders and Narrow Lanes to Increase Freeway Capacity, NCHRP Report 369, Transportation Research Board, Washington D.C., 1995.

New Toll Roads

Description

Implementation
Hurdles: All
Level: Areawide
Sector: Public
Locations: Routes

Toll roads provide an alternative method of financing transportation construction costs. The Harris County Toll roads provided freeway-level capacity many years before public funds would have been available for construction. Since the money for construction of the facility is available at the beginning, efficiencies in contracting can also occur, lowering total costs. Tolls have been used to finance highways, bridges, and tunnels. The users of the facility rather than the general public pay for the construction of the facility, freeing public resources for other uses. Over half of the states in the United States have passed legislation to allow partial or total private investment in roadway construction, which is recouped through user tolls. Interest in toll roads is being spurred further by advancements in electronic toll collection and changes in federal aid policy that now allow some toll projects to be eligible for federal aid.

Many of the negative aspects historically associated with toll roads were related to the standard methods used to collect tolls. The limited capacity of manual toll booths and automatic coin machine booths required expansive toll plazas, as five to six toll booth lanes were required for each general traffic lane to maintain toll road capacity through the plaza. These expansive toll plazas required significant investments in right-of-way and infrastructure costs. Furthermore, these standard toll collection methods incurred high operating and maintenance costs and required motorists to significantly slow.

Target Market

Electronic toll collection technologies have made the construction of toll roads more attractive in recent years. Motorists establish prepaid accounts with most systems and are debited for each toll via an automatic vehicle identification system consisting of tollbooth-mounted antennas, a computer system, and vehicle-mounted transponders. Since tolls can be collected electronically at normal speed, motorists are not delayed and fewer tollbooth lanes are required, reducing required right-of-way, infrastructure, and operating and maintenance costs. Express lanes, which allow payment only by electronic toll collection, provide 2.6 times the capacity of an automatic coin machine tollbooth lane, and 4.1 times the capacity of a manual tollbooth lane (1). Electronic toll collection also makes variable toll pricing feasible as a traffic demand management tool.

There are currently 138 toll bridges, 10 toll tunnels, and 89 toll roads in 31 states within the United States. Approximately 60 percent of these facilities have already implemented electronic toll collection systems. These 237 toll facilities process approximately 4.9 billion annual transactions, representing approximately $5.6 billion in toll revenue (2). Harris County's toll road system cost over $1 billion to construct and handles in excess of 125 million annual transactions generating $217.8 million in revenue.

Implementation Issues

Toll roads can be financed through general obligation bonds, revenue bonds, revenue bonds with supplemented income, private financing, or combinations of sources. A number of public-private partnership models have been developed to finance, construct, and operate toll facilities. In the build-own-operate model, a private organization finances, constructs, owns, and operates the facility. In the build-operate-transfer model, a private organization finances, constructs, and operates the facility for a specified time period collecting the tolls. At the end of the time period, facility ownership is transferred to a governmental agency. In the build-transfer-operate model, a private organization finances and constructs the facility at which time ownership is transferred to the governmental agency. The facility is then leased by the private organization, which operates the facility and collects tolls. In the buy-build-operate model, a private organization buys an existing facility from the government, upgrades the facility, then owns and operates the facility collecting tolls. In the lease-develop-operate model, a private organization leases an existing facility from the government, upgrades the facility, then operates and collects tolls during the period of the lease. Finally, in a temporary privatization model, a private organization takes over operation of an existing facility, upgrades the facility, and collects tolls until the costs plus an agreed upon reasonable rate of return on capital is attained, at which time operations and maintenance revert back to the governmental agency which continuously holds ownership.

1. Analysis of Automatic Vehicle Identification and its Potential Application on the Florida Turnpike: Technical Memorandum 2, Center for Urban Transportation Research, University of South Florida-Tampa, 1990.

2. United States Toll Facilities. Website address: http://www.ettm.com/usafac.html.

Grade Separation

Description

The capacity of roads is limited by the capacity of intersections with other minor or major streets, freeways, or rail lines. When traffic control devices at intersections of two facilities are inadequate to handle approach demand or safety becomes a concern due to frequent accidents, grade separation may provide a solution to eliminate or reduce resulting delay and greatly improve motorist/ pedestrian safety. Grade separation refers to the physical separation of facilities using overpasses or underpasses to eliminate conflicting movements. Grade separations may be used to separate freeway-freeway intersections, freeway-street intersections, street-street intersections, or roadway-pedestrian facility intersections. Grade separations for pedestrians may be warranted to increase pedestrian safety where high volume pedestrian movements exist or where pedestrians encounter high volume or high-speed roadways.

Implementation
Hurdles: All
Level: Target Markets
Sector: Public
Locations: Sites

Target Market

Grade separation of arterial streets is useful when other strategies such as signal timing improvements and adding turn lanes cannot relieve the congestion and delay incurred at the intersection and where right-of-way limitations prohibit additional through lanes. If congestion is significant only on one street, a typical two-level interchange with a bridge for the through movement of the major arterial may provide the needed capacity. If both directions are experiencing severe congestion, a three-level interchange may be required to provide the desired capacity. Grade separation is also very useful at highway-rail grade crossings to reduce motorist delay and eliminate train/vehicle collisions. Potential accidents are eliminated, trains are able to travel at higher speeds along corridors with grade-separated intersections, and motorists experience no delay due to train crossings.

Benefits and Costs

As an example, the conversion of an at-grade crossing to a grade separated crossing in Austin (due to a high number of fatal collisions) not only eliminated the accident potential, but was estimated to save 28,000 vehicle hours of delay annually. Although the cost of the project was approximately $2.6 million, the project provides an estimated delay reduction benefit of more than $400,000 per year (1). In general, the costs associated with street grade separations are $2 to $6 million per intersection (2).

Implementation Issues

Although grade separation of streets can be costly, dramatic reductions in motorist delay and reduced accident potential can be achieved. The difficulty in finding intersections where land and public approval can be obtained to develop grade separations can be addressed by acquiring more right-of-way for new street corridors, and by targeting especially significant problems in built-up areas. This technique was used in Houston during the 1980s and 1990s by developing a rail-highway intersection priority list; this process should be re-examined and funding targeted for corridors near high-volume railroad lines.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.

2. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.

Geometric Design

Implementation
Hurdles: None
Level: Area
Sector: Public
Locations: All

Description

The purpose of geometric design standards for roadways is to provide for safe, efficient, and economical movement of traffic. Design principles taking driver behavior and vehicle/traffic stream performance into account have evolved over the years. The American Association of State Highway and Transportation Officials (AASHTO) has been responsible for developing much of today's design standards. Some of the major areas of geometric design are locational design, alignment design, cross-section design, and access design.

Target Market

The process of selecting the location of a new facility involves input from many groups including engineers, planners, economists, ecologists, sociologists, and politicians as well as the general public. This process considers the location of the roadway from the standpoint of user benefits and economy, but also takes into consideration social, economic (potential for development/redevelopment) and environmental impacts. The actual design of roadways is based on design criteria such as vehicle characteristics (classifications of vehicles, minimum turning radii), vehicle performance (accelerating/decelerating characteristics of vehicle classifications), driver performance characteristics (information handling capabilities, perception/reaction time, and other human factors), and traffic characteristics (traffic volumes, percentage heavy vehicles, design speed).

The elements of roadway design include stopping sight distance, horizontal or vertical alignment, cross-section, and roadside design. Designing for stopping sight distance at every point on a facility with respect to horizontal and vertical alignment provides drivers traveling at the design speed of the facility enough distance to come to a stop if necessary based on such factors as driver perception reaction time, vehicle operating characteristics, pavement conditions, etc. Horizontal alignment elements include degree of curvature and cross-slope to provide for adequate drainage and reduced centrifugal forces in curves. Vertical alignment elements include type of curve (over a hill or in a valley), degree of slope, and length of slope. The vertical design of a facility will determine if provision of climbing lanes or emergency escape ramps are warranted in rural areas.

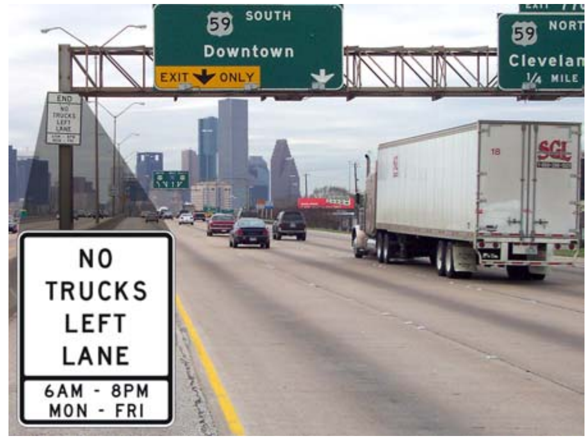
Cross-section design elements include the paved surface, roadside area, traffic separation devices, and provision of bicycle and pedestrian facilities. The design of the paved surfaces includes determining the type of pavement needed to support estimated traffic loads (asphalt or concrete), the number of lanes required to accommodate estimated volumes, the width of the lanes, and type and width of shoulders/curbs. Shoulders are typically used on high-speed facilities, while curbs may be used on lower speed facilities. Shoulders provide a location for vehicle recovery/evasive action, storage for vehicle breakdowns, improved horizontal sight distance, and improved capacity. Curbs are used to provide drainage control, pavement edge/sidewalk delineation, right-of-way reduction, and aesthetics. Roadside area design includes features such as side slopes, horizontal clearance to obstructions, medians, and drainage ditch design. Medians provide for the separation of opposing traffic flows, while traffic separation devices including longitudinal traffic barriers, median barriers, and crash cushions serve to decelerate and redirect errant vehicles from oncoming vehicles or the roadside.

Implementation Issues

Using accepted design standards and principles in the design of roadways will produce higher capacity facilities with improved safety. Studies have shown that substandard design elements such as lanes less than the standard 12 foot width, lateral clearances to obstructions of less than six feet, substandard horizontal/vertical alignment, and inadequate weaving areas result in reduced facility capacity (1). Existing facilities can be upgraded through improvements such as increasing lane width, increasing the lateral clearance to obstructions, straightening alignments, etc., resulting in improved capacity and safety.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997

Managed Lanes/Truck Lanes



Implementation

Hurdles:	All
Level:	Target Markets
Sector:	Public
Locations:	Routes

Description

The term managed lanes has recently been used to allow for a more flexible definition of how a lane or group of lanes may operate. The term "managed" implies that the lanes operate under some set of restrictions; however, the restrictions or purpose of the lanes may be varied over time to meet changing needs. One focus of the managed lane concept is to design as much flexibility into the lanes to allow for future changes in the way the lanes are operated. Some of the impetus for the managed lane concept has been the evolution of some high-occupancy vehicle (HOV) lanes to high occupancy toll (HOT) lanes. While each project is typically designed with an initial operating scenario, design considerations for new facilities using the managed lane concept would include assessing the requirements and feasibility of operating the facility in the future as a bus facility, a truck facility, an HOV facility, a tolled facility, or a facility for a combination of users. The provision for heavy vehicle operations (buses and/or trucks), occupancy requirements, tolling capability, and enforcement abilities all affect the design. User combinations or restrictions may be implemented on either a full-time basis or a time of day basis.

Target Market

Statewide truck restrictions in Michigan restrict trucks to the right two lanes on roadways with three or more lanes. The implementation was thought to be politically motivated and no studies have been conducted to determine the impact of the restrictions. Trucks have been restricted to the right lane(s) in Georgia except to pass or make a left hand exit. Prior to the restriction, trucks often occupied all freeway lanes prohibiting passing. Truck restrictions were imposed on the Maryland Capital Beltway. Public opinion favors the restrictions; however, the safety impact has not been determined. Truck restrictions were implemented in Illinois in 1964; public support and better operations were cited.

Benefits and Costs

A six-month trial of time of day truck lane restrictions was conducted on I-95 in Broward County, Florida in 1988. The hours of the truck lane restrictions were 7 AM to 7 PM. A review of accidents during the study period showed that overall accidents increased 6.3 percent during the restriction time period, but truck accidents declined 3.3 percent. Four studies have been conducted to assess the impact of truck lane restrictions on the Virginia Capital Beltway. One study was conducted over a two year period, while three other studies were conducted over one year periods. Public and political opinion favor the continuance of the restrictions; however engineering studies recommended removal of the restrictions due to a 13.8 percent increase in accident rate (1).

Implementation Issues

A 1986 FHWA survey of 26 states with truck lane restrictions showed that common reasons for implementation were to improve highway operations (14 states), reduce accidents (8 states), pavement and structural considerations (7 states), and locations with construction zones (5 states) (2). Some of the limitations associated with imposing truck lane restrictions are that they are difficult to enforce, could accelerate pavement deterioration, could increase merging conflicts, and could have limited application in areas with freeway to freeway interchanges due to "must exit" lanes on the side of the mainlanes. In some cases, truck lane restrictions have been implemented with little effort to evaluate their impact.

1. Middleton, D., Fitzpatrick, K., Jasek, D., and Woods, D. Truck Accident Countermeasures on Urban Freeways, Research Report FHWA-RD-92-059, FHWA, U.S. Department of Transportation, Washington D.C., May 1994.
2. Effects of Lane Restrictions for Trucks. Draft Report, FHWA, U.S. Department of Transportation, Washington D.C., June 1986.

New Streets in New Developments

Description

A functional hierarchy is used in street classification. Major thoroughfares that provide mobility to large volumes of vehicles are arterials. Smaller streets that provide access to houses and shops are collectors and locals. Arterials can further be subdivided into classifications of major arterials and minor arterials.

Implementation

Hurdles:	All
Level:	Target Markets
Sector:	Private & Public
Locations:	Sites

Target Market

Urban major arterials make up a small percentage of any street system, but serve the highest non-freeway traffic volume corridors. Major activity centers, universities, shopping centers, and special event centers are examples of locations serviced by major arterials. Mobility is provided by the number of lanes and the type of users on the facility and enhanced by the limited access points. Major arterials only make up 5 percent of total street mileage, but carry approximately 50 percent of total traffic volumes. Minor urban arterials connect the major arterials with the collector system. Minor arterials provide slightly less mobility than major arterials, but provide slightly greater access. Minor arterials make up approximately 10 percent of total street mileage and carry approximately 25 percent of traffic volumes.

Collector streets provide mobility around residential, commercial, and industrial areas as well as some land access. Collectors make up a relatively small portion of the total street mileage and operate at lower speeds than arterials. Collector streets connect the arterial street system with the local street system. Collector streets make up approximately10 percent of total street mileage and carry about five percent of traffic volumes. Local streets make up the majority of total street mileage of a city, but serve small volumes of vehicles at slow speeds. Local streets provide low levels of mobility but provide high levels of direct access to residential, commercial, and industrial facilities. Local streets make up approximately 75 percent of total street mileage and carry approximately 20 percent of total traffic volumes.

Implementation Issues

Mobility can be provided in new areas by a street system using the correct mix of functional streets. The function classification of streets is similar to the branching network of a tree. Major arterials provide high levels of capacity to serve high volumes of vehicles at high speeds with very limited access. Each classification down from major arterials (minor arterial, collector, and local) provide successively lower levels of mobility as capacities and speeds become successively lower, but provide successively higher levels of access. Other strategies such as geometric design, urban design elements, intersection improvements, and arterial access management help maximize the mobility of new street systems.

HOV Lanes

Description

HOV lanes are exclusive roadways or lanes designated for high occupancy vehicles, such as buses, vanpools, and carpools. The facilities may operate as HOV lanes full time or only during the peak periods. HOV lanes typically require minimum vehicle occupancy of two or more persons. However, in some locations such as the Katy or Northwest Freeways, occupancy requirements have been raised to preserve the high speeds on the facility. Support facilities such as park and ride lots and transit centers with direct access to the HOV lane are important system elements to increase facility use. HOV lanes may also be used to provide bypass lanes on entrance ramps with ramp meter signals.

Implementation

Hurdles:	Public
Level:	Target Markets
Sector:	Public
Locations:	Routes

Several common types of HOV lanes are barrier separated, concurrent flow, and contra flow lanes.

- Barrier-separated lanes like those that carry more than 87,000 persons daily in Houston are typically constructed in the center of the freeway and physically separated from the general-purpose lanes with concrete barriers. Single lane facilities operate as reversible lanes, flowing in one direction during the morning period and the other direction in the evening period. Multiple lane facilities may either be operated as two-way facilities or reversible facilities.
- Concurrent flow HOV lanes (commonly the inside lane) operate in the same direction of flow as the general-purpose lanes and are usually separated from the general-purpose lanes by a small buffer and wide paint stripe. Dallas' 4 concurrent flow HOV lanes carry more than 88,000 persons each day.
- Contra flow lanes make use of the inside off-peak direction general-purpose lane during the peak period. Movable concrete barriers are used on several facilities around the U.S. including one in Dallas that carries more than 18,000 persons daily. Houston's I-45 contraflow lane, now replaced by a barrier-separated HOV lane, was a pioneer in the late-1970s—plastic posts were the only available separation technique at that time.

Target Market

HOV lanes increase the overall person carrying capacity in a corridor, improve transit service and reliability, and encourage carpool/vanpool formation and bus usage. During the peak rush hours, the six HOV lanes in Houston move the same number of persons as 10 general purpose freeway lanes in each peak direction, equaling 20 lanes of freeway. Successful HOV lanes work best in congested corridors serving major activity centers. The combination of high person demand and slow speeds on the general purpose lanes make buses and carpools more attractive travel options. When combined with parking cost, stress levels, unreliable trip times incurred by solo drivers, HOV lanes can be very successful improvements. Transit usage in Houston corridors with HOV lanes has grown more rapidly than those without HOV lanes. After the implementation of the I-64 HOV lane in Hampton Roads, Virginia in 1992, the freeway experienced an increase of approximately 3,000 person trips with a reduction of over 700 vehicle trips per day (1).

Benefits and Costs

HOV lanes provide significant benefits to transit service. Peak hour bus operating speeds on Houston HOV corridors have increased from 26 mph prior to the HOV lanes to 54 mph with the HOV lanes. The reduction of travel time is estimated to have reduced the required operating time by 31,000 hours and result in a savings of approximately $4.8 million annually. Similar travel time reductions were seen in Pittsburgh on the East Busway where travel times were reduced by 40-50 percent. In Ottawa, Ontario, the transit authority estimates that the busway system has saved the cost of buying 220 regular buses and 40 articulated buses to provide comparable service without the busway system (1).

Studies have shown that HOV lanes increase carpool and transit usage. Of the persons using the I-10 Katy Freeway HOV lane in Houston, 36 percent of carpoolers and 36 percent of bus riders previously drove alone. On the I-395 HOV lane in Northern Virginia, approximately 23 percent of carpoolers and 49 percent of bus riders previously drove alone. On the I-10 San Bernardino HOV lane in Los Angeles, 46 percent of carpoolers and 50 percent of bus riders previously drove alone. On the I-45 HOV Lane in Houston, approximately 39 percent of carpoolers and 39 percent of bus riders previously drove alone (1).

The costs associated with the implementation of HOV lanes are largely dependent on the type of facility. Contraflow lanes cost approximately $3 million per lane mile and can be constructed in 1 to 2 years. Concurrent flow lanes cost approximately $1 to $2 million per lane mile and require 1 to 3 years, depending on the amount of construction. Barrier separated lanes constructed in the center of freeways cost $4 to $6 million per lane mile, while HOV facilities constructed on their own right-of-way can cost $7 to $8 million per lane mile. These are significant projects requiring 2 to 4 years of construction. Additional costs associated with HOV lane systems include construction of support facilities and operations and enforcement costs (2).

The capital costs for constructing the barrier-separated Houston HOV lane system were approximately $8.5 million per mile, including $2.8 million per mile for park and ride lots, park and pool lots, and transit centers, and $300,000 per mile for surveillance, communication, and control systems. Annual costs for operating the Houston HOV lane system are $675,000 ($1995), while annual enforcement costs are $625,000 ($1995). These costs correlate to an average of approximately $260,000 for operations and enforcement per HOV facility per year. Annual operations costs for the movable concrete barrier system used on the East R.L. Thornton HOV lane in Dallas were approximately $600,000, almost equal to the operations costs for the entire 5 corridor Houston HOV system in 1995. Benefit/cost analyses for the Houston and Dallas HOV lanes have yielded results of 8:1 to 48:1, with all cases exceeding the benefit/cost ratio of alternatives with additional mainlanes (3).

Implementation Issues

The primary implementation issue is cost, including costs for the HOV lane, park and ride lots, communication and control systems, and operations and enforcement. Secondary issues involve design considerations when retrofitting existing roads. In both cases, the issues involve federal, state, and local responsibilities.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.
2. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.
3. Henk, R., Morris, D., and Christiansen, D. An Evaluation of High-Occupancy Vehicle Lanes in Texas, 1995. Research Report FHWA/TX-97/1353-4, Texas Transportation Institute, Texas A&M University, College Station, TX, October 1996.

Multimodal Transportation Corridor

Description

A relatively new concept in transportation facility design is the multimodal transportation corridor. Historically, freeways were developed in corridors to provide high volume movement. The concept of a multimodal transportation corridor is that freeways alone may not be the best solution in a given corridor to provide high person movement capacity. Other facilities that may be incorporated into corridor capacity include light rail and designated lanes for buses only, buses or carpools only, trucks only, toll facilities, or combinations of these, in addition to the general-purpose lanes. Transportation demand management strategies may also be considered as part of this process.

Implementation

Hurdles:	Public
Level:	Target Markets
Sector:	Public
Locations:	Routes

Target Market

Multimodal planning requires involvement by a number of constituencies, often including a department of transportation, area transit authority, metropolitan planning organization, community officials and agencies, and various advocacy groups. Advocacy groups may include environmental groups, employers and developers, business associations, etc. Relatively few projects have incorporated the multimodal transportation corridor concept into the preliminary design process. Florida is one of the first states to mandate multimodal transportation corridor design for urban areas with populations over 200,000 persons. Corridors will provide a maximum of six general purpose lanes, four managed lanes, and have a provision for a light rail system to handle future person demand in excess of the capacity of the freeway/managed lane system (1).

Benefits and Costs

Benefits that could be provided from this concept include increased capacity and safety, reduced congestion and travel times, economic development, and environmental quality. The combination of design elements that work best is dependent on the needs and resources of individual communities. The capacity to move large numbers of people is ideal for serving major activity centers. The corridor would be combined with a number of other strategies such as ridesharing programs, parking policies and targeted infrastructure investment.

Implementation Issues

During planning stages of the reconstruction of the I-15 corridor in Salt Lake City, the multimodal alternatives considered with respect to cost and person movement included no build, improved bus service, improved bus service + one highway lane, improved bus service + two highway lanes, reversible HOV lanes, two-way HOV lanes, light rail transit on two tracks, light rail transit on four tracks, light rail transit on two tracks + two highway lanes, or light rail on four tracks + one highway lane. The Maryland Department of Transportation worked with over 50 individual groups during the planning process for the US-301 reconstruction project. The process took a number of years to complete, but resulted in a plan that achieved consensus and resulted in the provision of both highway and transit elements.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.

Freight Rail Improvements

Implementation
Hurdles: Local
Level: Target Markets
Sector: Private
Locations: Routes

Description

The presence of highway-rail grade crossings has significant impacts on both rail and automotive traffic. Highway-rail interactions pose accident hazards and operational problems in addition to the safety concern of rail and automotive passengers. Trains blocking intersections during peak periods can result in long queues that may impede flow on surrounding roadways. The resulting queues have a negative impact on vehicle flow, transit service, and emergency vehicle operations. Traffic management of freeway incidents by diversion can be severely impaired by trains crossing a diversion route. Train movement information is still difficult to get at traffic management centers due to communication system differences; these are being worked on but it remains a significant obstacle.

Advancements in technology being used by the railroad industry may also benefit passenger vehicle operations. Identification of railroad cars is accomplished through electronic equipment identification systems utilizing railcar-mounted transponders, railside antenna readers, and computer systems. These systems are equivalent to the automatic vehicle identification systems used by toll roads. Positive train separation uses satellite-based positioning systems to track train location and prevent collisions. Several railroads have developed network operation centers (NOCs). These centers are capable of managing the entire fleet of trains and tracking maintenance vehicles from a central location. Functions of the centers include planning, controlling, and monitoring the flow of trains in the network to optimize service and minimize cost, managing the assignment of locomotives to trains, and providing crew and road operations management.

Other applications of technology to enhance safety and operations are being studied. Railroad crossing monitoring systems could use readers alongside rail lines to determine the position, identification, length, and speeds of trains. This information could be used in conjunction with various information and traffic management strategies. Examples include the placement and operation of dynamic message signs on arterial approaches to at-grade crossings, notifying emergency services of train locations to enable route planning that minimizes response times and notifying transit services to enable changes in scheduling and routing of buses. This information could also be used in conjunction with “smart” intersection controllers that can implement signal timing plans and phase sequences to optimize flow during train crossings.

Operation Respond is a research project designed to improve emergency response to train accidents with hazardous cargo. Software was designed for the program to allow emergency services (police, fire) dispatchers the ability to dial into railroad data centers and access railroad databases to access information on train content and cargo handling. This information can then be relayed to responding personnel to increase the safety and efficiency of the response in much the same way as transit, freeway, and street traffic management centers operate.

Benefits and Costs

Separating highway-rail grade crossings has many benefits with respect to vehicle and rail operations and safety. Potential accidents are eliminated, freight trains are able to travel at higher speeds along corridors with grade separated intersections, and motorists experience no delay due to train crossings. The conversion of an at-grade crossing to a grade separated crossing in Austin not only eliminated the accident potential, but is estimated to save 28,000 vehicle-hours of delay annually. Although the cost of the project was approximately $2.6 million, the project provides a benefit of approximately $435,000 per year in delay savings savings (1).

Implementation Issues

Cost is the major implementation issue to be considered and is, in most cases, a shared responsibility between federal, state, and local governments. Safety issues require close cooperation and involvement with the rail industry.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.

Bus Rapid Transit

Implementation
Hurdles: Public
Level: Target Markets
Sector: Public
Locations: Routes

Description

Bus Rapid Transit (BRT) refers to a bus-based system with a separate right-of-way for at least a part of its route. BRT is designed to improve transit travel times, service reliability, and customer convenience and, ultimately, to improve transit ridership. BRT is based on rail transit principles, but instead of the required investment in trains and track, it uses buses and some exclusive facilities integrated with key components of the roadway system. BRT can be characterized by one or more of the following features: exclusive right-of-way at key congestion points or over line-haul segments; improved travel times and service reliability through signal prioritization, bus pull-outs, and automated vehicle location systems that allow real time dispatching; advanced bus technology, which could include quick access, low-floor or multiple door buses to speed boardings and alightings or clean fuel, quick propulsion technologies; faster fare collection to speed boardings, either through the use of prepaid fares or stations designed to separate fare collection from boarding; fewer stops than traditional local transit service, but potentially more stops than park and ride transit; and increased service frequency.

BRT can be applied along an existing freeway through construction of an exclusive bus lane or in combination with high occupancy vehicle (HOV) lanes. There is currently no exclusive busway in North America in a freeway right-of-way. There are, however, many examples of BRT/HOV combinations within freeway right-of-ways, including Houston (North, Northwest, Katy, Southwest, and Gulf Transitways), Washington, D.C. (Shirley Highway and I-66), and Los Angeles (El Monte). These BRT/HOV lanes are used by buses, vanpools, and carpools (of differing occupancy requirements).

BRT can also be built on a separate and exclusive right-of-way, such as a railroad right-of-way. Examples of BRT on a separate and exclusive right-of-way include the busways in Ottawa and Pittsburgh. These busways are used only by buses; vanpools and carpools are not allowed.

Finally, BRT can be built within, along, or even under arterial streets. An arterial street application can range from dedicated lanes of a street (e.g., Lymmo, Orlando's new downtown circulator system or the extensive system in Curitiba, Brazil) to an exclusive bus tunnel (e.g., Seattle).

Off-line BRT bus stops are designed to be away from the busway or HOV lane, and stops are made at off-line, adjacent transit centers or bus stops. The primary advantages of off-line BRT bus stops are provisions for express bus movements when stops are not requested and the feasibility of usage by carpools and vanpools without introducing conflicts with stopping buses.

The primary disadvantages of off-line bus stops are delay to bus riders from the time it takes to exit the busway or HOV lane to reach an off-line station and the space requirements of the off-line stations. The minimum cross-section required (not counting space for off-line stations) would be 36-40 feet. Off-line bus stops are provided for BRT/HOV transitways in Houston and for an exclusive busway in Pittsburgh.

On-line BRT bus stops are located immediately adjacent to the busway, similar to rail stations. Buses stop on the busway for boarding and alighting, and buses cannot pass one another. The primary advantages of on-line BRT stops are minimal delays from stops and minimal right-of-way requirements. The primary disadvantages of the on-line BRT stops are inability of buses to pass one another and infeasibility of allowing use by carpools or vanpools. The minimum cross-section required between stations would be the same as for off-line busways (36 to 40 feet) but a 60 to 70 foot cross-section would be required at stations. On-line bus stops are provided in the Seattle bus tunnel and throughout the Curitiba system.

On-line BRT bus stops with bypass lanes are located immediately adjacent to the busway. Buses stop on the busway for boarding and alighting, but bypass lanes around the stations allow other buses to pass nonstop. On-line BRT bus stops with bypass lanes combine the advantages of the off-line and on-line stations but require additional right-of-way and capital investment to build. Again, between stations, a minimum cross-section of 36 to 40 is required, but the cross section would increase to 60 to 85 feet at stations. On-line bus stops with bypass lanes are provided on the Ottawa busway.

Target Market

The target markets for BRT are congested corridors where transit is already firmly established. The trips carried on BRT are predominantly work trips, since these trips take place during the most congested periods.

Benefits and Costs

The benefits and costs of a BRT system are similar to that of various types of HOV systems. These benefits and costs are discussed in more detail in the HOV lane section of this toolbox. BRT provides significant benefits to transit service, increasing peak hour bus operating speeds similar to HOV applications (see later section). The reduction of travel time provides an incentive for transit use and reduced transit operating costs.

The costs associated with the implementation of BRT are largely dependent on the type of facility. Barrier separated lanes in the center of freeways cost $4 to $6 million per lane mile to build, while BRT facilities in their own right-of-way can cost $7 to $8 million per lane mile to build (including right-of-way costs). These are significant projects requiring 2 to 4 years of construction (1).

The capital costs for constructing the barrier-separated Houston HOV lane system were approximately $8.5 million per mile, including $2.8 million per mile for park and ride lots, park and pool lots, and transit centers, and $300,000 per mile for surveillance, communication, and control equipment. Annual costs for operating the Houston HOV lane system are $675,000 ($1995), while annual enforcement costs are $625,000 ($1995). These costs correlate to an average of approximately $260,000 for operations and enforcement per HOV facility per year (2).

Implementation Issues

If existing HOV lanes and off-line BRT bus stops are used, there are few significant cost issues involved. Implementation issues are primarily associated with bus/line management. Additional BRT lines may well require the addition of new stops and/or new HOV lanes that would involve potentially significant costs. In the later case, federal and state, in addition to local funds, could be involved.

1. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.

2. Henk, R., Morris, D., and Christiansen, D. An Evaluation of High-Occupancy Vehicle Lanes in Texas, 1995. Research Report FHWA/TX-97/1353-4, Texas Transportation Institute, Texas A&M University, College Station, TX, October 1996.

Heavy Rail

Implementation
Hurdles: Public
Level: Target Markets
Sector: Public
Locations: Routes

Description

Heavy rail systems are most suitable for corridors with high-density office developments and some medium density residential high-density areas with a high level of nonresidential development. Heavy rail systems provide high speed/high capacity service, but at a high cost due to the required exclusive right-of-way (with no at-grade crossings) and high cost of vehicles. Long trains of six to ten cars, third rail power supply, high passenger loading platforms, high degree of automation, and sophisticated signaling are all associated with heavy rail. The capacity of heavy rail train lines is a function of car size, seating arrangements, door configuration, number of cars in the train, number of allowable standees, and minimum headways. Minimum headways are dependent on dwell times at stations, train lengths, acceleration and deceleration rates, train control systems, and track arrangements. A number of systems around the world operate up to 30 trains per hour during peak periods with headways of two to three minutes moving 15,000 to 80,000 passengers per hour in the peak direction (1). In general, costs associated with development of heavy rail transit are approximately $80 to $100 million per mile (2).

Target Market

Historically, heavy rail systems have been implemented in high-density urban areas where both origins and destinations can be served Policies and programs to increase the population and employment in the areas immediately adjacent to rail stations are also important to encouraging walk trips to/from the rail stations.

1. Transportation Planning Handbook, Institute of Transportation Engineers, Washington D.C., 1992.

2. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.

Commuter Rail

Source: Dallas Area Rapid Transit

Implementation
Hurdles:	Public
Level:	Target Markets
Sector:	Public
Locations:	Routes

Description

Commuter rail systems generally operate between suburban areas and urban centers providing high-speed service between stations with single or multiple car passenger trains. Because commuter rail typically uses existing rail right-of-ways—either with the construction of new tracks adjacent to the freight rail tracks or by upgrading the freight rail tracks—it is can be less costly and faster to implement than rail systems requiring new or exclusive right-of-way.

Commuter rail service is most common in high-volume congested corridors, operating for many years in large cities in the Northeast and Midwest U.S. and in Canada. More recent commuter rail operations have begun in California, Texas, Florida, and Washington. In general, costs associated with the development of commuter rail transit are approximately $5 to $10 million per mile (1).

The Trinity Express commuter rail services the 27-mile line between Union Station in Downtown Dallas and Richland Hills in northeast Tarrant County with stops at five intermediate stations. An extension of the line into downtown Ft. Worth is scheduled to open in Fall 2001. Service from Union Station to Richland Hills is available during peak periods only Monday through Friday, while service from Union Station to DFW Airport is available Monday through Saturday from 6 AM to 11:30 PM. Travel from Union Station to Richland Hills takes approximately 45 minutes, while travel from Union Station to DFW Airport takes approximately 30 minutes. The Trinity Express operates on approximately 30 minute headways between Union Station and DFW Airport on weekdays and one hour headways on Saturdays. Trinity Express tickets may be used for free transfers to bus, light rail, or DFW Airport shuttles. Customers may park for free at several Trinity Express stations or any of the DART light rail stations then transfer free to the Trinity Express. The Trinity Express uses both self-propelled diesel rail cars and double decked passenger coaches powered by locomotives.

Target Market

A number of comparisons have been made between the characteristics associated with cities with light rail systems and those with commuter rail. Most of these differences can be explained by the differences in developments and travel markets that they serve. Commuter rail travel times are 50 percent greater and distances 200 percent longer than those with light rail. The average spacing of stations is approximately two miles for commuter rail and a half-mile for light rail. Approximately 90 percent of commuter rail stations have significant parking, while only one-third of light rail stations have significant parking. The population density within two miles of commuter rail station is 1.8 persons per acre, while the density around light rail stations is 4.5 persons per acre (2).

In locations where commuter rail is being implemented in lower density areas, it is important to have adequate support facilities such as park and ride lots and bus service to and from rail stations.

1. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.

2. Parsons Brinckerhoff Quade and Douglas. Transit and Urban Form, Transit Cooperative Research Program Report 16, Transportation Research Board, Washington D.C., August 1996.

HOUSTON'S TRAVEL RATE IMPROVEMENT PROGRAM

"TOOLBOX" OF IMPROVEMENT STRATEGIES

CHANGE THE URBAN SCHEME

Prepared for
Greater Houston Partnership

Prepared by
Texas Transportation Institute
The Texas A&M University System

April 2001

CHANGE THE URBAN SCHEME

Transportation systems and land use patterns are linked and influence each other. Modifying the way that shops, offices, homes, schools, medical facilities and other land uses are arranged have a significant effect on the traffic volume that is generated. The techniques listed in this section are usually much more effective at reducing the rate of vehicle use if several of them are enacted together.

Not many neighborhoods, office parks, etc. will be developed for auto-free characteristics—that is not the goal of these treatments. The idea is that some characteristics can be incorporated into new developments so that new economic development does not generate the same amount of traffic volume as existing developments.

The “tools” included in this category are:

- Arterial Street Access Management
- Light Rail
- Diverse Development Patterns
- Assessing the Transportation Impacts
- Parking Strategies
- Bicycle and Pedestrian Elements

Arterial Street Access Management

Description

Arterial access management increases mobility and safety by controlling the spacing, location, and design of driveways; medians and median openings; intersections; and traffic signals. Elements of access management include physically restricting left turns, restricting direct access driveways (in favor of shared driveways), separating obvious conflict areas, eliminating on-street parking, locating intersections at regular intervals, and constructing frontage roads to collect local business traffic and distribute it to nearby intersections.

Target Market

Implementation

Hurdles:	Local & Public
Level:	Target Markets
Sector:	Both
Locations:	Sites

Studies have shown a direct relationship between the number of driveways per mile with the number of accidents per mile. Better management of arterial access not only increases arterial and intersection capacity and reduces congestion and conflicting maneuvers, but also greatly increases safety. Some agencies incorporate access management issues into land use development policies. Regulations may include restrictions on driveway spacing, sight distance, and corner clearance; increasing minimum lot frontage along thoroughfares; minimizing commercial strip zoning and promoting mixed land use. An aspect commonly associated with access management strategies is the potential for negative impacts on some types of business. Businesses that depend on pass-by traffic, such as gas stations, convenience stores, and fast food stores, are most susceptible to decreased sales due to reductions in access. Studies by the Florida Department of Transportation have shown that the capacity of a four-lane arterial can be increased nearly 50% by providing access control measures (1).

Corner clearances are the minimum distances that driveways can be constructed either upstream or downstream of a nearby intersection. Inadequate corner clearance can result in operational, safety, and capacity problems such as higher accident rates, through movements being blocked by vehicles turning into or out of a driveway, backups from far side driveways into the intersection, insufficient weaving distances, and reduced intersection capacity. Colorado policy does not allow driveways within a 325-foot clearance zone from the intersection. More common practices are to require corner clearances in the 100 to 200 foot range. Mitigating actions where inadequate corner clearances exist include locating driveways at the farthest edge of the property from the intersection, consolidating driveways for multiple properties, closing driveways on the principal road and requiring access on the secondary road, and installing raised median barriers to prevent left turns into or out of the driveway.

Benefits and Costs

Traffic signal spacing on arterials has an impact on accident rates, delay, and travel speeds. Colorado and Florida require ½ mile signal spacing on principal arterials. Studies have shown that accident rates are approximately 40 percent higher when signals are spaced at ¼ mile intervals as opposed to ½ mile intervals. Closely or irregularly spaced signals effect the efficiency of progression on the arterial. Signals spaced at ¼ mile intervals can provide progression at speeds of 26 to 30 mph with 60 to 70 sec cycle lengths, whereas ½ mile signal spacing can provide progression at speeds of up to 45 mph with 80 to 120 sec cycle lengths. The spacing of driveways on arterials produces similar results—the closer the spacing the higher the accident rate and the slower the travel speed.

Turn restrictions are commonly implemented to reduce accident frequency at a location. Accidents at four intersections in San Francisco dropped 38 to 52 percent after turn restrictions were implemented. The use of a continuous raised median to restrict left turns between intersections in Wichita, Kansas resulted in a reduction in accidents of 43 to 69 percent (2). The cost of implementing left turn restrictions on two-way streets are approximately $400 per intersection. The cost of implementing continuous raised median strip to restrict left turns is approximately $2,000 per block (3). Channelization at intersections may be used to provide positive separation of conflicting movements, control the angle of conflicts, reduce excessive pavement areas, control speed, provide pedestrian refuge, protect turn bay storage areas, block prohibited movements, and protect traffic control devices.

Two-way left turn lanes and raised medians (to a greater extent) are median treatments that can reduce accident rates and increase vehicle speeds on undivided arterials. Two-way left turn lanes allow separation of left turns improving flow in the through lanes. Raised medians provide positive separation of opposing vehicle movements and eliminate left turns resulting in fewer conflicts, greater safety, and more uniform arterial speeds. As raised medians will transfer turning volumes to intersections and median breaks, adequate storage should be provided to keep turning vehicles from interfering with through operations. Costs for implementing a two-way left turn lane or raised median include the cost of providing an extra lane as well as approximately $25,000 per mile in incremental costs for two-way left turn lanes and an additional $210,000 per mile to convert two-way left turn lanes to raised medians. The conversion of a two way left turn lane to a raised median has been shown to provide a benefit/cost ratio of 4:1.

Implementation Issues

The spacing, location, and design of driveways; medians and median openings; intersections; and traffic signals as well as restricting left turns, separating obvious conflict areas, eliminating on-street parking, locating intersections at regular intervals, and constructing frontage roads to collect local business traffic and distribute it to nearby intersections are all governed through subdivision regulations, development standards and regulations, in some cases, street design standards. Writing, adopting, and enforcing such regulations and standards are public-sector functions.

1. Sokolow, G. Access Management and Its Role in Congestion Management, Florida Department of Transportation, presented at RA/International Conference Centre Amsterdam, The Netherlands, April 1992.

2. Traffic Engineering Handbook, Institute of Transportation Engineers, Washington D.C., 1992.

3. Transportation Control Measure Information Documents, Environmental Protection Agency, Washington D.C., 1991.

Light Rail

Implementation
Hurdles: Public
Level: Target Markets
Sector: Public
Locations: Routes

Description

Light rail systems are capable of operating either in exclusive rights of way or within shared rights of way on city streets. Light rail systems typically draw power from overhead wires, are driven manually, and can load passengers from low level platforms. Car and train sizes, operating headways, and passenger loading rates determine the capacity of a light rail system but it is typically less than heavy rail systems. Most light rail trains consist of a maximum of three cars when used on-street. Longer trains would interfere with street operations on short blocks, would require longer clearances to clear at-grade intersections, and require longer station platforms. Loading rates are a function of the number of doors, platform heights, and the fare collection process. Prepayment systems greatly reduce the amount of time required to handle fare collection in comparison with on-board payment, thus allowing for shorter headways. Headways of less than one minute can be achieved with on-street single car trains known as streetcars. In general, costs associated with development of light rail transit are approximately $20 to $30 million per mile (1)

The Dallas Area Rapid Transit (DART) light rail system is comprised of 20 miles of track linking 20 stations with one route extending north of downtown Dallas and two routes extending south of Dallas. Future plans call for an extension of the system on all routes to a total of 93 miles of light rail. Trip, day, and monthly passes are all purchased through ticket vending machines. Tickets are not collected on board, but uniformed fare inspectors make random checks. The light rail system operates seven days a week from 5:30 AM to 12:30 AM with five to ten minute headways during peak hours (6 to 9 AM and 3 to 6 PM) and 10 to 20 minute headways during off peak hours. Rail tickets may be used for free transfers to and from buses. Several projects are underway to create mixed-use facilities (commercial, residential, and entertainment complexes) out of what were abandoned buildings near the rail lines.

Target Market

A number of comparisons have been made between the characteristics associated with cities with light rail systems and those with commuter rail. Most of these differences can be explained by the differences in developments and travel markets that they serve. Commuter rail travel times are 50 percent greater and distances 200 percent longer than those with light rail. The average spacing of stations is approximately two miles for commuter rail and a half-mile for light rail. Approximately 90 percent of commuter rail stations have significant parking, while only one-third of light rail stations have significant parking. The population density within two miles of commuter rail station is 1.8 persons per acre, while the density around light rail stations is 4.5 persons per acre (2).

In locations where light rail is being implemented in lower density areas, it is important to have adequate support facilities such as park and ride lots and bus service to and from rail stations. Other policies and programs like the other tools in Change the Urban Scheme can help encourage population and employment growth in the areas immediately adjacent to rail stations. This is an important aspect as it helps generate walk trips to/from the rail stations which supports the rail ridership as well as the commercial activity.

Benefits and Cost

One of the characteristics of rail is that, subsequent to the initial investment, the rail line can accommodate significant increases in demand while maintaining premium level of service, with comparatively low incremental cost. For example, when the 7.5-mile METRORail opens, the initial operating plan of one-car trains every 6 minutes in the peak can carry about 2,000 people per hour in each direction, the equivalent of about two freeway lanes. By increasing frequency of one-car trains, METRORail will have a capacity of 4,000 per hour in each direction. By adding vehicles, METRORail can run two-car trains at 3 minute headways, providing capacity to carry 8,000 people per hour in each direction. The increase in capacity, which is the equivalent of expanding from two freeway lanes to eight freeway lanes, can be achieved within the same facility by lengthening trains and increasing frequency.

The METRORail light rail line is projected to have approximately 40,000 boardings per average weekday in 2020. METRORail estimated travel time from University of Houston/Downtown to Fannin South Park and Ride lot will be 29 minutes. By comparison, bus routes #15 and #8 take 45 minutes on a weekday schedule to travel the same corridor today. Systemwide travel time savings in 2020 is estimated at over 4,000 persons per day.

As presently viewed, trains will run every 6 minutes in peak times and 12 minutes during off peak times. Light rail will replace about 1,200 bus trips per day in the corridor. Pollutant emissions and fuel consumption will be reduced.

The cost of the 7.5 mile METRORail project is $300 million, or about $40 million per mile. This includes all engineering, right-of-way, design services during construction and project management, as well as construction. Care should be exercised in comparing costs/mile to ascertain what each cost does or does not include. (One should not assume all costs are comparable.)

METRORail is forecast to stimulate significant economic development in the corridor. Additional private sector development in the range of $470 million to $892 million is expected to occur within the corridor as a result of the METRORail. The City of Houston estimated that through 2020, the additional development around the light rail station areas will generate $219 million in additional property and consumer tax revenues.

Implementation Issues

Before rail in Houston could be extended beyond the 7.5 mile METRORail line, corridor studies will need to be conducted to determine preferred modes and alignments. If the corridor studies result in a rail system plan, METRO's Board of Directors has committed that METRO will seek voter approval. METRO will need to identify funding sources and a financing plan for any sizable rail system.

1. Henk, R., Poe, C., and Lomax, T. An Assessment of Strategies for Alleviating Urban Congestion, Report FHWA-TX-2-10-90/1-1252, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1991.

2. Parsons Brinckerhoff Quade and Douglas. Transit and Urban Form, Transit Cooperative Research Program Report 16, Transportation Research Board, Washington D.C., August 1996.

Home/Work Patterns

Description

Implementation	
Hurdles:	Local & Public
Level:	Area
Sector:	Private
Locations:	All

Improvements to the transportation network without development strategies in place can often result in a cyclical process. The construction of a new facility or reconstruction of an existing facility to improve capacity increases accessibility to the area. This increase in accessibility leads to increased development and increased traffic demand. Without adequate development policy, strip development with closely spaced and poorly designed access creates numerous operational problems, resulting in increased congestion, delay, and accident potential. Further roadway improvements are then required to address the congestion developing as a result of the initial improvements. To avoid the unintended, but predictable, consequences it is necessary to change the traditional development scheme.

Target Market

Urban development strategies can seek to improve mobility, reduce vehicle travel, and reduce vehicle trips by promoting higher density development, mixed-use development, balanced development of housing in proximity to jobs to minimize long distance commutes, and incorporation of bicycle/pedestrian/transit friendly site designs into development plans. Mixed-use developments generally make walk/bicycle trips more feasible as housing, employment, and commercial centers are located in the same vicinity. Mixed-use development located within a five- to ten-minute walk of a transit facility can also support transit usage. Land-use plans could direct higher intensity development to locations well served by transit and provide access for pedestrians, bicyclists, and transit riders (1).

Benefits and Costs

Houston has recognized the benefits of targeting its development strategy. In 1992 the city implemented a Neighborhoods to Standard (NTS) program with the intent of stabilizing its older neighborhoods with an infusion of capital expenditures. The goal was to attract residents and businesses back to the inner city (2). The program focuses on improving the basic physical attributes of the neighborhood: upgrading water and wastewater service, overlaying asphalt on streets, maintaining roadside ditches, mowing right-of-ways, installing street lights and repairing traffic signs and signals.

With its initial success two complementary programs were added. The Parks and Recreation Department's Parks to Standard Program provides new jogging trails and playground equipment. The Department of Public Works and Engineering's Safe School Sidewalk Program constructs sidewalks adjacent to schools to allow children easier, safer access to schools. To date, approximately 112 of Houston's 600 neighborhoods have been completed (approximately 14 per year).

The results have been promising. In a select number of neighborhoods, property values have increased as much as 30% (3). Based on building permits and other records, the city estimates that approximately 5000 residents are returning annually to the older neighborhoods inside the

Loop, tax revenues have increased, crime is down and park attendance has increased. Houston funds the program through community development block grants, an expanded sales tax base through the city's Metropolitan Transit Authority and a series of bonds. City officials and residents view the related cost of the program relatively inexpensive given the higher cost of replacing existing infrastructure features. As a result of their efforts Houston earned the American City & County's 1996 Infrastructure Award.

A correlation exists between residential density and transit usage. The Denver Regional Transit District found that a minimum density of seven dwelling units per acre was necessary to support local bus routes operating at 30 minute headways. Transit usage was seen to triple with densities of 30 dwelling units per acre. At a density of 50 dwelling units per acre, transit usage exceeded automobile usage. Transit usage also increases significantly as employment density exceeds 50 employees per acre or in activity centers with more than 10,000 jobs (4).

A study and program known as Land Use-Transportation-Air Quality (LUTRAQ) was conducted in Washington County (suburban area of Portland, Oregon) in the early 1990s to assess the impact of urban design. Three development strategies that were seen to increase transit usage were: mixed-used development, development of sites near transit stations, and development of neighborhoods located on feeder bus lines (5). The LUTRAQ program provided for light rail, express bus service to activity centers, local feeder buses, bicycle and pedestrian improvements, and minor roadway improvements. In comparison with an alternative plan to accommodate growth solely through highway capacity increases, the LUTRAQ plan was estimated to reduce SOV work trips by approximately 22 percent; increase transit and non-motorized travel by 27 percent; reduce highway congestion by 18 percent; reduce vehicle hours of travel during the evening peak hour by 11 percent; reduce energy consumption by 8 percent; and reduce emissions (6 percent for hydrocarbons, 9 percent for nitrous oxides, and 6 percent in carbon monoxide) (6).

Implementation Issues

Programs like NTS and LUTRAQ require a partnership between the city and the community. The community provides an organizational liaison to facilitate communication with public officials and agrees to efforts such as hosting semi-monthly meetings. There are no public-sector implementation impediments present. The City of Houston, with the backing of neighborhood organizations, has begun to enforce building code violations. Private sector involvement is voluntary, but is particularly important in aspects such as redeveloping commercial areas.

There is also a significant role for these design elements and location decisions in the suburbs. While many of the studies and discussion have focused on the older neighborhoods, much of the growth will occur in areas outside these areas. If newer suburbs incorporate more of these principles, the transportation impact will be less. And if the already constructed areas change or redevelop, there are many retrofit possibilities that can improve the transportation situation without a significant amount of construction. The goal, in conceptual terms, would be to reduce the vehicle trips for some, but not all, of the person trips. Affecting those trips that could be made by other modes or at other times can reduce the peak impacts, while preserving the mobility and choice that travelers desire.

1. Harvey, G. Relation of Residential Density to VMT Per Resident: Oakland, Paper prepared for the Metropolitan Transportation Commission, Oakland, CA, 1990.

2. Neighborhoods to Standards, Mayor Bob Lanier's Transition Subcommittee, Houston, TX, June 1992.

3. Houston Neighborhoods Program Gets Top Honors, American City & Country, December, 1996.

4. Creating Livable Communities, Regional Transit District, Denver, CO, March 1996.

5. Making the Connection, A Summary of the LUTRAQ Project, 1000 Friends of Oregon, Portland, OR, February 1997.

6. An Evaluation of the Relationships Between Transit and Urban Form, Research Results Digest, Transportation Research Board, June 1995.

Assessing the Transportation Impacts

Implementation
Hurdles: Local & Public
Level: Area
Sector: Private
Locations: All

Description

Development strategies are used to characterize the spatial distribution and use of land. These patterns largely determine trip making patterns, volumes, and modal distributions. The wide availability of the automobile after World War I is largely responsible for changes in urban development patterns. Prior to the automobile, cities tended toward greater densities and less sprawl. The automobile provided higher travel speeds, convenience, and flexibility. The increase in mobility provided by the automobile contributed to an increase in separation of land use. The potential size of urban areas increased, while densities declined. As jobs and housing areas became further and further apart, average commute distances and travel times became longer and longer.

Target Market

This initiative is applicable with regard to any proposed development likely to generate transportation impacts. The transportation impact analysis can be made a part of any permitting procedure associated with development. In some areas, local officials require site designs of proposed developments to be analyzed specifically with respect to transit, pedestrian, and/or motor vehicle access. In addition, site design criteria may include elements such as office buildings located in close proximity to the street for easy pedestrian access (avoiding long walks across parking lots) or orienting building entrances towards parks, plazas, and pedestrian-oriented streets. Other design criteria that could be required include minimizing the walking distance between offices/homes and transit routes, small block sizes in business districts, sidewalks on one or both sides of the street, and bus stops with patron shelters. Street and intersection geometries can also be optimized for transit vehicles and on-street parking can be controlled in office parks to improve the competitive situation of carpools and transit.

Benefits and Costs

A study and program known as Land Use-Transportation-Air Quality (LUTRAQ) was conducted in Washington County (suburban area of Portland, Oregon) in the early 1990s to assess the impact of urban design. Three development strategies that were seen to increase transit usage were: mixed-used development, development of sites near transit stations, and development of neighborhoods located on feeder bus lines. The assessment of impacts included many of the analyses and evaluation measures that are needed to develop a full picture of the alternatives.

The LUTRAQ program provided for light rail, express bus service to activity centers, local feeder buses, bicycle and pedestrian improvements, and minor roadway improvements. In comparison with an alternative plan to accommodate growth solely through highway capacity increases, the LUTRAQ plan was estimated to reduce SOV work trips by approximately 22 percent; increase transit and non-motorized travel by 27 percent; reduce highway congestion by 18 percent; reduce vehicle hours of travel during the evening peak hour by 11 percent; reduce energy consumption by 8 percent; and reduce emissions (6 percent for hydrocarbons, 9 percent for nitrous oxides, and 6 percent in carbon monoxide) (1).

Implementation Issues

This initiative will require changes in the approach currently used to evaluate new developments. Local governments may need to adopt regulations that require transportation impact assessments regarding certain developments. The public sector, or the private sector as a part of an existing permitting process, can perform those assessments. There may be fees tied to the results, or incentives to reduce the impact on the transportation network during the most congested periods.

1. Making the Connection, A Summary of the LUTRAQ Project, 1000 Friends of Oregon, Parking Strategies. February 1997.

Parking Strategies

Description

A number of parking strategies have been conceived as potential means of reducing single occupant vehicle trips in congested activity centers and increasing transit and carpool ridership. In areas with high densities, parking fees are imposed and higher transit ridership than in lower density suburban areas where parking is typically free and transit ridership tends to be lower. The 1990 Nationwide Personal Transportation Study found that 87 percent of worktrips and 91 percent of all trips are made by automobile—parking issues are important (1).

Implementation

Hurdles:	Public
Level:	Area
Sector:	Private
Locations:	Businesses

Two strategies to increase carpool and transit usage aim to increase the price of parking through taxes based either on parking revenues or taxes based on the number of parking spaces provided regardless if a fee is charged. Both strategies could result in the cost of taxes being passed on to the consumer in the form of higher prices. Basing taxes on revenues would effect parking providers in high-density areas that realize revenue from parking. The impact of this strategy would vary depending on the level of transit service provided in affected areas and the amount of the tax. Too low of a tax would have little impact on modal shifts, while too high of a tax may cause only a short term modal shift to transit. But the high tax could, in the long term, encourage businesses to move to suburban areas where taxes would not apply, since parking is typically free. Taxes based on parking spaces would affect all business districts. However, implementation of such a tax would require new legislation in most places, unlike taxes based on revenue. A survey of 20 cities showed that ten cities impose taxes on parking revenue, but none of the cities imposed taxes on parking spaces (2).

Target Market

A strategy that can be used by employers that lease parking spaces and provide subsidized parking to employees is called cashing-out employer provided parking. Employers give employees the cash value of the parking benefit provided and employees are then free to use it however they want—for continued parking, for transit fares, etc. This strategy would primarily affect employers in the CBD, as that is where leased parking is typically located. This strategy is being implemented by individual employers in the Los Angeles area on a demonstration basis.

One set of strategies focuses on changes to zoning ordinances, by decreasing the minimum parking requirements, imposing maximum parking requirements, or issuing conditional use permits. Ordinances often specify minimum parking requirements to provide adequate parking during peak use. The result, however, is that an excess of parking often exists during non-peak periods. Reducing minimum parking requirements on developers would help bring parking supply closer to typical nonpeak needs. Another strategy is to impose parking maximums to limit the amount of parking provided by developers. Conditional use permits may be issued to allow a developer to provide less than the minimum parking requirements. The limitation of this strategy is that it would only affect new development or redevelopment – stable land use areas would not be influenced. Reducing minimum parking requirements has been implemented in Midtown Atlanta where the area is serviced by rail transit service.

Several transportation demand management strategies include satellite parking lots with shuttle service, preferential parking for carpoolers, and transit incentive programs. Satellite parking lots with shuttle service might be justified for a large employer or activity center where the cost of providing such a service is less than the cost associated with adding more on-site parking. Preferential parking involves employers providing spaces dedicated for carpool vehicles. In order to be effective, the spaces must be better than regular spaces with respect to location, security, price, or other amenities such as covered parking.

A strategy that seeks to improve the efficiency of parking operations and reduce parking related congestion is the implementation of advanced parking information systems. These systems provide drivers with real-time information on parking conditions at various parking facilities through on-street combination static/dynamic message signs. These systems direct motorists to facilities with available parking, reducing search time and unnecessary travel. Displays may be used to indicate the number of available spaces or whether the parking facility is open or full. The availability of parking spaces is determined through the use of vehicle detection systems that keep track of the number of vehicles entering and exiting the facility. Systems that may be used for vehicle detection include barrier contacts on entry/exit gates, inductive loops, ultrasonic, infra-red, microwave, laser, and machine vision sensor technologies. A telecommunications network is used to connect vehicle detection systems to a computer system, which is connected to dynamic message signs. Advanced parking information systems are common in European countries and Japan. Studies of these systems have shown decreases in illegal parking, decreases in on-street parking, and increases in off-street parking, decreases in search time, decreases in queue length and delay entering parking facilities, and more uniform use of off-street parking facilities.

Benefits and Costs

Parking incentives may be used by employers to encourage carpooling or vanpooling. Free or differential parking rates can be offered to high occupancy vehicles. An example of a parking incentive scheme is a schedule whereby an employer provides zero percent parking subsidy to employees in single occupant vehicles, 50 percent subsidy to two-person carpools, and 100 percent subsidy to carpools with three or more persons or vanpools. A study in the Washington, DC area showed a 20 to 40 percent increase in commuters that were willing to carpool where parking incentives were offered. A study of a Boston company incentive parking program showed a 34 percent increase in three person carpools when daily parking fees were eliminated for 3 person carpools. Incentive programs help employers maintain or reduce costs for leased parking or reduce the need for construction of additional parking spaces.

Implementation Issues

There are several implementation issues associated with parking strategies. If the strategy to be adopted is to assess parking taxes, the taxes (which would be passed on to consumers) must be high enough to cause commuters to consider switching transportation modes, while not high enough to cause businesses to move out of the area. Another public-sector strategy is to impose development standards that limit the number of parking spaces. Still another strategy might include preferential parking rates or special allocated spaces for vanpoolers or those ridesharing. All of the above-mentioned strategies would require policy/legislative action by the appropriate public body.

1. Vincent, M., Keyes, M., and Reed, M. NPTS Urban Travel Patterns: 1990 National Personal Transportation Survey, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management, 1994.

2. Bianco, M., Dueker, K., and Strathman, J. Parking Strategies to Attract Auto Users to Transit, Proceedings of the 77th Annual Meeting of the Transportation Research Board, Washington, D.C., 1998.

Bicycle and Pedestrian Elements

Description

Urban designs should include components such as bicycle and pedestrian facilities, policies or elements that promote bicycling and walking. Bicycle and pedestrian facilities provide a non-motorized alternative to vehicular trips. These forms of transport have historically received little consideration by the transportation community; however, they are being increasingly seen as an important part of an overall program to reduce vehicle trips. Bike and walk trips serve three primary trip purposes: as a means to make a complete origin/destination trip, as a means to connect to other modes such as public transit for longer trips, and for circulation within an activity center. The costs associated with bicycle/walking facilities (trails, lanes, storage facilities) are relatively minor in comparison with facilities for other modes of travel. In addition to providing safe and convenient access to bike/walk facilities (secure bicycle storage, marked/lighted sidewalks), other strategies such as the provision of shower facilities, guaranteed ride home program for emergencies, etc. can support and encourage bike/walk transport.

Implementation

Hurdles:	Public
Level:	Target Market
Sector:	Public
Locations:	Routes

Target Market

While bicycle and pedestrian facilities are commonly provided as parallel facilities along roadways, they may also be used to provide access across barriers where roadways do not. Examples include openings or paths to connect neighborhoods to other neighborhoods, cul-de-sacs to perimeter neighborhood streets, or neighborhoods to facilities along drainage channels or greenbelts, etc. These strategies may allow pedestrian and bicycle trips to be accomplished via much shorter distance trips than would be available by following existing roadways. These non-roadway connections make bicycle/walking trips more feasible and thus encourage non-motorized transport. Trees and landscaping can make these areas more accommodating in Houston's summer months, and lighting and open designs can increase the feeling of safety for nighttime use.

While bicycles do not make up a significant portion of total travel, they do effect operations on roadways and sidewalks. Bicyclists traveling on sidewalks interfere with pedestrians, while bicyclists on roadways are affected by cross section design, facility type, and facility operating speed. Bicycle accommodation on roadways can be categorized in one of five manners.

- With a shared lane, bicyclists are accommodated within a standard width traffic lane.
- With a wide outside lane, bicyclists are accommodated in a wider than normal outside lane, typically 14 foot wide or greater.
- Bicycle lanes officially designate a portion of the roadway cross-section using pavement markings and signing for exclusive use.
- Roadway shoulders may be used to accommodate bicyclists.

- A separate facility may be provided to physically separate bicyclists from the roadway traffic.

An education component is an important part of a bicycle facility improvement program. For bicycle facilities to be perceived as successful, they should attract bicycle riders, improve travel options, and not adversely impact vehicle congestion levels. In the early stages, bicycle volume may be low as travelers get accustomed to the idea and the system is developed as unconnected pieces. In later stages, bicycle volume may remain low relative to some vehicle user expectations. It is important to communicate what "success" looks like and emphasize the relatively small amount of road space dedicated to cycling. Plans that use separate paths and minor streets as the bicycle "backbone" can assist in the "share the road" concept between vehicles and bicycles.

Examples of bicycle facility development policies include using bikeways to provide links to serve transportation purposes, establishing a signed route network on streets suitable for bicycle use, and accommodating bicyclists on new facilities in bicycle or wide outer lanes. Off-street facilities on separate rights-of-way or separate but parallel bicycle and pedestrian off-road facilities may also be provided to reduce vehicle conflicts. Street construction using bicycle friendly elements, such as bicycle safe drainage inlet grates and smooth and swept street surfaces, also encourage bicycle use. Some agencies review accident records to determine if high accident locations can be retrofitted to improve safety,

Pedestrian facilities include sidewalks and street crossings. Sidewalks of four to six feet in width are considered appropriate in most cases with five feet being common. Widths of six feet or more may be justified on high speed/volume roadways or to handle high pedestrian volumes that occur in locations such as schools, libraries, parks, transportation terminals, high-rise buildings, event centers, parking facilities, and pedestrian overpasses. Pedestrian overpasses may be used in locations to safely handle high pedestrian volumes in the vicinity of high-speed roadways. Potential locations include near schools on major arterials, over freeways, and near park/recreational areas. The distance between the edge of the sidewalk and the edge of the roadway is referred to as a setback. Setbacks of a couple of feet are common to allow for placement of utilities, fences, traffic control devices, parking meters, mailboxes, provide a safety margin for children, and to reduce splashing of pedestrians. Larger setbacks of five to ten feet are more desirable for high volume/speed roadways to minimize pedestrian-vehicle conflicts. In locations where no setback is available, wider sidewalks of six to eight feet are preferable.

Sidewalk policies may include requirements that sidewalks be included in the design of new streets as well as street reconstruction or retrofitting sidewalks on one side or both sides of the roadway. Achieving "critical mass" necessary to create a walkable area usually includes providing continuity, safe roadway crossings and sidewalks connecting to transit stops and other major pedestrian trip generators. Curb cuts should be designed to meet or exceed the Americans with Disabilities Act and illumination may be provided for pedestrians walking at night.

Implementation Issues

Design standards for development, roadways, intersections, transit stops, and sidewalks that increase the number of bicycles and pedestrians are all public-sector policy functions. There are no implementation issues associated with such an initiative other than insuring those policies are in place and enforced. The cities and counties in the Houston region are pursuing a variety of bicycle treatment planning activities.

HOUSTON'S TRAVEL RATE IMPROVEMENT PROGRAM

"TOOLBOX" OF IMPROVEMENT STRATEGIES

INCREASE SYSTEM EFFICIENCY

Prepared for
Greater Houston Partnership

Prepared by
Texas Transportation Institute
The Texas A&M University System

April 2001

INCREASE SYSTEM EFFICIENCY

The basic transportation system—the roads, transit vehicles and facilities, sidewalks and more—is designed to accommodate a certain amount of use. Some locations, however, present bottlenecks, or constraints, to smooth flow. At other times, high volume congests the entire system.

The strategies listed in this section are aimed at improving peak hour mobility. Improving the operating efficiency of roads, transit and other transport system elements improves the utilization of the capacity that is constructed. The community benefits from reduced congestion and reduced emissions, as well as more efficiently utilizing the infrastructure already in place.

The "tools" included in this category are:

- Flow Signals
- Traffic Signal Improvements
- Incident Management
- Event Management
- Changeable Lane Assignments
- Technology-Based Transit Improvements
- Electronic Toll Collection Systems
- Intersection Improvements
- One-Way Streets

Flow Signals

Description

Implementation
Hurdles: Public
Level: Target Markets
Sector: Public
Locations: Routes

Flow signals (also called ramp meters) are modified traffic signals placed on the entrance ramps of urban freeways. They may operate on a pre-timed cycle or be responsive to conditions on the freeway mainlanes. Flow signals typically release one vehicle per cycle from the ramp. The goal of flow signals are to smooth out the flow of vehicles entering the freeway. Groups of vehicles entering a freeway that is approaching capacity can cause the freeway demand to exceed capacity. Stop and go traffic, reduced volume, and increased accident potential are associated with traffic demand exceeding capacity. If vehicles enter the freeway at a uniform rate, however, the smooth flow of traffic on the freeway can be preserved longer. Ramp meters will not eliminate congestion in most cases, but delaying stop-and-go conditions for 15 to 30 minutes has significant benefits.

Target Market

The flow signals do delay travelers wishing to enter the freeway; however, the emphasis is on preserving smooth flow on the mainlanes. HOV bypass lanes can be used in conjunction with flow signals to retain the travel time savings and delay reduction desired to encourage bus and carpool use, allowing these vehicles to bypass the queues and signals. Flow signals can also have the effect of discouraging short trips on the freeway.

Locational equity considerations (issues related to which ramps have longer wait times) can be accommodated by using a control strategy that presents equal waiting times to close-in and suburban entrance ramps, regardless of freeway conditions in the immediate area. This may result in a less efficient system, but greatly increase the chance of success for the traffic management system.

Benefits and Costs

Flow signal studies have shown that average speeds on the mainlanes increase, travel times decrease, and accident rates decrease. Accident rates have been reduced in the vicinity of flow signals as they provide for improved merging operations. Average volumes on the mainlanes have also increased as higher volumes can be achieved with smooth flow, rather than stop-and-go conditions. The amount of change in travel time is related to the amount of ramp control that is used and how much of the "bottleneck" effect can be addressed by the flow signals.

A summary of studies conducted to assess the impact of flow signals on freeway operations is provided in the table below. Construction and operation costs can be substantial if metering is installed as a stand-alone system, but with Houston's TranStar operation providing communication networks and operations personnel, the cost for new flow signal systems should be much less (1). It is important that the systems be maintained after installation—an element overlooked initially by some other cities. Installation costs are near $35,000 per ramp with annual operating and maintenance costs near 10% of that, with replacement of broken and destroyed signals a significant cost element.

Impact of Flow Signals on Freeway Operations

Location	Change in Spot Speeds	Change in Corridor Travel Time	Change in Accidents	Change in Volume
Portland, OR	+156%	-61%	-43%	NA
Minneapolis, MN	+35%	NA	-27%	+32%
Seattle, WA	NA	-48%	-39%	+62%
Denver, CO	+16%	-37%	-5%	+19%
Long Island, NY	+21%	-20%	NA	NA
Houston, TX	+5% to 10%	-5% to 20%	NA	NA

Source: Reference 2

Implementation Issues

Flow signals are a relatively new technique for Houston, and as such, relatively little data and public reaction is available to assess their future. Tow issues are clear—better public information and more aggressive operating strategies are needed to maximize the system benefits. Implementation thus far has been at a very modest level, given the newness of the idea, but more awareness and knowledge have to be created among travelers and the transportation agencies must be more active in adjusting the green signal rates and monitoring the effect on freeway speeds and queuing.

1. A Successful Return to Ramp Metering, The Houston Experience. John M. Gaynor and Darrell W. Borchardt. Presentation at ITS America's 7th Annual Meeting, 1997.
2. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility. Institute of Transportation Engineers, Washington D.C., 1997.

Traffic Signal Improvements

Implementation
Hurdles: None
Level: Target Markets
Sector: Public
Locations: All

Description

Traffic signals can provide for the orderly movement of traffic, increase the capacity of intersections, and reduce the frequency of accidents. Making improvements to traffic signals can be one of the most cost-effective tools to increase mobility on arterials. In many cases, traffic signal equipment can be updated to more modern equipment to allow for greater flexibility of timing plans, including coordination with other nearby signals for progression. In some cases, existing equipment may be adequate, however, due to changing traffic patterns, timing plan improvements may be needed to more efficiently handle current traffic flows.

Target Market

The benefit of studying signal timing and locations is seen when comparing the incurred costs with the amount of delay reduction that can be achieved. In some cases, signals may no longer even be warranted due to changing traffic patterns. In such cases, using stop signs on the minor street may be more beneficial, reducing delay and unwarranted stops. If signal control is warranted only during peak periods, the signal can be timed for flashing operations in the off peak, maintaining the benefit of the signal during peak periods and the benefit of two-way stop control during the off-peak. To determine if traffic signal improvements are warranted, an inventory of existing traffic signals, the approach volumes, and the operating speeds being provided should be undertaken. Studies have shown that travel time and fuel savings from signal retiming programs can produce benefits many times over the costs associated with the program.

Benefits and Costs

Costs associated with signal improvements vary depending on the extent of work performed. Making improvements to existing timing plans or signal removals incur minor expenditures of $300 to $400 per signal. Updating equipment or software can cost between $2,000 and $10,000 per signal. Providing communications between signals to allow for signal coordination can range from $5,000 to $13,000 per signalized intersection (1).

A study of 26 projects in Texas showed an overall benefit/cost ratio of 38:1. A total of $1.7 million was spent among the projects, which resulted in average delay reductions of 19.4 percent, an 8.8 percent reduction in number of stops, and a 13.3 percent reduction in fuel consumption (2). A program to optimize 3,172 signals in California resulted in a benefit/cost ratio of 58:1. The program provided an average delay reduction of 15 percent, 16 percent reduction in stops, 9 percent reduction in fuel consumption, and travel time savings of 7 percent (3). A Virginia signal improvement program resulted in travel time and fuel cost savings of over $7 million annually, with a benefit/cost ratio of 20:1. Providing signal preemption for buses in combination with bus only lanes has improved average transit speeds of up to 20 percent (4).

1. Transportation Control Measure Information Documents, Environmental Protection Agency, Washington D.C., 1991.

2. Fambro, D. et al. Benefits of the Texas Traffic Light Synchronization Grant Program, Research Report 0280-1F, Texas Transportation Institute, Texas A&M University, College Station, TX, 1995.

3. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility. Institute of Transportation Engineers, Washington D.C., 1997.

4. VASTOP Final Project Report for the Northern Region, Virginia Department of Transportation, August 1991.

Incident Management

Implementation
Hurdles: None
Level: Areawide
Sector: Public
Locations: All

<u>*Description*</u>

Approximately half of the delay experienced by travelers in the United States is due to causes other than simple high volume of traffic. This nonrecurring congestion occurs as the result of traffic accidents, stalled vehicles, spilled loads, maintenance/construction activities, special events, and weather. The California DOT estimates that for each minute an incident blocks a lane, approximately five minutes are added to the total time the freeway will be congested. The actual capacity reduction of an incident blocking a lane is greater than the physical reduction in capacity due to motorist "rubbernecking"—slowing down to look at the incident—often on both roadway directions. Although a one-lane blockage out of three lanes translates to a 33 percent reduction in physical capacity, studies have shown an incident blocking a single lane out of three lanes results in a capacity reduction of up to 48 percent. Similarly, a two-lane blockage can reduce the capacity of a three-lane section by as much as 79 percent (<u>1</u>).

One method of combating congestion from nonrecurring incidents is to implement an incident management system. Incident management is a coordinated and planned approach for restoring freeway capacity as quickly as possible after an incident has occurred. The major elements of an incident management system are: detection and verification, response, clearance, and motorist notification.

<u>*Target Market*</u>

Systems such as closed circuit television (CCTV) cameras, motorist call systems (call boxes and cell telephones), freeway service patrols, and commercial traffic information services are used in incident management programs to reduce the amount of time required to detect and verify incidents. Preplanning by involved agencies can establish procedures to reduce the time to respond and clear incidents (including alternate route planning, incident manuals, fast removal legislation, removal equipment). Finally, motorist notification can be given through dynamic message signs (DMS), highway advisory radio, commercial radio broadcasts, etc., to allow motorists to make informed route choice, mode choice, and departure time decisions. Motorist notification can also reduce incident congestion by causing some motorists to divert to alternate routes.

Cellular telephone call-in programs are an effective tool for detecting incidents. In addition to the typical 911 hotline, many metropolitan areas with incident management programs are implementing cellular telephone hotlines to report incidents. Some of the advantages of relying on cellular telephones as an incident detection tool are: the increasing prevalence of motorists with cell phones, uninvolved motorists can report incidents from the safety of their vehicle while incurring no delay to themselves, and motorists can report conditions that may lead to other incidents such as hazardous debris, animals, signal malfunctions, etc. Some disadvantages include motorist distraction, the possibility for false calls, the frequency of duplicate calls, and the potential that call-in motorists may not be familiar enough with the location of the incident to pinpoint the location. US Wireless, Inc. is testing a system in several areas including Washington, D.C., San Francisco, California and Hampton Roads, Virginia to automatically locate and track cell phone calls that could greatly improve the locational accuracy.

Some of the cities that have implemented cellular call-in hotlines to report incidents include Atlanta, Ft. Lauderdale, Charlotte, Greensboro, Boston, Miami, St. Louis, Riverside, Sacramento, Chicago, Pittsburgh, Columbia, Washington DC, Winston-Salem, and Norfolk. For simplicity, most call in program utilize abbreviated numbers such as *SP (state police), *DOT (department of transportation), *HP (highway patrol), *FHP (Florida Highway Patrol), *95 (Interstate-95), etc. In almost all cases, calls are free to the motorists making the calls. Funding for call-in programs made be made available with state funds, a monthly surcharge added to cellular customers' bills, or paid for as a service of the cellular carrier. A 1993 survey by the Cellular Telephone Industry Association reported that 13 percent of cellular customers had made emergency medical calls for themselves, 29 percent had made emergency medical calls for someone else, 34 percent had made calls for assistance with their disabled vehicle, and 40 percent had made calls for assistance with someone else's disabled vehicle (2).

Another potential strategy to help reduce congestion might be to institute a training program for police officers who are called upon to direct traffic around incidents as well as at special events. The same training could also include training for officers who wish to be employed in an off-duty capacity by retail centers, event promoters, or others.

Benefits and Costs

Freeway service patrols—such as the Houston Motorists Assistance Program (MAP)—have been cited as the single most effective element of an incident management program. Freeway service patrol programs use roving vehicles to patrol congested or high incident sections of freeway. The objectives of freeway service patrols are to locate incidents, minimize incident duration, restore capacity to the facility, and reduce the risks of secondary accidents. At present, there are over 53 service patrols in operation in the United States. Programs vary in size from a single vehicle patrolling a single route to the largest program in Los Angeles, with 150 vehicles covering 41 routes. Budgets range in size from a few thousand dollars a year up to $20 million. The service patrol in San Francisco estimates that response times for incidents serviced by the patrol were reduced by 57 percent since the patrol was implemented. Benefit/cost analyses were performed for 15 of the existing patrols with resulting ratios ranging from 3:1 to 36:1. A 1994 analysis of the Houston Motorist Assistance Program resulted in benefit/cost ratios of between 6:1 and 23:1 (3).

Implementation Issues

Increasing the amount of roadway covered by the Motorists Assistance Program and the time of operation can improve the benefits to Houston travelers. The Harris County Sheriff who staff the vans and the Houston Automobile dealers who provide them are to be congratulated on the service they provide. Ensuring the rapid communication of information between the operators, the TranStar center and the traveling public will maximize the benefits of this program.

1. Goolsby, M. Influence of Incidents on Freeway Quality of Service, Highway Research Record 349, 1971.
2. Gravino, P. Nonbusiness Use Rises for Portable Telephones, Associated Press article appearing in the Washington Times, c. 1993.
3. Fenno, D. and Ogden, M. Freeway Service Patrols: A State of the Practice. Transportation Research Record No. 1634, Transportation Research Board, Washington, D.C., 1998.

Event Management

Implementation
Hurdles: None
Level: Target Markets
Sector: Public & Private
Locations: Sites

Description

Special events such as concerts, fairs, sporting events, and rodeos create high traffic demands that can cause traffic congestion in the vicinity of the event, delaying not only event attendees but also the general public traveling through the area. Unlike other types of nonrecurring congestion, congestion due to special events is more predictable and can be planned for in advance. Various transportation and enforcement agencies have developed special event plans or special event centers to mitigate congestion and delay due to special events.

Target Market

The first step in planning for event management is to identify major concerns related to the site and surrounding transportation infrastructure. Examples may include limited access to the site, limited capacity of roadways leading to the site, concurrent events within the area of influence, availability of on-site and surrounding area parking, availability of transit services, and potential hot spots such as signalized intersections or vehicle/pedestrian conflict zones.

Special event plans can then be developed to address these concerns. Freeway segments near special event centers often experience a large portion of the event-related congestion. One aspect of a special event plan is to identify and promote the use of alternative entrance and exit routes, which are often underutilized. In many cases, drivers are unaware of the alternate routes or are unaware of the extent of congestion on the primary freeway route. Dynamic message signs, highway advisory radio, temporary signing, and commercial radio can be used to provide alternate route information. For larger events, printed media in the form of brochures or maps may be appropriate.

Temporary capacity improvements can be implemented to address the limited capacity of roadways leading to and from the site. Capacity improvements to the roadway may include the use of reversible lanes, left turn restrictions, restrictions of on-street parking, and lane closures. A lane closure in the outside lane upstream of a freeway entrance ramp allows for improved flow of vehicles exiting the event onto the freeway. Similar lane closures may be made on an arterial to allow for improved flow of event traffic turning onto a multilane arterial.

Temporary capacity improvements may also be made to intersections on entrance and exit routes to the facility. Capacity improvements may include blocking off a street to reduce the number of signal phases, left turn restrictions, and on-site traffic management by traffic officers. Officers may either manually direct traffic at an intersection or provide real-time signal control by manually operating the traffic signal at the controller box. A combination of cones, barrels, and barricades may also be used to enhance traffic control and flow by channeling traffic in the desired direction.

Other elements of special event planning include separation of pedestrian, automobile, and bus traffic to the extent possible, blocking off neighborhood streets to discourage undesired parking, monitoring on-street parking in the vicinity, enforcing illegal parking, and monitoring event traffic flow with CCTV systems. Traffic management centers conserve as a central point of coordination for agencies involved in the planning and implementation of special event traffic plans.

Benefits and Costs

A strategy to reduce the number of vehicles arriving at a special event is to promote transit use. Bus service to special events can be provided from park and ride lots or designated parking areas such as shopping malls. For events in downtown areas, downtown circulator transit service can be used in conjunction with area parking garages. Transit operations are particularly important for events at facilities such as Houston's Enron Field or the Alamodome in San Antonio where on-site parking is only adequate for a small portion of attendees. Examples of events where transit ridership is high (level of transit use in parenthesis) include Convention Center events in Anaheim (30 percent), Disneyland in Anaheim (50 percent), the Florida Citrus Bowl game in Orlando (35 percent), and large events at the Alamodome in San Antonio (50 percent). In addition to public transportation, many hotels and private companies operate shuttles/tour buses to special events.

One of the goals of event management is the diversion of vehicles from primary routes to alternate underutilized routes. A special event route diversion study conducted at the Texas State Fair in Dallas showed the effectiveness of dynamic messages in diverting freeway traffic to alternate routes. Approximately 56 percent of traffic bound for the State Fair diverted in response to the first dynamic message, while approximately 44 percent of the remaining vehicles bound for the State Fair diverted in response to the second dynamic message (1).

A study on the effectiveness of highway advisory radio (HAR) for encouraging motorist diversion was conducted during the Wurstfest event in New Braunfels. Advance signing was used to inform motorists to tune to the HAR frequency for event information. Approximately 56 percent of vehicles bound for the Wurstfest saw the advanced signing and approximately 67 percent of those drivers diverted to the alternate route, representing 22 percent of all traffic bound for the Wurstfest (2).

Implementation Issues

There are no specific issues that hinder the implementation of special event strategies. As noted earlier, unlike other types of nonrecurring congestion, congestion due to special events is more predictable and can be planned for in advance. The critical elements of this planning process to involve insuring that all of the various departments and personnel who have traffic control and management as well as those with parking management responsibilities are involved in the planning. The planning process should include not only public agencies, but appropriate personnel representing those staging the event. In addition, it is critical that parking ingress and egress strategies are coupled with traffic flow strategies. Finally these strategies must include specific plans to separate vehicle and pedestrian traffic, as well as traffic management on neighborhood streets.

1. Weaver, G., Dudek, C., Hatcher, D., and Stockton, W. Approach to Real-Time Diversion of Freeway Traffic for Special Events, Transportation Research Record 644, Transportation Research Board, National Research Council, Washington D.C., 1977.

2. Richards, S., Stockton, W., and Dudek, C. Analysis of Driver Responses to Point Diversion for Special Events, Transportation Research Record 682, Transportation Research Board, National Research Council, Washington D.C., 1978.

Changeable Lane Assignments

Implementation

Hurdles:	None
Level:	Target Markets
Sector:	Public
Locations:	Routes

Description

Changeable lane assignment systems (CLAS) can more efficiently provide capacity to high volume movements that only occur during a portion of the day. Many facilities experience highly directional demands during peak periods, e.g., heavy flows in one direction in the morning peak period and heavy flows in the opposite direction in the evening peak period. Changeable lane assignment systems temporarily borrow capacity from a low volume movement to provide additional capacity to the higher volume movement to reduce congestion during the peak hours. Common examples of changeable lane assignment systems in Houston include frontage road changeable lane assignment systems and reversible lanes.

Target Market

The frontage road system is an essential element in the design and operation of urban freeways in Texas. When frontage road interchanges experience high turning movement demands, permitted double turns are often used to maximize traffic throughput. However, traffic demands can have entirely different characteristics between the morning, mid-day, and evening peak operations, which lead to the need for different lane use controls on a recurring time of day basis. Freeway incidents can often impact frontage roads by creating high frontage road through demand as freeway traffic diverts. Changeable lane assignment systems can address lane imbalances seen on a time of day recurring basis and during freeway incidents.

A frontage road CLAS installation consists of an upstream warning sign, overhead signs near the intersection, and an at-intersection sign. Fiber optic (light bulb) signs are capable of displaying lane assignment configurations that can be adjusted based on volume patterns. The system can operate in a pre-timed manner to accommodate time of day turning demands -- a double turn lane when high turning volumes occur and more through capacity during time periods with higher through demand. When used as an incident management tool, CLAS increases frontage road throughput by displaying the minimum turn configuration (through movement allowed from all lanes).

Benefits and Costs

The results of an analysis of CLAS for time of day operations at three Houston frontage road intersections indicated that the system can provide delay and queue reduction and improved lane balance; however, the travel time benefits were not statistically significant. The results of an analysis indicated that CLAS could provide incident delay reductions for the total freeway/frontage road network when activated in the mid-day and peak direction of flow; the off peak direction of flow caused slight increases in delay (1).

In urban areas, two-way arterials may experience highly directional volumes during different portions of the day. By designating one or more lanes as reversible lanes, they can be operated in the peak direction for part of the day and the normal direction during the remainder of the day. In the case of a three-lane arterial, the center lane may operate as a two-way turn lane during off peak hours and serve the peak direction during peak periods. Reversible lanes increase mobility by temporarily providing additional capacity in the direction of flow during the peak time periods. Under appropriate conditions, this management of capacity potentially relieves the need to increase capacity through the construction of additional lanes. Reversible lanes are typically implemented by one of three methods: suspending lane use signals over the lane (shows a red "X" or a green arrow to indicate the appropriate direction of flow), permanent signs stating the reversible nature of the lane and the hours they are in effect, or physical barriers such as cones and movable barriers.

Implementation Issues

As with many system efficiency measures, the public and governmental agencies must be active partners in identifying potential improvement sites and altering the travel patterns to fit the new operation. Changeable lane assignments and reversible lanes are relatively active methods of adjusting roadway capacity—methods that are technically easy, but which need to be marketed to the public as methods to get the most benefit from the transportation network. The techniques also have to be "marketed" to public sector operators to get them to implement and operate systems that require more active involvement and updating as new techniques are developed and experience is gained.

1. Goolsby, M., Fenno, D., and Voigt, A. Changeable Lane Assignment System (CLAS) on Frontage Roads, Project Summary Report 2910-0, Texas Transportation Institute, Texas A&M University, College Station, TX, 2000.

Technology-Based Transit Improvements

Implementation
Hurdles: None
Level: Area
Sector: Public
Locations: All

Description

METRO has identified four advanced transit technologies that can be implemented as a integrated system for managing METRO vehicles. As a group, these four projects are called the Integrated Vehicle Operations Management System (IVOMS). IVOMS includes: automated vehicle location (AVL) system, automatic passenger counters (APC), vehicle tracking system, and bus annunciator system. These new components will work in conjunction with existing technologies such as Electronic Registering Fareboxes, Geographic Information Systems (GIS), Automated Telephone Information System, RCTSS traffic signal priority system, and the Advanced Radio Communications System to allow METRO to fully integrate its systems management.

The AVL system will provide real-time vehicle location for all METRO vehicles. By combining geographic and schedule data with AVL data, real-time calculations will continuously notify the bus operator of schedule deviations to promote on-time vehicle performance. Schedule deviations will be reported to dispatchers, who can then initiate corrective action. The APCs will provide passenger boarding and alighting data that will allow METRO to perform improved ridership and performance evaluations. The vehicle tracking system is a software application tied to the AVL system that will assist operations personnel with bus operations. The Bus Annunciator System will provide audible annunciation of next stop information in compliance with the Americans with Disabilities Act.

Target Market

The projects in IVOMS should benefit riders of all METRO services.

Benefits and Costs

The technologies included in IVOMS are designed to improve several areas of bus service: patron and operator safety; on-time performance; compliance with Americans with Disabilities Act; passenger data collection and reporting; and route and stop analysis. By improving these areas of bus service, METRO will attract more riders as well as provide existing services more cost-efficiently.

Implementation Issues

There are no implementation barriers regarding the technology itself. Education of bus drivers, transit managers, and supervisory personnel will be critical to insure that the system is being used at optimum levels.

Electronic Toll Collection Systems

Description

Implementation
Hurdles: None
Level: Area
Sector: Public & Private
Locations: Business & Routes

Many of the negative aspects historically associated with toll roads were related to the standard methods used to collect tolls. Electronic toll collection technologies have made the construction and expansion of toll roads more attractive in recent years. The Harris County Toll Road Authority's program is similar to most—motorists establish prepaid accounts and are debited for each toll via an automatic vehicle identification system consisting of tollbooth-mounted antennas, a computer system, and vehicle-mounted transponders. Since tolls can be collected electronically at normal speed, motorists are not delayed and many fewer tollbooth lanes are required, reducing required right-of-way, infrastructure, and operating and maintenance costs.

Target Market

Electronic toll collection also makes variable toll pricing feasible as a traffic demand management tool. A prime example is the toll schedule being used on California's SR-91 Express Lanes. There is a different toll schedule for each day of the week and each direction of travel. Tolls on weekdays are varied an average of 10 times during each day in increments as small as one hour. Tolls range from a low of 75 cents to a high of $3.75. Such a complex system is much easier to deploy with automated toll systems.

Benefits and Costs

The capacity of a manually operated tollbooth is approximately 350 vehicles per hour, while the capacity of an automatic coin machine booth is approximately 500 vehicles per hour (1). To maintain the capacity of the basic section of a toll facility, five to six traditional tollbooths are required for each basic lane. In addition to the costly expense for the right-of-way required for such large toll plazas, manual and automatic coin machine tollbooths cost approximately $60,000 per lane (2). These traditional collection methods also incurred high operating and maintenance costs of approximately $45,000 per lane per year for automatic coin machine tollbooths and $140,000 per lane per year for manual tollbooths (2). Other negative aspects included increased accident potential due to speed differentials and weaving maneuvers upstream/downstream of the toll plaza and increased vehicular emissions due to idling and acceleration.

Cost data averaged from five toll facilities in five states showed electronic toll collection systems provide cost savings of over $40,000 per lane for equipment costs, and $40,000 per lane in annual operating and maintenance costs compared with automatic coin machines, and $135,000 per lane in annual operating and maintenance costs compared with manual tollbooths (2). Express lanes, which allow payment only by electronic toll collection, provide 2.6 times the capacity of an automatic coin machine tollbooth lane and 3.7 times the capacity of a manual tollbooth lane (3). Electronic toll collection is estimated to provide emission savings of up 83 percent for hydrocarbons, 75 percent for carbon monoxide, and 50 percent for nitrous oxide (4).

Implementation Issues

Electronic toll collection systems can also be used for a variety of parking or other transportation pricing programs. The non-stop and automated nature of the technology can provide a relatively easy way to track parking use, and to reward those who use parking spaces only a few times per month. Discounted transit passes or close-in parking can be the reward for carpoolers or frequent transit riders. Car use would not be prohibited, making the program more adaptable for those who periodically need their vehicle. Toll systems could be programmed to accept lower toll payment for those users participating in a need-based social service program. Food stamp recipients, for example, could pay half of the toll as a way to allow them easier access to jobs in the suburbs where transit is not as accessible. The automated nature of the technology makes the program design more flexible and the options much greater.

1. Lawrence, Y. AVI – A Management View, AVI Technology for Toll Collection: An International Symposium, International Bridge, Tunnel, and Turnpike Association, 1990.
2. Cost-Effectiveness Analysis of AVI/ETTM for Florida's Turnpike System, Center for Urban Transportation Research, University of South Florida-Tampa, 1992.
3. Analysis of Automatic Vehicle Identification Technology and Its Potential Application on the Florida Turnpike: Technical Memorandum 2, Center for Urban Transportation Research, University of Florida-Tampa, 1990.
4. Public Technology, Inc. Traveling with Success, How Local Governments Use Intelligent Transportation Systems, Washington D.C., 1995.

Intersection Improvements

Description

Implementation	
Hurdles:	None
Level:	Area
Sector:	Public
Locations:	Routes

Intersections are locations where vehicle conflicts exist. Intersection designs should provide operational quality and safety for all types of vehicles and for pedestrians. The street capacity is not usually controlled by the general segments but by the intersection capacity. Improvements such as providing traffic control devices (e.g., yield and stop signs or traffic signals) can provide significant capacity and safety improvements. Providing the appropriate traffic control for the existing volumes will maximize these benefits.

Roadways should ideally intersect at 90 degrees, but desirably no less than 75 degrees. Intersections with less than 90-degree intersections have larger crossing distances for the minor street movement and increase crossing vehicle exposure time. The capacity of an intersection decreases approximately 1 percent for each one degree of intersection angle less than 90 degrees (1). Intersections where the angle of intersection of the two roadways is 60 degrees or less may require reconstruction or positive traffic control such as signalization to improve operations and safety. A number of options exist for redesigning the minor road alignment where small angles of intersection exist. Intersections with more than four "legs" experience significant operational problems and should be avoided.

Locating intersections on horizontal and vertical curves is also undesirable due to limitations of stopping sight distance, driver expectancy, and driver inability to judge the increase or decrease in stopping distance required by steeper grades. Ideally, intersections should be located on level, straight road sections. Corner radius design (sharpness of the turn) is based on providing turning paths for the type of vehicles expected to use the intersection. Inadequate design can lead to operational problems. Corner radii designed for smaller vehicles can create problems for oversized vehicles using the intersection, while designs for larger vehicles create larger intersections that are more difficult to mark, signalize, and increase pedestrian crossing distances.

Target Market

As traffic demands change over time, changes of intersection traffic control devices may be warranted to improve intersection operations. As demand reaches certain thresholds, the conversion of a stop-controlled intersection to a signal controlled intersection can provide increases in capacity and safety. Likewise, if traffic patterns change significantly, intersections operating under signal control might be better served with stop-control. In areas where vehicle flow is the dominant concern, traffic control devices should be designed to favor the heavier and faster flow movement to reduce accident potential and delay. In other areas where walking, cycling, or access to property or businesses is more important, traffic can be controlled to a lower speed.

Benefits and Costs

Raised areas that guide traffic flow at intersections can reduce the number and severity of conflicts at intersections. Traffic islands not only increase the safety of vehicle-vehicle conflicts but also serve as pedestrian refuge locations at large intersections. At intersections with moderate to high turning volumes, slow or stopped vehicles waiting to make turning movements can greatly reduce the capacity of the through movement. The addition of turning lanes separates these movements by providing storage for turning vehicles and reducing conflicts between the through and turning vehicles. The addition of right turn bays and double left turn bays to all intersection approaches of two major arterials in Dallas increased intersection capacity by approximately 30 to 40 percent. The addition of right turn bays on all approaches at the intersection of two major arterials (single left turn bays already present) resulted in total intersection capacity gains of approximately 10 to 15 percent (1). At some intersections, especially on local streets, improving speeds and capacity may not be the goals of intersection improvements. The implementation of traffic circles may be used to increase bicycle and pedestrian safety through reduced vehicular speeds.

Providing standard lane widths of 12 feet improves the capacity of intersections relative to lesser dimensions. Studies have shown that intersections with 11-foot lanes have total intersection delays of approximately 16 percent higher than comparable intersections with 12-foot lanes (2). Additional discussion of these and other intersection design considerations are included in a later section on arterial access management.

Implementation Issues

There are a number of potential implementation issues associated with intersection improvements. First, most all improvements cost money, including signalization, intersection geometry, traffic islands, turning bays, and lane-width increases. Second, intersections require sufficient long-range planning that facilitates future expansion when traffic volumes warrant. Both are functions of the public-sector.

1. Stover, V. and Koepke, F. Transportation and Land Development, Institute of Transportation Engineers, Washington D.C., 1988.

2. Traffic Engineering Handbook, Institute of Transportation Engineers, Washington D.C., 1992.

One-Way Streets

Description

Implementation	
Hurdles:	Public
Level:	Target Markets
Sector:	Public
Locations:	Businesses

In new developments such as shopping centers, sports arenas, parks, etc., one-way streets may be included in the original street and traffic plans. In other cases, existing two-way streets may be converted to one-way streets. Streets in major activity centers such as central business districts are often converted to one-way streets and traffic signal timing improvements implemented to serve high volumes through closely spaced intersections more efficiently. One-way streets may be operated as reversible lanes serving the predominate direction of flow in the morning and evening peak periods or adjusting to serve special events.

Target Market

One-way streets can provide numerous benefits including: allowing lane width adjustments to increase capacity of existing lanes or adding lanes which may be general purpose or special use lanes, redistributing traffic to relieve congestion on nearby streets, providing multiple turn lanes, allowing for improved signal timing with respect to progression and reduced phasing, and reducing pedestrian-vehicle conflicts. One-way streets can also preserve frontage assets such as sidewalks, trees, and other vegetation that might otherwise be lost due to widening of the two-way street to increase capacity. Negative impacts of one-way streets may include higher speeds, which may reduce pedestrian safety, and the potential for adverse impacts on businesses.

Benefits and Costs

The capacity of a street lane may be increased by as much as 50 percent when converting from two-way to one-way (1). There are no delays in turning movements due to oncoming vehicles and the pavement is used more efficiently. The additional space and traffic capacity may also permit full time or part time parking that would otherwise be infeasible with two-way operation. The conversion of a two-way street to a one-way street greatly reduces the number of conflict points at intersections. Studies have shown that the conversion can result in accident and travel time reductions of 10 to 50 percent, depending on the problem severity and design quality in the "before" case (1). Conversion of Fifth Avenue in New York to one-way operations resulted in decreased travel time of 37 percent and reduction in number of stops by 60 percent, even though volumes increased by 19 percent. Accident rates on Madison Avenue and Fifth Avenue in New York declined 44 and 32 percent, respectively after conversion to one-way operations. Included in those figures are reductions of accidents involving pedestrians of 41 and 29 percent, respectively (1). Basic costs associated with converting two-way streets to one-way streets range from $500 to $2000 per block; they can be much more depending on the types of improvements other than traffic-related (2).

Implementation Issues

Some one-way street programs have been criticized as being bad for businesses located along the street. Loss of parking or faster traffic past businesses sometimes has the effect of making an area less pedestrian or shopper-friendly. The way to make a one-way street conversion successful appears to be to design the program to accomplish local business and traffic goals. Areas with few merchants may benefit from smoother, faster traffic flow, while shopping areas may benefit more from a program oriented toward parking and pedestrian accommodations.

1. Traffic Engineering Handbook, Institute of Transportation Engineers, Washington D.C., 1992.

2. Transportation Control Measure Information Documents, Environmental Protection Agency, Washington D.C., 1991

HOUSTON'S TRAVEL RATE IMPROVEMENT PROGRAM

"TOOLBOX" OF IMPROVEMENT STRATEGIES

MANAGE THE CONSTRUCTION AND MAINTENANCE

Prepared for
Greater Houston Partnership

Prepared by
Texas Transportation Institute
The Texas A&M University System

April 2001

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MANAGE THE CONSTRUCTION AND MAINTENANCE

A frustrating aspect of transportation improvement programs is the congestion that sometimes increases during the construction period. Narrower roadways, closed facilities and re-routed bus, auto and pedestrian traffic can make the improved operations seem a long way off. The strategies in this section include methods to improve the construction phase by shortening the amount of time, or moving the construction to periods where traffic volume is relatively low. Some strategies can also be applied to maintenance activities. Also include are strategies to increase transportation funding.

The "tools" included in this category are:

- Contracting Strategies
- "Working Day" Adjustments
- Design-Build Strategies
- Public/Private Partnerships
- Toll Roads
- Road Bonds and "GARVEE" Bonds: Guaranteed Anticipated Revenue Bonds
- Tax Increment Financing for Roads
- "Maintenance of Traffic" Strategies
- Local Option Fees
- Variable Pricing

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Contracting Strategies

Implementation

Hurdles:	None
Level:	Area Wide
Sector:	Public
Locations:	Routes

Description

A+B contracting procedures require the contractor bidding on a job to bid the number of days required to do the work in addition to bidding on the cost of the construction. The "B" part of the contractor's bid - the time cost bid - is calculated as the number of days to complete the project multiplied by the daily time costs listed in the request for bids. Critical to A+B contracting are the development of daily time costs based on road user cost estimates which are, in turn, based on estimates of the traveler delay expected given the construction scenario (1,2).

Incentive/disincentive (I/D) contract provisions provide penalties and bonuses based on the contractor's performance relative to a specified project schedule. As with A+B contracting, the daily value of time is based on road user cost estimates. Bonuses are awarded for the number of days the contractor finishes early, and penalties are assessed for each day the contractor exceeds the deadline.

In many instances, A+B and I/D contracting provisions are used in combination. In such cases, the contractor bids the project price, plus the number of days to complete the project. The contract is awarded based on the contract price, plus a value for the number of days to complete the project. I/D provisions are included, again, based on specified road user costs or some other predetermined value.

Target Market

Senate Bill 370, passed during the 75th Legislative Session mandated that TxDOT "develop a schedule for liquidated damages that accurately reflects the costs associated with project completion delays, including administrative and travel delays". As a result, guidelines were developed in 1998 by the Construction Division of TxDOT and were provided to highway districts to assist in the process of determining whether Road User Costs should be incorporated into a construction contract. The guidelines specify several potential scenarios in which these strategies might be employed including, "projects that add capacity (including grade separations), projects where construction activities are expected to have a significant impact to local communities and businesses, or rehabilitation projects in very high traffic volume areas.

Benefits and Costs

The benefits of these contracting strategies include the likelihood of contractors maintaining or beating project schedules and/or budgets because of financial incentives to do so and financial penalties failure to do so. The "cost" to public entities in terms of potential increases in bid prices as contractors attempt to "price risk" is more than offset by savings in road user costs associated with longer construction (2).

Implementation Issues

There is a substantial body of literature, supported by real-world experience in Texas and elsewhere that A+B, I/D, and combination strategies can play a positive role in reducing contracting time and cost. In prior years, the major hurdle to these types of contracting procedures was technical in terms of the validity and accuracy of road user cost and value of time calculations. Significant improvements have been made however in estimating such costs. Further, there is more awareness on the part of contracting agencies, contractors, and the highway users as to the practical reality of road user costs. Those realities, now supported by policy decisions established by Texas Legislature through the passage of Senate Bill 370, provide the necessary structure within which to implement these strategies.

1. McFarland, William F., Kabat, Richard J., and Krammes, Raymond A. Comparison of Contracting Strategies for Reducing Project Construction Time, Research Report 1310-1F, Texas Transportation Institute, Texas A&M University, College Station, TX, March 1994.

2. Daniels, Ginger, Ellis, David R., and Stockton, Wm. R., Techniques for Manually Estimating Road User Costs Associated with Construction Projects, Texas Transportation Institute, Texas A&M University, College Station, TX, December 1999.

"Working Day" Adjustments

Description

Seven-day workweeks, 24-hour workdays, and working on holidays are all methods to compress project time. In addition, "start later" contractor workday strategies can have a significant impact on air quality issues by lessening the impact of congestion and construction equipment operation during critical morning hours. (See "maintenance of traffic strategies" below.)

Implementation

Hurdles:	None
Level:	Area Wide
Sector:	Private
Locations:	Businesses

Target Market

Working day adjustments can be potentially appropriate on any project where road user costs associated with increased project duration are significant. The higher the road user costs, the greater the savings available to offset the increased costs associated with ramp queuing, lane closures and the like. Further, in instances where there are significant peak periods of traffic, extending the construction work day to include periods prior to and after peaks can yield significant benefits in terms of increased productivity - and subsequently a shorter project duration - at a diminished incremental cost in terms of road user delay.

Benefits and Costs

The increase in contracting costs associated with overtime, double-time, and holiday pay are offset by a reduction in project duration costs (measured in daily road user costs). This is, in effect, a trade-off between cost increases associated with overtime and traveling public cost reductions associated with reduced project duration. As noted above, environmental costs associated with congestion impacts and construction equipment also provide significant potential benefits to this strategy.

Implementation Issues

As with A+B, incentive, and combination A+B/Incentive strategies, the potential cost savings are in large measure a function of the development of defensible values of time and other factors associated with road user cost calculations. There are no other impediments to pursuing workday alteration strategies.

1. ODOT Recognized for Innovative "Maintenance of Traffic" Program, The Urban Transportation Monitor, Volume 14, Number 19, October 2000.

2. Telephone Interview with Oregon Department of Transportation officials, February 2001.

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Design-Build Strategies

Description

The design-build concept is attracting increased attention in highway construction. Allowing one firm, or a team of firms, to undertake the project from design to final completion will likely foster shorter project duration, and, in turn, reduce road-user costs associated with project delay.

Implementation

Hurdles:	State/Federal
Level:	Area Wide
Sector:	Public
Locations:	Routes

Target Market

The majority of design-build experience has been with new construction projects. However, design-build strategies can play an important role in reducing total project time on major reconstruction projects as well. It should be noted however, that because of the relative newness of design-build as a contracting strategy in highway construction, such projects should probably best undertaken on a pilot-project basis in order to gain further experience with the concept.

Benefits and Costs

The benefits of a design-build approach are both cost and time savings associated with permitting one firm, or a team of firms, to undertake the projects from design to final completion of the construction stage instead of the more traditional method dividing the project into two separate phases with two separate bid processes. The I-15 project in Utah and the East Loop in Denver, Colorado provide examples as to the cost and time savings associated with the design-build approach (1).

Implementation Issues

There are no major implementation issues barriers associated with this approach from a legal perspective. The approach would likely require the development of policy guidelines in terms of when such an approach might be most applicable as well as potential policy changes relating to oversight and/or bid review.

1. Flynn, Kevin and Schriener, Judy, Road to Somewhere, in Design-Build, October 1999.

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Public/Private Partnerships

Description

Implementation
Hurdles: Local
Level: Target Markets
Sector: Public/Private
Locations: Sites

Because the private sector requires a return on its investment, toll facilities have been the most common type of facility proposed for public-private partnerships. The Texas Turnpike Authority has the statutory authority to participate in public-private partnerships in several different ways including eminent domain, regulation of tolls, use of tax-exempt debt, and tort liability. In addition, the 1994 Texas Transportation Plan recommended that TxDOT be allowed to purchase right-of-way for highway corridors and transit facilities for later sale, lease, or operation by private enterprise (1).

Other public/private cost-sharing options include owner contributions of right-of-way or cash. Institutional-based cost-sharing arrangements can involve negotiated developer agreements, impact fees, special assessment districts, and tax increment finance districts (see more on TIF districts below).

Negotiated developer agreements are financing mechanisms where the private developer agrees to contribute resources to a transportation project in exchange for changes in building regulations or for other special permit considerations.

Impact fees are charges imposed on new development as a condition for some regulatory approval of development. This form of alternative transportation capital finance flows out of local government's power to regulate development. Local governments may exercise their police power to protect the health, safety, and welfare of the public. Thus, exactions are an exercise of the police power in protecting the public from the consequences of onerous traffic delay and congestion.

Special assessments are charges imposed on owners of property to pay for government programs designed primarily to benefit the owners of that property, such as the construction of roads serving previously underdeveloped areas or the expansion of the road system serving rapidly growing areas.

Target Market

Public/private partnerships can strategies can serve as potential tools for transportation improvements under several different scenarios including extension of transportation infrastructure into new areas or the expansion of such services into high growth areas.

Benefits and Costs

Public/private partnerships can provide an approach to transportation expansion that provides a more market-based approach as well as a means for agencies to share the cost of such projects with those who will benefit most directly from the project. Furthermore, there are numerous different approaches available providing the partners with the flexibility necessary to structure a financing scenario that provides each with the maximum benefit. In fact, public/private partnerships may provide the greatest opportunity of flexibility in developing a financing solution tailored to each specific project.

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Implementation Issues

Public/private partnerships are not a new concept and have become an increasingly important tool in determining project feasibility. In Texas, the powers of regional tollway authorities are somewhat limited. Specifically, under Chapter 366 of the Transportation Code, a regional tollway authority may, "enter into leases, operating agreements, service agreements, licenses, franchises, and similar agreements with public or private parties governing the parties' use of all or any portion of a turnpike project and the rights and obligations of the authority with respect to a turnpike project." In addition, and under the same chapter, an authority, "receive loans, gifts, grants, and other contributions for the construction of a turnpike project or system and receive contributions of money, property, labor, or other things of value from any source…to be used for the purposes for which the grants or contributions are made, and enter into any agreement necessary for the grants or contributions."

1. Economics and Planning Division, Texas Transportation Institute, Legislative Framework and Implementation Issues Relating to Public-Private Partnerships for Highway Development in Texas. Working Papers. Texas Transportation Institute, Texas A&M University, College Station, TX, 1995.

Toll Roads

Description

Implementation

Hurdles:	Local
Level:	Target Markets
Sector:	Public
Locations:	Routes

Toll facilities are undergoing resurgence in the U.S. The advent of automatic vehicle identification or electronic toll collection technologies increases the viability of toll roads. Not only are the delays associated with toll collection eliminated, but also the automated billing technologies tend to reduce popular opposition to tolling. Toll roads are not a unique concept to Texas or to the Houston area. The Sam Houston, Hardy, and Jesse Jones facilities are already operated by the Harris County Toll Road Authority and, in aggregate, are on sound financial footing.

Target Market

Toll facilities have potential as a strategy on any relatively high volume facility as a means to finance new construction or, under the provisions of Section 180, Chapter 3612 of the Transportation Code, as a means of financing improvements to existing "free" public highways if the facility is transferred to the Turnpike Authority. In fact, over the course of the last 20 years, much of the statistical gains relative to relieving congestions can be attributed to the addition of new lanes miles as a result of toll roads (1).

Benefits and Costs

Tolls serve as a means to finance highways on a more direct road-user cost basis. Through a bonding program, the facility can be paid for "up front" while the debt is serviced by road user fees over the life of the bonds. The additional cost associated with this approach is, of course, the interest on the bonds issued to cover the construction costs.

Implementation Issues

None. Toll roads are a proven concept in Texas. However, toll road opportunities are not infinite. Not all transportation needs can be financed via tolls and even if they could, there is a finite capacity for debt. There are, however, several toll road opportunities in the greater Harris County area.

1. Lomax, Timothy J., Dresser, George B., Ellis, David R., Glenn, Thomas L. Goff, Zane, A., Horton, Ann C., and Turnbull, Katherine F. Refinancing Texas Transportation, Project Summary Report 1728-S, Volume 1., Texas Transportation Institute, Texas A&M University, College Station, TX, June 1998.

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Road Bonds and "GARVEE" Bonds: Guaranteed Anticipated Revenue Bonds

Implementation

Hurdles:	Local Process
Level:	Target Markets
Sector:	Public
Locations:	Routes

Description

Guaranteed Anticipated Revenue or "GARVEE" bonds are a means to leverage future federal highway funds in order to construct roadways. Such bonds are allowed in 10 states. The Texas Senate approved the funding mechanism in 1999 but the Texas House of Representatives took no favorable action. The bonds would allow construction to be financed now with the debt secured by future federal highway fund allocations to Texas (1).

Target Market

Such bonds are applicable in both new construction and reconstruction projects when such projects would otherwise be eligible for federal funding in current or future years.

Benefits and Costs

The differential between the cost of the bonds and the traditional pay-as-you-go approach is, conceptually, more than covered by the decreased road-user costs associated with the reduced project time. The risk associated with this approach lay in the future availability of federal highway funds sufficient to cover the cost of the bonds plus interest in light of other potential unforeseen demands that might be placed on the State's highway system in future years.

Implementation Issues

As noted above, currently this approach is not authorized by Texas statute and would require an amendment to the State's constitution. However, bonding authority for highway construction is expected to be an issue that will receive serious consideration during the next session of the Texas Legislature.

1. Senate Committee on State Affairs, Intermodal Transportation, Report to the 77th Legislature, November 2000.

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Tax Increment Financing for Roads

Implementation

Hurdles:	Local Process
Level:	Target Markets
Sector:	Public
Locations:	Sites

Description

This concept is similar to that of Tax Increment Financing (TIF) districts used primarily for infrastructure improvements associated with economic development projects. An "impact zone" associated with the road project would be designated and, for a specified period of time, the increase in property tax revenue (the "tax increment") associated with increased property values as a result of the project would be designated for the entity(s) financing the road improvement.

Target Market

TIF bonds can be used with both new construction projects as well as major reconstruction and/or capacity expansion projects. The major criteria are that the project must have a defined area of impact and that the project must have a defensible method of allocating benefit (and subsequently cost) to the defined area.

Benefits and Costs

As with other such funding mechanisms TIF districts allow for a more direct connection between the costs associated with transportation improvements and those who will be the most direct beneficiaries of the improvements.

Implementation Issues

There are no legal impediments to the creation of such districts. In 1997, the Texas Legislature provided TxDOT with the ability to use TIF Districts. However, this approach would probably require the development of guidelines and policies to measure benefits associated with a particular project and thereby allow the allocation of costs. For example, part of the benefit of a particular project may be to provide greater access to a property, thereby increase it's value for development, or to provide greater access to existing businesses, thereby increasing sales and value. Those costs might be recovered through a TIF district. However, there may well be other benefits associated with increased capacity or speeds for through traffic. Identifying those benefits which accrue within the district's boundaries versus those that accrue outside of the district's boundaries could be problematic (1).

1. Economics and Planning Division, Texas Transportation Institute, Legislative Framework and Implementation Issues Relating to Public-Private Partnerships for Highway Development in Texas. Working Papers. Texas Transportation Institute, Texas A&M University, College Station, TX, 1995.

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"Maintenance of Traffic" Strategies

Implementation
Hurdles: Local Process
Level: Area
Sector: Public
Locations: Sites

Description

Proper management of work-zone traffic control can have a significant impact in reducing delay time, queue length, emissions, and road user cost. Closing lanes or ramps to decrease the construction time, using Flow Signals to improve traffic flow, using reversible lanes to make the most efficient use of the available road space, increasing transit usage to reduce vehicle demand are among the strategies that might be used. Computer models can use person and vehicle volumes, road designs and operational strategies to estimate the impact on travel delay and emission statistics in work zones (1, 2).

Target Market

"Maintenance of traffic" strategies can be used on any reconstruction, expansion, or maintenance project. These strategies can have a potentially significant marginal impact not only in terms of traffic flow, but also in terms of safety for both road users and construction crews. In fact, many of these practices are already standard procedure in Texas.

Benefits and Costs

Real costs can be relatively low in that implementation is primarily a function of planning, scheduling, and management as opposed to being a function of construction.

Implementation Issues

Planning, scheduling, and project coordination become even more critical in order to make significant differences in queue length, delay time, and their related costs. Computer modeling of the potential impacts of these management strategies becomes increasingly important to the decision-making process.

1. ODOT Recognized for Innovative "Maintenance of Traffic" Program, The Urban Transportation Monitor, Volume 14, Number 19, October 2000.

2. Telephone Interview with Oregon Department of Transportation officials, February 2001.

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Local Option Fees

Description

Houston's residents could be given the option to support transportation programs with direct taxes or fees. Described below are a few techniques that might be used – common elements are the need for State level support for the local option concept and the desirability of dedicating any revenue for specific uses such as mobility improvements. Voter approval would provide additional local matching funds and demonstrate the commitment to attacking the serious mobility problem (1).

Implementation

Hurdles:	Local Process
Level:	Local
Sector:	Public
Locations:	All

- Local option vehicle registration fees: This initiative would allow an additional vehicle registration fee to fund local roadway improvements. For example, a $10 local option registration fee per vehicle in Houston would raise approximately $36 million annually.
- Local option gasoline tax: A cents-per-gallon based gasoline tax would produce approximately $20 million annually per one cent of tax. This is similar to the current federal and state taxes.
- Local option gasoline sales tax: A sales tax on the sale of gasoline will preserve the current cents-per-gallon taxing mechanism for the State and federal governments. It is estimated to produce in excess of $20 million per year per one percent of tax.

Target Market

Local option fees of this type can be implemented to help cover the costs of any construction, expansion, or maintenance effort.

Benefits and Costs

Additional revenue may well mean that some projects can be begun earlier than would otherwise have been the case. It is important to note that the marginal value of the fees described above is not just the revenues raised by the imposition of the fees, but also the additional state and/or federal match that might be acquired as a result of the funds.

Implementation Issues

All of the options mentioned above would require legislative approval and represent a significant polity shift, and potentially require a significant voter education campaign on the part of local authorities. In addition, allowing the Authority, a city, or county to impose a cents-per-gallon gasoline tax would likely require an amendment to the State's constitution. Further, it is likely that any such tax on a cents-per-gallon basis would require that ¼ of the proceeds be dedicated to public education. It is unlikely, however, that a sales tax on gasoline would necessitate such a dedication.

1. Daniels, Ginger, Ellis, David R., and Stockton, Wm. R., Techniques for Manually Estimating Road User Costs Associated with Construction Projects, Texas Transportation Institute, Texas A&M University, College Station, TX, December 1999.

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Variable Pricing

Description

Variable pricing is the application of user surcharges for using congested highway facilities. Its goal is to provide an additional option for travelers – a reliable high-speed trip. The benefits include decreased travel time, increased transit productivity, and reduced pollution and energy use. Variable pricing could potentially provide additional financial support for other transportation improvements or current operations. Advances in electronic tolling could be used to address negative economic or social impacts (1,2).

Implementation

Hurdles:	Local Process
Level:	Target Markets
Sector:	Public
Locations:	Routes

Target Market

Variable pricing strategies can be imposed on existing toll roads, new toll facilities in "free" corridors, or on new projects that come on-line at future times.

Benefits and Costs

The benefits of variable pricing strategies include the capability to attach a user fee to a facility that is more reflective of the market as well as allowing price to be used as a tool to help influence transportation decisions across a variety of user options including shifting demand away from peak hours, telecommuting, and flex hours. There is very little cost to implement such a policy.

Implementation Issues

For existing toll facilities, there are no significant implementation issues. For new toll facilities in existing "free" corridors there will be issues associated with colleting fees/tolls and/or distributing permits to authorized users.

1. Sullivan, E. Evaluating the Impact of the SR 91 Variable Toll Express Land Facility – Draft Final Report, Cal Poly State University, San Luis Obispo, CA, January 1998.

2. Wyckoff, P. Turnpike Out to Cut Off-Peak Toll Rates, Star-Ledger Newspaper, June 12, 1998.

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HOUSTON'S TRAVEL RATE IMPROVEMENT PROGRAM

"TOOLBOX" OF IMPROVEMENT STRATEGIES

MANAGE THE DEMAND

Prepared for
Greater Houston Partnership

Prepared by
Texas Transportation Institute
The Texas A&M University System

April 2001

MANAGE THE DEMAND

Peak hour congestion on urban freeways is largely due to the predominance of the standard 8 AM to 5 PM work schedule. The structure of many large cities can also compound congestion as widely distributed workers funnel through a few congested corridors to several large activity centers. The peak hour trips associated with the 8 AM to 5 PM schedule not only saturate freeway corridors, but also saturate downtown streets, parking facilities, and elevators.

The strategies listed in this section promote reduced vehicle trip making. Many of them are oriented toward commute trips—those are the trips that endure the most congestion and those that may be most amenable to travel modes other than single-occupant private vehicles. Reducing the commute trips has many benefits to individuals and the community as a whole. Individuals benefit from low stress communities with time to read, sleep, etc., lower fuel consumption, reduced travel time, and parking fee savings. The community benefits from reduced congestion, lower emissions due to fewer cold starts, and reduced parking demand.

The “tools” included in this category are:

- Variable Pricing
- Alternative Hours of Travel
- Telecommuting
- Ridesharing
- Vanpools
- Local Bus Service
- Express and Park & Ride Bus Service
- Park and Ride Lots
- Activity Center Circulator Buses
- Neighborhood Circulator Buses
- Demand-Response and Hybrid Bus Service
- Fare Strategies

Variable Pricing

Description

Implementation

Hurdles:	Public & Federal
Level:	Target Markets
Sector:	Public
Locations:	Routes

Variable pricing on toll facilities is a strategy used to manage congestion during peak periods. Motorists are charged higher tolls during the peak period and charged lower tolls or no tolls in the off-peak hours. The purpose of variable pricing is to spread peak hour demand over a greater time period to reduce the peaking characteristics of rush hour traffic flow. Studies have shown that pricing is the most effective method of changing motorist travel behavior, whether influencing a motorist's decision on route choice, departure time, or travel mode. Some portion of motorists will alter their travel times to incur smaller tolls, alter their route to non-tolled facilities, switch transportation modes, telecommute, eliminate lower value trips, or combine multiple trips into a single trip. Although the concept of variable pricing is not a new idea, advances in electronic toll collection have made variable pricing strategies feasible. Strategies can also be implemented to further encourage transit and carpool/vanpool usage by allowing those vehicles to travel at reduced tolls or for free.

An example of a variable pricing program to manage transportation demand is the toll schedule being used on California's SR-91 Express Lanes. There is a different toll schedule for each day of the week and each direction of travel. Tolls on weekdays are varied an average of 10 times each day in increments as small as one hour. Tolls range from a low of 75 cents to a high of $3.75. As an example, the toll schedule on a Wednesday for the Eastbound lanes is (toll in parenthesis): 12 AM to 7 AM ($0.75), 7 AM to 1 PM ($1.50), 1 PM to 2 PM ($2.00), 2 PM to 3 PM ($2.95), 3 PM to 4 PM ($3.20), 4 PM to 6 PM ($3.50), 6 PM to 7 PM ($3.20), 7 PM to 8 PM ($2.25), 8 PM to 10 PM ($1.50), and 10 PM to 12 AM ($0.75).

Information on toll schedules for the SR-91 toll road is disseminated through a website: www.91expresslanes.com, at their customer service center, and a toll free automated fax-back request line (800) 600-9191. Users are notified to check the actual toll on advance dynamic message signs before entering the lanes, as toll schedules are subject to change without notice.

Target Market

Variable pricing can be implemented in combination with other demand management measures. Parking management and transit operations can be part of a package of options for travelers to large activity centers. Electronic collection of fees can accommodate equity concerns and transition to work programs by automatically debiting an amount less that the regular fee for trips taken by program participants.

Benefits and Costs

The SR-91 express lanes provide a travel time savings of approximately 20 minutes over the 10 mile length compared with the adjacent free general purpose lanes. Public opinion surveys report the project is viewed favorably by 65 percent of the express lane users, 62 percent of the free HOV lane users (3+ vehicles use express lanes for free), and 53 percent of the mainlane users (1).

The New Jersey Turnpike Authority is planning a variable pricing structure for commercial truck traffic. The goal is to offer incentives to encourage truck traffic during off-peak hours. The planned structure for off peak travel will give a 15 percent discount for companies that spend $50 to $200 per month, a 12.5 percent discount to companies that spend $200 to $500 per month, and a 7.5 percent discount to companies that spend over $500 per month. This structure was selected to avoid the potential for a large decrease in toll revenue (2).

Implementation Issues

The variety of possible options is limited only by a widespread lack of knowledge about pricing program benefits and resistance to a technique that initially appears to charge for a commodity that had been free. The notion of congestion having a cost, however, is more widely discussed, and variable pricing can play a role in addressing mobility concerns if public support can be developed.

Existing toll facilities can benefit from a variable pricing program that encourages use at times other than the usually congested periods. But the entire transportation system can also benefit if toll facilities are only one part of a broader pricing strategy.

1. Sullivan, E. Evaluating the Impacts of the SR 91 Variable Toll Express Lane Facility – Draft Final Report, Cal Poly State University, San Luis Obispo, CA, January 1998.

2. Wyckoff, P. Turnpike Out to Cut Off-Peak Toll Rates, Star-Ledger Newspaper, June 12, 1998.

Alternative Work Hours

<u>Description</u>

Flexible work hour programs allow employees to work a schedule within a range of time periods. For example, employees may be allowed to work an eight-hour shift starting between 6 AM and 9 AM and ending between 3 PM and 6 PM. Some programs allow participants to shift their schedule on a day to day basis, while other programs require that participants work a selected schedule on a routine basis. This flexibility allows employees to shift trips to and from work either before or after the peak hour.

Staggered work hour programs vary the arrival and departure times of groups of employees within a company before and after the typical 8 AM to 5 PM schedule. The term staggered indicates that employees arrive in different shifts at different times within a time period. Unlike flexible work hours, employees in a staggered work schedule may have no ability to choose which shift they work on.

Implementation

Hurdles:	Public
Level:	Target Markets
Sector:	Private
Locations:	Businesses

Compressed workweek schedules typically involve longer, but fewer, workdays (e.g., 10-hour, 4-day workweeks). Compressed workweeks are advantageous in two ways. Days of commuting and commute trips are eliminated and longer work days require the employees to arrive earlier and leave later, removing trips from the peak hours.

<u>Target Market</u>

An increasing number of businesses are candidates for alternate work hour strategies. As electronic communication technology improves and computers become more available at home and office, new segments of the economy have the possibility of using the flexibility they provide. Staggered work hours are advantageous for large companies or plants to alleviate on-site crowding at entrances/exits, parking areas, or elevators. Staggered work hours work well for assembly line type operations where the beginning and end of work shifts can be easily managed. Flexible work schedules work especially well for persons that work independently.

<u>Benefits and Costs</u>

In Bishop Ranch, California, 14,800 employees took part in a flextime program as part of a required trip reduction program. The percentage of employees arriving before 7 AM increased from 8 to 17 percent, while the percentage of employees arriving after 9 AM increased from 1 to 9 percent (1). The City of Berkeley reported that its flextime program reduced annual overtime costs by $18,000 and sick leave costs by $26,000 (2). Similarly, the Pacific Gas and Electric Company of San Francisco reported that its flextime program reduced sick leave costs by $20,000 and resulted in savings of $46,000 in decreased use of work time for personal business (2).

Several studies in the 1970s in New York and Ottawa, Canada showed that staggered work hours can smooth out the peaking characteristics of arrivals and departures for work trips. The Ottawa study involved 33,000 government employees (47 percent of downtown employees) using a combination of staggered work hours and flexible work hours. A study showed the morning peak 15-minute arrivals were reduced by approximately 50 percent and the evening peak 15-minute departures were reduced by approximately 57 percent (3). A 1988 study in Honolulu showed that staggered work hours for 7 percent of the workforce benefited participants with travel time reductions of three to four minutes. When surveyed, however, 80 percent of participants were against mandatory schedule changes, while 80 percent favored voluntary schedule changes (4). In a 1992 study in Denver, a total of 9,000 federal employees in 42 agencies participated in a 4-day, 10-hour compressed work week program. The maximum percentage of arrivals in any one half-hour period decreased from 56 percent to 42 percent. The maximum percentage of departures in any one half-hour period decreased from 47 percent to 34 percent (5).

Implementation Issues

There are costs and business proactive changes that must be made to begin these types of programs. Businesses in many sectors of the economy have found, however, that providing flexibility in work schedules or altering the work times have benefits to their employees, as well as decreasing the load on the transportation system. There is some reluctance to initiate these programs when company ridesharing programs are also encouraged—because flexible work hours decrease the possible rideshare partners—but if groups of companies in buildings, office parks or activity centers coordinate their programs, the businesses, employees and the transportation system can all benefit.

1. Beroldo, S. Bishop Ranch 1990 Transportation Survey, Rides for the Bay Area, San Francisco, CA, December 1990.

2. Seattle METRO. Transportation Demand Management Strategy Cost Estimates, Service Development Division, Seattle, WA, July 1989.

3. Safavian, R. and McLean, K. Alternate Work Schedules: Impacts on Transportation, NCHRP Synthesis of Highway Practice No. 73, Transportation Research Board, Washington D.C., November 1980.

4. Giuliano, G. and Golob, T. Staggered Work Hours for Traffic Management: A Case Study. In Transportation Research Record 1280, Transportation Research Board, National Research Council, Washington D.C. 1990, pp. 46-58.

5. Atherton, T. Transportation Related Impacts of Compressed Workweek: The Denver Experiment, Transportation Research Record 845, Transportation Research Board, Washington D.C., 1982.

Telecommuting

Description

Implementation	
Hurdles:	Public
Level:	Areawide
Sector:	Private
Locations:	Business

Telecommuting allows workers to either eliminate a commute trip all together by working from home or to reduce trip length by working from a satellite office. Telecommunications and computers have made it possible to reduce trips by performing a variety of trip purposes over the telecommunications network. For example, telecommuters can access work files and programs via the Internet from home. Teleconferencing allows workers at multiple locations to conduct meetings, shopping can now be done over the Internet, and banking transactions can be done over the Internet or at automated teller machines (ATMs). The capability of making electronic transactions either eliminates trips or reduces vehicle travel.

Target Market

Telecommuting is not an option in all work positions, but professional and managerial staffs tend to be the most applicable positions, while business services, wholesaling, and banking/finance tend to be the applicable industries. The costs of establishing a telecommuting program are usually minimal as many individuals have home computers and Internet access. Some telecommuters are able to do their work without the need for a computer.

Satellite worksites may be owned/operated by a single company or by multiple organizations. These facilities are typically equipped with computers and modems to allow workers that would normally travel long distances to be connected electronically to their offices. While these facilities may be effective in reducing vehicle miles traveled, they are typically not effective in reducing emissions from cold starts and may actually increase vehicle trips as members of rideshare programs or transit may opt to drive alone to a nearby center.

The majority of telecommuters split time between the home and office. A 1991 US DOT survey of telecommuters showed that the average total time per week worked at home by telecommuters was 18.6 hours. Approximately 26 percent of the survey participants reported working at home an average less than eight hours per week (1).

Benefits and Costs

Improved productivity is one of the benefits cited as being associated with telecommuting programs. Control Data Corporation telecommuters estimated their productivity increased by 35 percent on telecommuting days, while their managers similarly estimated the productivity improvement at 30 percent (2). Pacific Bell managers estimated productivity improvements of 20 percent due to telecommuting in addition to office space savings (3).

Reduced cold starts, emissions, and VMT are all benefits of telecommuting. A study of 400 State of California employees participating in a telecommuting program showed that on telecommuting days, participants reduced their cold starts by 39 percent, CO emissions by 64 percent, NOx emissions by 69 percent, particulate matter emissions by 78 percent, and total VMT by 77 percent.

Implementation Issues

There are no implementation issues associated with this initiative. However, the public sector can play a major role in educating both employers and employees regarding the potential positive impacts of telecommuting as well as in helping employers identify specific jobs that might be appropriate candidates for the initiative.

1. 1991 Home Office Overview, No. 0322, LINK Resources Corporation, December 1991.
2. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.
3. Turnbull, K., Higgins, L., Puckett, D., and Lewis, C. Potential of Telecommuting For Travel Demand Management, Report 1446-1, Texas Transportation Institute, Texas A&M University, College Station, TX, November 1995.

Ridesharing

Description and Target Market

Ridesharing programs provide a service of matching up potential carpoolers and/or vanpoolers through a database of interested participants based on the locations of their origins/destinations. Rideshare programs are commonly developed at the regional level, sub-regional level, and by private employers. Regional programs are typically sponsored by a department of transportation or transit agency to promote ridesharing for an entire region. A local unit of government such as a city or county may sponsor subregional programs with the program often being tailored for the local market. Privately sponsored programs are limited to employees within a company. The company may establish its own rideshare matching capabilities or utilize the services of a local or regional ridesharing agency.

Implementation

Hurdles:	Public
Level:	Target Market
Sector:	Public
Locations:	All

Benefits and Costs

Incentives are widely used in privately sponsored rideshare programs to encourage employee participation. Elements that increase benefits or enhance ride-sharing include high occupancy vehicle lanes, high occupancy vehicle ramp meter bypasses, guaranteed ride home programs, flexible work schedules, preferential parking for high occupancy vehicles, and strong employer management support.

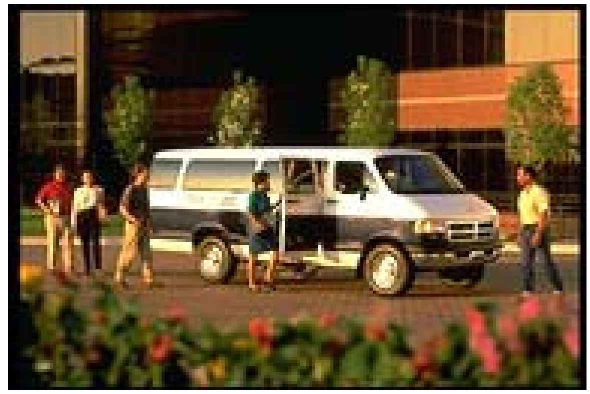
Guaranteed ride home programs provide rides to rideshare participants in the event of an emergency, a key concern of potential program participants. Studies have shown that guaranteed ride home program costs are low because participants tend to rely on coworkers, family, and friends in most cases and typically use the guaranteed ride home program as a last resort. Studies have shown program costs to range between $15 to $20 per participant per year. A study of 250 people registered for a guaranteed ride home program in Bellevue, Washington found that only 12 percent of participants used the program in the first year (2).

Implementation Issues

There are several areas where the public-sector can assist in such programs. For example, the public-sector can play an important role in matching riders as well as in assisting in the development of a guaranteed ride home program to assist riders who have family emergencies, illness, or other unanticipated transportation needs during the day. Parking incentives, both public and private, can also help encourage ridesharing efforts.

1. Schuetz, J. A Regional Transportation Demand Management Strategy for Southeastern Wisconsin, Proceedings of the 77th Annual Meeting of the Transportation Research Board, Washington D.C., 1998.
2. Transportation Demand Management Strategy Cost Estimates, Service Development Division, Seattle METRO, Seattle, Washington, July 1989.

Vanpools



Description

Vanpools use passenger vans to provide organized transit service to a registered group of individuals. Vanpools reduce congestion by organizing groups of individuals to share trips made in a van with driver service provided by an employee of the vanpool program or by one of the vanpool participants. Vanpools are most effective serving long distance commuters and are an effective tool for reducing vehicle miles of travel (VMT). Park and ride lots and park and pool lots often serve as meeting places for vanpool participants. Employers participating in vanpool programs may benefit through improved worker moral, reduced absenteeism/ tardiness, and lower parking costs (in cases where parking costs are subsidized by the employer).

Implementation

Hurdles:	None
Level:	Area
Sector:	Private
Locations:	Business

Target Market

Three main types of vanpool programs are: company sponsored vanpools, third party vanpools, and owner operated vanpools. In a company sponsored vanpool program, the company either owns or leases a van and administers the program. In a third party vanpool program, a third party agency administers the program assuming all liabilities associated with operation and providing ridematching services. Owner/operator vanpool programs are the sole responsibility of the owner/operator. In some cases, employers subsidize some of the costs associated with the program, while the patron may assume a portion or all of the costs, typically through a monthly subscription fee.

A task force of cities and transportation agencies in the Boston region is considering a two year incentive program to promote vanpool usage. Under the proposed plan, commuters would lease vanpool vehicles from a vehicle vendor. The commuters leasing the vehicle would receive financial incentives over a six month period that would be paid directly to the vehicle vendor on the commuter's behalf. The incentives would gradually decrease over the six month period to prepare the commuters to pay the actual costs associated with the leased vehicle (1).

Benefits and Costs

A voucher program in the Puget Sound region of Washington allows employers to purchase vouchers, which are given to employees and redeemed for full or partial fare payment for transit or vanpool fares. The vouchers are good for a period of 13 months. There are currently over 100 companies participating in the voucher program, with the program being credited for attracting approximately 440 new vanpool users in 1997. Metro Transit has a fleet of 615 active vanpool vans and provided 2.8 million vanpool rider trips in 1997.

Student and faculty/staff of the University of Washington Seattle campus may participate in the U-PASS program, which allows them to purchase quarterly passes for unlimited usage of King County Metro and Community Transit bus service. The program also provides subsidized vanpool fares. U-PASS holders receive a $40 discount on the monthly vanpool fare, which is determined by a number of factors including trip distance, number of riders, and size of van. The cost of the U-PASS is only $31 for students and $42 for faculty and staff per quarter. Prior to the U-PASS program there were eight vanpools in operation with 79 participants. Since the implementation of the program in 1991, the vanpool program has grown to 31 vanpools with a total of 266 participants in 1999 (2).

Implementation Issues

Vanpools are, in most cases, a private-sector function so there are no direct public-sector implementation issues involved. However, there are several issues the public sector can address in order to encourage and facilitate the development of privately-operated vanpools. Those issues range from direct subsidies to cover part of the cost of van operations to discounted parking rates at park and ride lots or destination lots.

1. Allen, G., Lipton, S., and Brooke, B. Unique Voucher Programs Increase Alternative Commuting, Proceedings for the ITE 2000 Annual Meeting, Institute of Transportation Engineers, Washington, D.C., August 2000.

2. Dewey, P. and Rutherford, G. The Evolution of a Successful Travel Demand Management Program, Proceedings for the ITE 2000 Annual Meeting, Institute of Transportation Engineers, Washington, D.C., August 2000.

Local Bus Service

Description

Local bus service is the backbone of a transit system. Local service provides access to and from all parts of the community, with closely spaced routes and bus stops. In Houston, local service covers most of the area inside of Beltway 8. Local bus routes can be split into two groups—radial routes and cross-town routes. Radial routes are oriented to or through downtown but may also serve other major activity centers. Local radial routes, which operate limited-stop with the purpose of relieving route congestion or improving average speeds, are also included in this category. Buses typically travel on major arterials, with bus stops every quarter mile. In Houston, most radial routes also serve one or more neighborhood or regional transit centers to allow patrons to transfer to and from other bus routes. Cross-town routes do not serve downtown and are typically anchored at other major activity centers or transit centers. These routes generally operate along arterials and are perpendicular to radial routes; they may travel in a circle or back-and-forth along a street.

Implementation

Hurdles:	None
Level:	Area
Sector:	Public
Locations:	Routes

Most local radial and cross-town routes in Houston are served with 35- to 40-foot long (standard) buses. Some high demand local radial routes are also served with higher capacity buses, such as articulated (bending) or coach buses. Standard buses have a seated capacity of approximately 40 persons, while articulated buses have seated capacities of 60 to 67 persons. For short distances in the peak periods, an additional 25% of passengers may be standing on local routes.

Target Market

Target markets for transit can be defined by geography, trip purpose, time of day, motivation to use transit, and many other ways. Local bus service by its very nature is designed to serve as many origins and destinations as possible, particularly within the dense inner city. Local radial and cross-town bus service provides access from residential areas to local and regional activity centers.

Examining target markets by trip purpose, most METRO local riders (57% from 1995 Origin-Destination Survey) are traveling to or from work. Another 16% are traveling to or from school or college, with the remaining passengers using transit for shopping (9%), recreation (6%), medical appointments (5%), or other reasons. Since the dominant trip purposes are work and school, most of these trips are during the peak periods when traffic congestion is highest (2).

A 1999 survey of Houston METRO riders showed differing reasons among local bus service passengers for using transit. The top four reasons cited by users of local bus service include: no car available (63 percent), reduced costs (25 percent), no drivers license (17 percent), and less stressful (16 percent). The “service” nature of METRO was indicated by patrons as elements of what they liked most (3).

Benefits and Costs

METRO's local bus service carries about 85% of the weekday transit boardings (4), with some routes carrying more than 14,000 daily passenger trips. Where unmet demand exists, increases in local bus service can generally result in additional increases in transit ridership. As service is extended into areas of lower density, the incremental passengers per revenue mile and cost per passenger trip generally increases. In the 15-year period from 1986 to 2000, METRO increased service by 45% (as measured in revenue miles) and ridership increased by 35%. Unadjusted for inflation, the cost per passenger trip over the same 15-year period grew only very slightly from $2.00 to $2.19 (5).

Other examples of changes in transit operations that have resulted in increased ridership are as follows. In Flint, Michigan, the number of miles served by buses was increased by 114 percent over a four-year period, resulting in an increase in passenger boardings of over 100 percent. In Riverside, California, changes implemented between 1991 and 1993 included new shuttle service, express routes, reducing headways by 50 percent in key corridors, new fares, discounted passes, and improved marketing. Annual ridership grew by 21.8 percent in 1991, 7.6 percent in 1992, and 12.8 percent in 1993. In Miami, changes were implemented to improve travel times by reducing stops in key corridors, smaller buses in lower demand corridors, emphasize service for special events, and improve transfers to other modes. Ridership increased by 11.4 percent after these changes (1).

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.
2. Houston METRO, 1995 Origin-Destination Survey.
3. Houston METRO, 1995 Customer Satisfaction Survey.
4. Houston METRO, FY2000 Average Weekday Customer Boardings Report.
5. Houston METRO, Office of Management and Budget Database.

Express and Park & Ride Bus Service

Description

Express and park & ride services also operate regularly scheduled service with designated stops; however, there may be either no intermediate stops or a very limited number of intermediate stops between origin and destination areas. Express and park & ride services are commonly used to provide fast service from suburban areas to major activity centers. These services can offer substantial travel time savings over automobile travel in the mainlanes when used in conjunction with HOV lanes. In Houston, express routes generally provide some local collection service followed by express operation to a major activity center. Service that collects passengers at a park & ride lot rather than with local buses is called park & ride service.

Implementation

Hurdles:	None
Level:	Target Markets
Sector:	Public
Locations:	Routes

Express and park & ride services generally operate on major arterials or freeways (which may also offer HOV lanes) to keep operating speeds high. Express service is usually provided with 35- to 40-foot long (standard) buses but may also be operated with over-the-road coaches. Higher capacity buses, such as articulated or coach buses, may be used in corridors with high transit demand. Park & ride service is often provided with over-the-road coaches that provide high passenger amenities for the longer transit trip (reclining seats, reading lights, package racks). Depending on the level of demand, the park & ride coaches can be standard, articulated, or mini buses. Standard buses have a seated capacity of approximately 40 persons, articulated buses have seated capacities of 60 to 67 persons, and mini-buses have a seated capacity of 20 to 25 passengers. Transit quality standards for express and park & ride services usually call for sufficient service to prevent the need for standees.

Park & ride services operate out of one or more park & ride lots. Park & ride lots are an important tool for encouraging carpool, vanpool, and transit usage by creating locations where people can leave their cars/bicycles and make the next portion of their journey in higher occupancy vehicles, be they carpool, vanpool, or transit vehicle. Parking facilities are most often independent, but can be shared, such as a signed area of a shopping mall parking lot. Park & ride lots are commonly used to support HOV/transit systems and may have direct access connections to the HOV lane. Parking facilities should be easily accessible, in a convenient location, and provide patron/vehicle safety elements such as perimeter fencing, overhead lighting, and on-site security. Park and pool lots are facilities that do not have transit service.

Target Market

The primary target market of express and park & ride services is activity center employees living in low-density suburban areas (at least 10 miles from destination) who own their own vehicles. A 1999 survey of Houston METRO riders showed the following top four reasons cited by users of express/park & ride bus service for using the service: less stressful (78 percent), reduced costs (71 percent), reduced parking costs (59 percent), and time to read, etc. (54 percent).

Approximately 81 percent of the express/park & ride bus riders previously used an automobile to commute, while approximately 43 percent of local bus riders previously used an automobile to commute (2). When return trips in the off-peak direction are made more frequent and off-peak-direction fare adjustments are made, the service can also serve a growing "reverse commute" market, as demonstrated by a number of Park and Ride routes in Houston.

A study involving users of 305 park & ride lots near HOV lanes was conducted in 1986 to determine the previous mode of travel by users. An average of 49 percent of patrons previously traveled in a single occupant vehicle, 23 percent were in a carpool, 10 percent used transit, and 15 percent did not previously make the trip. Houston presently has 25 park & ride lots and 5 park and pool lots associated with the HOV lane system. A total of 30,770 spaces are provided at these facilities with daily use measured in June 2000 of almost 16,000 parked vehicles. These parked vehicles correspond to approximately 32,000 daily vehicle trips being removed from the mainlanes of freeways.

Benefits and Costs

The benefits to express and park & ride services are compelling. Transit agencies offering express bus service have seen increases in transit usage. These services have been proven to attract users from single occupant vehicles, thus reducing congestion and emissions. In FY 2000, METRO carried over 20,000 passenger trips per weekday on its express routes and nearly 30,000 passenger trips per day on its park & ride routes (3). Ridership increased by 17 percent in Pittsburgh after express service was introduced. Corridor ridership increased by 100 percent in Washington, DC with work trip mode share increasing from 27 to 41 percent. Corridor ridership in Los Angeles increased approximately 200 percent with work trip mode share increasing from 12 to 24 percent. A new express service in Miami, in conjunction with a new park and ride lot, drew approximately 800 passengers a day, of which 64 percent previously traveled by automobile.

Express and park & ride service can be expensive (compared to local service) to provide. The service requires frequent service in the peak periods, with little demand for service in the off-peak period. Services with high peak period to base period ratios are costly, because the cost of the equipment and operators is spread over fewer hours of service. In addition, the premium vehicles needed to attract the target market are expensive.

Costs associated with the implementation of park & ride lots depend largely on land acquisition costs, the size of the lot, facilities such as parking structures and patron shelters, and presence of elevated direct access ramps to an HOV lane. In general, park & ride lots with direct access connectors to HOV lanes cost two to three times as much as facilities without direct access, because they are typically larger and the elevated ramps are costly to construct. Construction costs for seven of the Houston park & ride facilities without direct HOV access ranged from $3.9 to $5.5 million with an average of $4.5 million. Construction costs for eight of the Houston park & ride facilities with direct access connectors ranged from $8.1 to $15.8 million with an average of $11.3 million.

Lower cost parking facility alternatives to park & ride lots are park and pool lots. These facilities provide designated parking (paved surface, signing, and lighting) to encourage carpool and vanpool use, but are not typically served by buses. Park and pool lots are often located within existing right-of-way in one of the corners of a freeway/cross street interchange. The costs to implement the three park-and-pool lots in the Katy Freeway corridor were approximately $200,000 each in 1995 dollars.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.
2. Houston METRO 1999 Customer Satisfaction Survey.
3. Houston METRO FY2000 Average Weekday Customer Boardings Report.

Park and Ride Lots

Description

Park and ride lots are an important tool for encouraging carpool, vanpool, and transit usage by creating locations where people can leave their cars/bicycles and join up with higher occupancy vehicles. Facilities are most often independent, but can be shared, such as a signed area of a shopping mall parking lot. Park and ride lots are commonly used to support HOV/transit systems and may have direct access connectors to the lane. Facilities should be easily accessible, in a convenient location, and provide patron/vehicle safety elements such as perimeter fencing, overhead lighting, and on-site security. Park and pool lots are facilities that do not have transit service.

Implementation

Hurdles:	Public
Level:	Target Market
Sector:	Public
Locations:	Sites

Target Market

A study involving users of 305 park and ride lots near HOV lanes was conducted in 1986 to determine the previous mode of travel by users. An average of 49 percent of patrons previously traveled in a single occupant vehicle, 23 percent were in a carpool, 10 percent used transit, and 15 percent did not previously make the trip (1). Houston presently has 25 park and ride lots and 5 park and pool lots associated with the HOV lane system. A total of 30,770 spaces are provided at these facilities with daily use measured in June 2000 of almost 16,000 parked vehicles. These parked vehicles correspond to approximately 32,000 daily vehicle trips being removed from the mainlanes of freeways (2).

Benefits and Costs

Costs associated with the implementation of park and ride lots depend largely on land acquisition costs, the size of the lot, facilities such as parking structures and patron shelters, and presence of elevated direct access ramps to an HOV lane. In general, park and ride lots with direct access connectors to HOV lanes cost two to three times as much as facilities without direct access, because they are typically larger and the elevated ramps are costly to construct. Construction costs for seven of the Houston park and ride facilities without direct HOV access ranged from $3.9 to $5.5 million with an average of $4.5 million. Construction costs for eight of the Houston park and ride facilities with direct access connectors ranged from $8.1 to $15.8 million with an average of $11.3 million (3).

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Implementation Issues

There are no major implementation issues *per se* related to park and ride lots. Clearly, land use law case precedent, if necessary, will support the acquisition of the necessary space. As noted above, there are potentially major cost considerations involved. For example, the closer the facility is to H.O.V. access, the greater the cost is likely to be to acquire the land. However, the return on the land in terms of it's utility as a park and ride lot is likely to be greater. Conversely, the further away the facility is from H.O.V. access, the lower the cost is likely to be, but so to is the utility of the land as a park and ride lot.

1. Bowler, C. et al. Park and Ride Facilities, Guidelines for Planning, Design, and Operation, Federal Highway Administration, Washington D.C., 1986.

2. Houston High Occupancy Vehicle Lane Operations Summary, Texas Transportation Institute, Texas A&M University, College Station , Texas, July 2000.

3. Henk, R., Morris, D., and Christiansen, D. An Evaluation of High-Occupancy Vehicle Lanes in Texas, 1995. Research Report FHWA/TX-97/1353-4, Texas Transportation Institute, Texas A&M University, College Station, TX, October 1996.

Activity Center Circulator Buses

Description

Activity center circulators are bus routes that serve trips within a major activity center. To provide an attractive service, the stops are close together (every block or every other block) and service frequency is high (generally every 10 minutes or more frequent). The service can be operated with any type of vehicle but is sometimes operated with distinctive vehicles (such as the reproduction historic trolleys operated in downtown Houston) or with smaller vehicles. In the Houston area, activity center circulators are provided by a variety of entities in downtown Houston, the Texas Medical Center, Westchase, Clear Lake, and downtown Galveston (with a rail trolley). This type of service offers an opportunity for public/private partnership.

Implementation

Hurdles:	None
Level:	Target Markets
Sector:	Public & Private
Locations:	Businesses

Route alignments should be easy for users to identify. This requires that stop locations be clearly marked and maps display streets, stops, turns, directions and where possible, well-known landmarks and popular destinations. Schedule information should be available at each bus stop.

A specific vehicle type for the service also provides easy identification of the service and reinforces its image as a special service. Vintage trolley-style buses have been implemented in downtown Houston. While these vehicles are popular, the demand and purpose of each route must be considered when specifying vehicle type. A trolley bus may be appropriate and popular with lunchtime customers where a larger vehicle may be more appropriate for routes serving peripheral parking (such as in the Texas Medical Center) or special events. An issue with specialized vehicles may be the cost of purchasing a separate fleet that cannot be easily deployed for other services when needed.

Target Market

The target markets for activity center circulators vary by activity center but may include: parking shuttle, lunch destinations, visitors, special events, and special venues. Key factors for successful activity center circulators are: frequent service (generally, at least every 10 minutes), easy-to-understand route alignments, appropriate locations, and easily identifiable vehicles.

The span of service depends on the route: routes designed for the office worker market may run only weekdays during business hours while routes designed for entertainment circulation may run very late at night. Routes and schedules may vary according to time of day. Schedule and routing variations should be based on trip demand occurring during morning and afternoon peaks, noon/lunchtime, midday, evening, and weekends. Seasonal variations in service may also be necessary, particularly related to sport venues and retail centers (1).

<u>*Benefits and Costs*</u>

The benefits of activity center circulators include benefits to the community such as increased attractiveness of the activity centers for new retail and employment sites, reduced demand for parking in congested cores, opportunity to redevelop land dedicated to parking into more productive land uses, and removal of circulating traffic from congested activity centers. The transit agency may also benefit from increased awareness of its services and capture new riders for whom activity center circulators provide a test use of transit. Further, activity center ridership can be a growing market for transit. Ridership on METRO's downtown trolleys reached nearly 9,000 boardings per weekday, growing nearly 70% over the prior year (<u>2</u>).

The service can be costly, however, if the frequency and coverage is appropriately high. But provision of these services by the private sector or through public/private partnerships is possible.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.

2. Houston METRO, FY2000 Average Weekday Customer Boardings Report.

Neighborhood Circulator Buses

Description

To supplement local bus service, many transit agencies provide neighborhood circulator routes. These routes circulate through neighborhoods, often on collector streets as well as minor arterials, picking up passengers destined within the neighborhood or transporting passengers to a nearby transit center or park and ride lot. At the transit center or park & ride lot, the passenger can transfer to other routes that operate to other parts of town. (1)

Implementation

Hurdles: None
Level: Target Markets
Sector: Public
Locations: Homes

Often, neighborhood circulator routes are served with smaller capacity buses (seating 20 to 25 passengers). Smaller buses may be used for two reasons: (1) demand is lower and (2) neighborhood street sizes and configurations and residential community perception may make operation of a large bus difficult or disruptive, while a smaller vehicle can be accommodated.

Target Market

The geographic target markets of neighborhood circulators are suburban neighborhoods or inner city neighborhoods that are not well penetrated by major arterials. As with local service, these routes serve all trips purposes as feeders to the rest of the bus system.

Benefits and Costs

The benefits to neighborhood circulators include improved access to transit with reduced impacts to the neighborhoods. The cost to provide service is similar to that for local service, with some limited ability to reduce costs with reduced vehicle size. Ridership on neighborhood circulator routes is usually lower than for local routes, with daily ridership on METRO neighborhood circulators ranging from 200 to 2,300 riders per weekday (2).

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.

2. Houston METRO, FY2000 Average Weekday Customer Boardings Report.

Demand-Response and Hybrid Bus Service

Implementation
Hurdles: None
Level: Target Markets
Sector: Public
Locations: All

Description

Demand-response bus service provides curb-to-curb service on demand (generally with a reservation), often in a defined geographic area. Hybrid services can include route deviation service, where the bus operates over a fixed route with a fixed schedule but can deviate a certain distance from that route, and point deviation service, where the bus operates on a fixed schedule but with no fixed route. These services are usually provided with small buses, with capacities ranging from 12 to 25 passengers. Demand response and hybrid services can also be provided using vans.

Target Market

While this type of service is often associated with services for the disabled, demand-response service can be provided to the general public as well. General public demand-response and hybrid services are generally used in areas where population densities and demand are low or where the roadway network makes the design of efficient fixed routes impossible. General public demand-response service has been provided in suburban areas of Austin, and Fort Worth is currently using point deviation service in its lower demand areas. Demand-response services for the disabled are designed for individuals whose disabilities do not allow them to use fixed-route services, even if the fixed-route buses are equipped with wheelchair lifts.

Benefits and Costs

The benefits of these general public innovative bus concepts include the ability to cost effectively serve low density areas and the ability to test and grow a transit market prior to the commitment of more extensive transit services. Demand-response services for the disabled provide a critical lifeline that allows these individuals the ability to work, play, and participate in society. The cost of providing these services varies greatly. Demand-response service provided by a transit agency in compliance with the Americans with Disabilities Act (ADA) can be costly, since the trip lengths can be very long and scheduling efficiencies (due to disparate origins and destinations) can be low. The cost per passenger of the general public services can be significantly lower than for ADA services, since the service can be much more narrowly defined.

Fare Strategies

Description

An important element of transit service (both bus and rail) is fare structure and collection method. Differential fare structures often exist within a transit system to provide various services or to increase ridership in certain markets for a number of reasons.

Implementation

Hurdles:	Funding
Level:	Areawide
Sector:	Public
Locations:	All

Target Market

Discounted fares may be offered to increase mobility options of various groups based on age, financial capacity, disabilities, or affiliation (students, employer, etc.). Discounts may be offered based on factors such as frequency of use, prepayment, and time commitment of purchase (weekly pass, monthly pass, annual pass). Fare structures may also be differentiated based on trip characteristics such as trip location, length, and duration, time of trip (peak or off-peak, weekday or weekend), mode, and quality of service (express or local).

METRO provides discounts based on many of these stratifications, including discounts for prepaid fares, seniors, students, and the disabled. METRO provides its downtown circulator service free to encourage downtown workers to leave their cars for short trips. .

Benefits and Costs

An example of a transit incentive program is the U-PASS program on the campus of the University of Washington in Seattle. This program provides the 55,000 students and staff members of the University highly discounted transit services. Students and faculty/staff pay $31 and $42 a quarter respectively for the pass. Eighty five percent of students participate in the program. Single-occupant vehicle (SOV) use has declined from 44 to 40 percent among faculty/staff, while carpooling has increased from 15 to 19 percent, and transit use has increased from 25 to 35 percent. SOV usage among students has decreased from 25 to 16 percent. In similar college campus programs, students may be able to receive transit services at no cost.

Another example of a transit incentive program is the Commuter Bonus program available in the five county Puget Sound area, comprising 69 percent of Washington's population. The program is exclusively administered by King County Metro Transit. Under the program, employers purchase vouchers and give them to their employees. Employees can redeem the vouchers at over 200 outlets for full or partial fare payment for bus or vanpool use. The program is cited for being responsible for approximately 85,000 new annual bus trips and 440 new vanpoolers in one year. In Seattle, congestion was reduced by 2 to 4 percent after a fare free transit zone was established. .

Implementation Issues

Methods of fare collection include cash, token, magnetic stripe passes (prepaid pass), and magnetic stripe card/smart card (stored value card). Prepaid fares reduce cash handling and may decrease boarding times. Electronic fare payment systems also reduce cash handling and may decrease boarding times, but also allow transit agencies the flexibility to modify fares easily. These methods of fare collection can be used on all transit modes.

When fares are collected can also vary by mode and by agency. On most bus systems, patrons pay as they board the bus. Therefore, the bus must be stopped while each patron interacts with the bus driver or farebox. Fares can also be collected before the transit vehicle arrives, with the establishment of fare paid areas. Fare collection on most heavy rail systems is handled with paid fare areas. Fares are paid (likely through a turnstile) as the patron enters a loading area. Therefore, when the transit vehicle arrives, riders can board quickly through multiple doors. While this method is most common on heavy rail systems, it can be used on bus systems as well, particularly BRT systems or special event services.

Most fare strategies designed to increase ridership require a funding source to replace the revenue that would otherwise be collected. For this reason, not every fare category or ridership enhancement idea can be pursued.

1. A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington D.C., 1997.
2. Dewey, P. and Rutherford, G. The Evolution of a Successful Travel Demand Management Program, Proceedings for the ITE 2000 Annual Meeting, Institute of Transportation Engineers, Washington, D.C., August 2000.
3. Allen, G., Lipton, S., and Brooke, B. Unique Voucher Programs Increase Alternative Commuting, Proceedings for the ITE 2000 Annual Meeting, Institute of Transportation Engineers, Washington, D.C., August 2000.
4. Transit Ridership Initiative, Research Results Digest, No. 4, Transit Cooperative Research Program, Transportation Research Board, Washington, D.C., February 1995.