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Better Transportation Alternatives for Los Angeles

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EXECUTIVE SUMMARY

For several decades, the prospect of an urban rail system has been held up to the electorate as the key to mobility and clean air, but even cursory examination of system performance reveals that it is neither. The Los Angeles rail plan is essentially a failed experiment in transit provision, and all refinements and extensions predicated on expanding the rail system will only increase the cost of the failure. And the plan is not merely wasteful, but is harmful to existing transit options. The Los Angeles rail system is steadily destroying public transportation services in a city that should be much more respectful of the gap between the transit-optional haves and the transit-dependent have nots.

The Los Angeles County Metropolitan Transportation Authority's (LACMTA) commitment to the region's rail plan has placed it in a political conundrum. The MTA knows the system is a failure and that further investment in rail is harmful, yet the rail plan has been such a high profile project for so long that the prospect of abandoning the project is a source of political terror.

But alternatives are available, and MTA has the legal grounds to pursue them. The transportation advantages provided by exclusive rights of way are squandered if use of these guideways is restricted to rail cars. The MTA can build busways instead, facilities with greater flexibility, lower costs, and higher capacities than rail lines. If the agency stops rail construction, it can afford to place more buses in service on the elevated Harbor transitway. Existing rail rights of way, including tunnels, can be retrofitted for use as exclusive busways. Seattle is providing excellent service in its downtown bus tunnel. Los Angeles can do as well, even better. Buses can be granted priority access to city streets along the Blue Line right of way and elsewhere.

Southern California is fast becoming a leader in the construction, franchising, and operation of toll roads. Tolls can be used to pay for new facilities, but the real payoff is the opportunity they provide for controlling congestion by requiring drivers to pay the cost of the delay they impose on others. An electronically collected toll turns price into a lever for managing level of service.

Electronic toll collection is not the only technological fix available. Intelligent Transportation Systems (ITS) focus on expanding the capacity available from the existing transportation network. ITS includes many speculative elements, but also accounts for a number of nuts and bolts measures that focus on realistic system management options. The innovations provided by ITS are difficult to deploy, but may be simplest for public transit systems. The subsidies used to prop up public transit could just as easily be used to underwrite deployment of new technologies for transit.

Better yet, entrepreneurs should be allowed to enter the transit market and compete with the MTA, allowing the Authority to remain a public entity, but forcing it to accept the discipline imposed by market decisions. Many MTA services could be privatized to reduce cost and improve service. If the fare box is the only source of revenue available, then configuring service to capture fares becomes the order of the day.

At the very least, the MTA should proceed aggressively to meet its consent decree obligations to the Bus Riders Union and expand bus service. It should stop manipulating the definitions of funding categories to facilitate more rail expenditures, and it should vigorously fund construction of more High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes.

Part 1

Introduction

For many years, the health of Los Angeles' culture and economy has been equated with the health of its transportation system. From the Red Cars of the 1940s to the Car-Hops of the 1960s, to the Freeways of the 1970s, perceptions of Los Angeles as being either a futuristic city or a city in decay often involve the performance of the transportation system.

The Los Angeles metropolitan region experienced record growth during the 1980s, sparking a transportation agency response that included accelerated investment in rail transit during the 1990s. But initial elements of the Los Angeles rail system performed poorly relative to other North American rail systems and to bus modes.[1] Table 1 summarizes capital costs per passenger and per passenger mile for each of the five Los Angeles transit modes. Table 2 shows the number of trips and passenger miles paid for by the same level of subsidy across the four modes. The data in these tables indicate that the Los Angeles experience—like the experiences of other North American cities—is that non-rail transit (buses and just about any other form of transit) outperform rail transit systems by a very wide margin in terms of passenger-trips and passenger-miles per dollar of public subsidy.

Table 1: Capital Cost per Passenger and Capital Cost per Passenger Mile for Los Angeles Transit Modes[2]

Los Angeles Mode	Capital Cost per Passenger	Capital Cost per Passenger-Mile
Urban Bus	$ 0.25	$ 0.07
Light Rail	8.27	0.91
Heavy Rail	2.63	0.75
Long-Haul Commuter Bus	1.93	0.05
Commuter Rail	21.02	0.70

Notes:
a. "Urban Bus" and "Light Rail" are Southern California Rapid Transit District (SCRTD) FY92 average bus and Blue Line, respectively.
b. "Heavy Rail" is the Red Line as per EIS/EIR and is understated.
c. "Long-Haul Commuter Bus" is FY92 actual for four such New Jersey bus operators, pricing the actual fleet size at $300,000 per bus, annualizing over 12 years, and adding 20 percent for non-bus capital assets.
d. "Commuter Rail" is the FY95 projection for Metrolink from the FY93 Metrolink Budget and is understated.

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1 Thomas A. Rubin and James E. Moore II, "Why Rail Will Fail: An Analysis of the Los Angeles County Transportation Authority 20-Year Long Range Plan (Part 1 of a Series on the MTA)," Reason Foundation Policy Study No. 209, November 1996; Thomas A. Rubin and James E. Moore II, "Ten Transit Myths: Misperceptions About Rail Transit in Los Angeles and the Nation (Part 2 of a Series on the MTA)," Reason Foundation Policy Study No. 218, July 1996.

2 Los Angeles County Metropolitan Transportation Authority, *A Look at the Los Angeles County Metropolitan Transportation Authority*, March 1993.

Besides wasting a great deal of money, the poor cost-effectiveness of Los Angeles' rail systems has negative impacts on the level of transit and transportation service available in the region. The most visible result of inefficient investment in rail transit has been the recent and rapid deterioration of the Los Angeles bus system. Like other new rail cities, Los Angeles discovered that optimistic cost and ridership forecasts used to justify construction of rail projects lead to budget shortfalls.[3] And like other new rail cities, Los Angeles made up for those shortfalls by shifting resources from buses to trains, with perverse, anti-transit impacts: every dollar shifted from buses forces more riders off the system than new rail service can attract.

These developments are particularly important to Los Angeles because the rail plan is central to virtually all existing transportation development plans in the region. The MTA's rail plan is Los Angeles' longest-range plan, executed at the grandest scale. No other public project places such an enormous call on resources. And a lot of promises ride on this plan: local officials have proffered it as the means by which Los Angeles will decongest roads, clean the air, reconfigure land use, and revitalize the economy.

The first elements of L.A.'s rail system came on-line just as Los Angeles entered a period of intense challenge, and despite poor performance, political support for the rail plan has never wavered. Through a multi-year drought, an extended recession, a major correction in the housing market in 1990, the 1992 riot, several large fires, the 1994 Northridge earthquake, and the steady erosion of bus service, Los Angeles' leadership has kept its civic eye on the rail prize. But this tenacity comes at high cost: while the residents of Los Angeles County have agreed to tax themselves ever more intensively to pay for rail-transit systems, the County's least-fortunate residents have been squeezed into the most crowded buses in the United States. Moreover, in this same rail-building period, Los Angeles has closed trauma centers, scaled back public health resources, and slowed seismic retrofits of freeway structures.

Table 2: Los Angeles Public Transit Options Available for the Same Subsidy[4]

Mode	Passenger Trips	Average Length	Passenger Miles
Urban Bus	100	3.83 miles	383 passenger miles
Heavy Rail	40	3.52 miles	141 passenger miles
Light Rail	10	9.4 miles	94 passenger miles
Commuter Rail	6	27.8 miles each	167 passenger miles

A. Troubles with Transit

Urban rail transit once had an important role in American cities. Prior to the 1940s, public transportation was often the most common mode of urban transportation, especially for work trips. After World War II, however, mass transit companies lost ridership as a result of several factors, including increasing incomes, growing suburbs, cheaper automobiles, and changes in labor rules. Several transit subsidy programs were enacted during the 1960s and the 1970s to maintain public transportation services in the cities and metropolitan areas. The rationales for these investments included shaping urban growth; providing mobility for the poor, elderly, handicapped, and other transit dependent groups; preserving open space; conserving energy; improving air quality; and reducing traffic congestion.[5]

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3 Donald H. Pickrell, *Urban Rail Transit Projects: Forecasts vs. Actual Ridership and Costs*, U.S. Department of Transportation, Urban Mass Transportation Administration Report, U.S. Government Printing Office, Washington D.C., 1990.

4 MTA, *A Look at the LACMTA*, 1993.

5 David W. Jones, *Urban Transit Policy: An Economic and Political History* (Englewood Cliffs: Prentice-Hall, 1985).

By almost any measure, these transit-subsidy programs have been markedly unsuccessful. During the 1980s, the number of registered cars in the United States grew three times as fast as the population.[6] The average vehicle occupancy for all trips decreased from 1.9 persons per vehicle in 1977 to 1.6 in 1990.[7] The growth of automobile access and use contributed substantially to increases in average work-trip speed for all modes, from 29.1 mph in 1983 to 32.3 mph in 1990.[8] Nationally, transit ridership decreased steadily, and compared with transit ridership in other industrialized countries, can be considered insignificant. Currently, only about three percent of all trips in U.S. urban areas are taken by mass transit.

In most respects, Los Angeles proved no exception to these national trends. Southern California Rapid Transit District (SCRTD) ridership fell from 396.6 million in fiscal year 1980 to 354.1 million in fiscal year 1982. SCRTD base fares increased from $0.55 to $0.85 during the same period.

An important exception to these trends occurred in 1980, when Los Angeles voters passed Proposition A, agreeing to impose a one-half cent sales tax dedicated to transit. This began the most successful transit ridership experiment in recent history. Beginning in fiscal year 1983, an allocation of approximately 20 percent of Proposition A tax receipts was used to reduce the SCRTD base fare from $0.85 to $0.50. Other fares were reduced as well, as was the price of monthly passes. Over the three years of the $0.50 fare program, District transit ridership rose over 40 percent, and was still increasing in the last month of the experiment (see Figure 1). Very little about the bus system was changed except the fare. Revenue service miles increased only 1.5 percent, including special service added for the 1984 Los Angeles Olympics.

Beginning in fiscal year 1986, however, the Proposition A funds that had been used to subsidize the $0.50 bus fare were reallocated to rail construction in compliance with the terms of the ballot issue presented to voters. The funds transferred away from the fare subsidy program paid for about 35–40 percent of the reported construction costs of the Blue Line. Blue Line ridership peaked in 1995 at 12 million passenger boardings after an earlier dip.[9] The MTA currently predicts an annual Blue Line Ridership of 13.5 million.[10]

Bus fares were increased to $0.85 in fiscal year 1986 and then to $1.10 in fiscal year 1989. By fiscal year 1990, bus ridership had decreased by over 96 million passenger boardings per year, or 19.3 percent. District ridership has continued to sink further ever since. By 1995, the system had lost 133.5 million boardings per year, and had a ridership of 362.3 million across all modes. Bus ridership was 343.1 million. This lost ridership is more than ten times that gained by the Blue Line, and exceeded the entire patronage of the seventh largest urban bus system in the United States.

Of course, fare increases are not the only possible causes for declining bus ridership. Other possible causes include a softening economy, reductions in the level of bus service operated (an outcome also related to rail construction), the low cost of gasoline, current slower county population growth, and perceived increases in street crime. The trend-lines shown in Figure 2 are adjusted for these effects in a limited way, showing average SCRTD/MTA fares in constant 1980 dollars and per-capita ridership on SCRTD/MTA buses, other Los Angeles County transit operators, and trains. Even after these adjustments, the trend toward diminished bus ridership is very clear. The rail system's contribution to the region's transportation inventory is negligible.

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6 Ben Chinitz, "A Framework for Speculating about Future Urban Growth Patterns in the United States," *Urban Studies*, Vol. 28, no. 6, 1991, pp. 939–959.

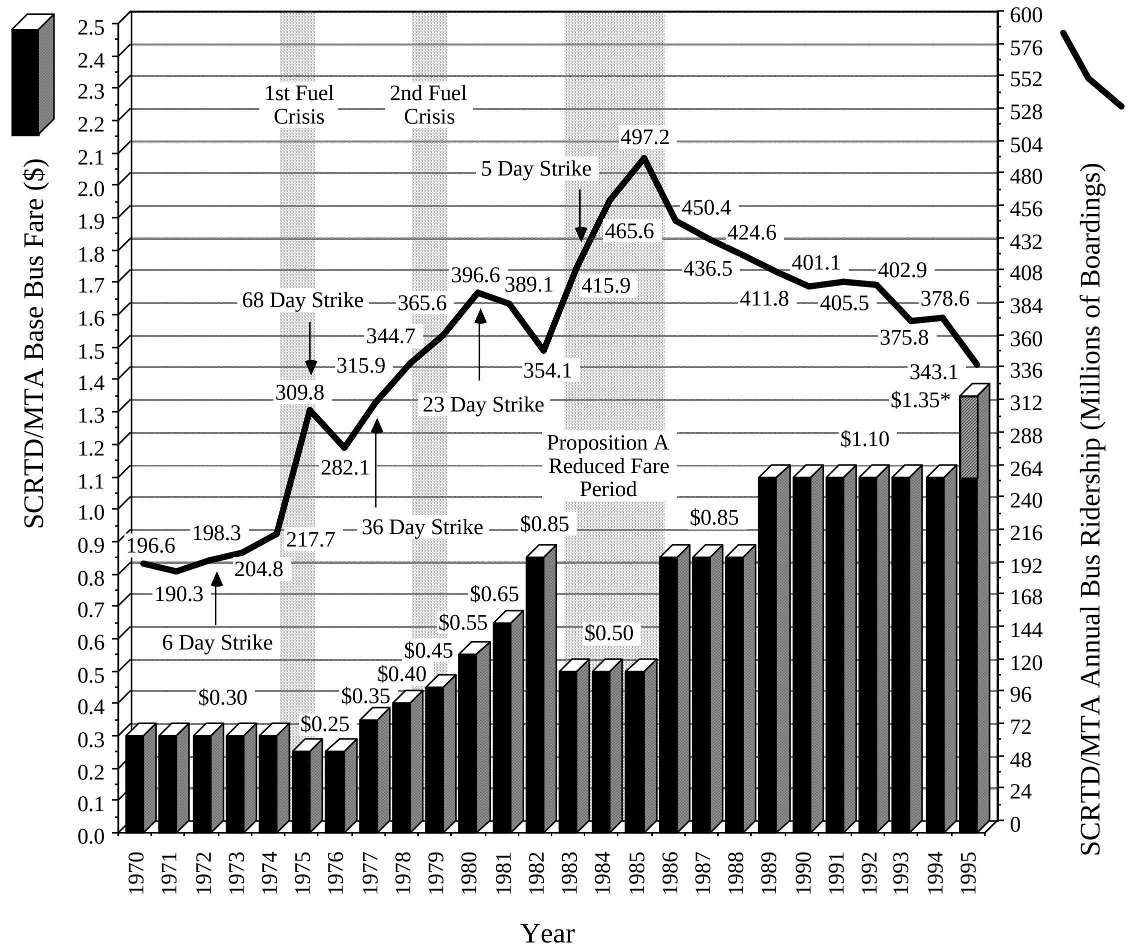
7 Alan E. Pisarski, *Travel Behavior Issues in the 90's* (Washington D.C.: Office of Highway Information Management, U.S. Department of Transportation, 1992).

8 Pisarski, *Travel Behavior Issues in the 90's*, 1992.

9 Los Angeles County Metropolitan Transportation Authority, *Section 15 Report Fiscal Year 1994*.

10 Los Angeles County Metropolitan Transportation Authority, *Budget Proposed 1996–97*, p. 3.

Figure 1: Ridership on SCRTD/MTA Buses Compared to Base Fares.[11]



Because of these and related outcomes in Los Angeles and other cities, the Los Angeles rail transit plan has come under fire from a growing number of groups, with dramatic effect.[12] Congress has all but explicitly repudiated the federal government's Full Funding Grant Agreement with the MTA. There is considerable uncertainty regarding the extent of future federal participation in the program and the restrictions this

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[11] LACMTA, *A Look at the LACMTA*, 1993; Federal Transit Authority, *Data Tables for 1993 National Transit Database Report Year*, Washington D.C.: FTA (1993); Federal Transit Authority, *Data Tables for 1994 National Transit Database Report Year*; Los Angeles County Metropolitan Transportation Authority, *National Transit Database Report (Section 15 Report) Fiscal Year 1995*; Los Angeles County Metropolitan Transportation Authority, *Section 15 Report Fiscal Year 1993*; Los Angeles County Metropolitan Transportation Authority, *Section 15 Report Fiscal Year 1994*.

[12] J. A. Gomez-Ibanez, "A Dark Side to Light Rail?" *Journal of American Planning Association*, Vol. 51, 1985, pp. 337–351; Pisarski, *Commuting in America: A National Report on Commuting Patterns and Trends*, Westport: Eno Foundation for Transportation, 1985; John Kain, "Choosing the Wrong Technology: Or How to Spend Billions and Reduce Transit Use," *Journal of Advanced Transportation*, Vol. 21, 1988, pp. 197–213; Pickrell, *Urban Rail Transit Projects*, 1990; Peter Gordon and Harry W. Richardson, "Notes from the Underground: The Failure of Urban Mass Transit," *The Public Interest*, Vol. 94, 1989, pp. 77–86; Martin Wachs, "U.S. Transit Subsidy Policy: In Need of Reform," *Science*, Vol. 244, 1989, pp. 1545–1549; Peter Gordon and Harry W. Richardson, "The Counterplan for Transportation in Southern California: Spend Less, Serve More," Reason Foundation Policy Report 174, 1994; James E. Moore II, "Ridership and Cost on the Long Beach-Los Angeles Blue Line Train," Transportation Research A, Vol. 27A, 1993, pp. 139–152.

participation might imply for rail construction, transit operations, and other MTA decisions.[13] The Congressional appropriation that was lobbied for intensively by the Authority has been reduced by more than half; and in December of 1996 (former) Secretary of Transportation Frederico Pena and Federal Transit Administrator Gordon J. Linton stated that the Department of Transportation might withhold $31 million in funds allocated to the agency by Congress. The General Accounting Office has reported that the agency does not have the fiscal resources to pursue its rail plan. In late October of 1996, the agency concluded two years of litigation by agreeing to mitigate the negative impact the MTA's rail plan has imposed on the bus services. U.S. District Judge Terry J. Hatter, Jr. has signed a consent decree in a law suit against the agency that is effectively a victory for the Bus Riders' Union, a grass-roots organization representing the MTA's largest client group. Former Chief Executive Joseph Drew, on the job less than a year following the firing of his predecessor, Franklin White, resigned under withering criticism from his own board of directors. The board's first two candidates for a permanent replacement declined the position.

This combination of recent events has brought the MTA to a crisis-point. The agency now finds itself committed to the FTA and the California Transportation Commission to construct rail lines it cannot afford to build or operate, while simultaneously under court order to decrease bus fares and increase service. Even prior to the action by the Bus Riders' Union, the MTA did not have sufficient funds to complete both the current subway extension to the East San Fernando Valley and the Pasadena Blue Line extension. The agency might yet finish one project or the other, but it can't finish both, much less the other eight rail lines it identifies as priorities.[14]

In the best case, the legal requirement to commit resources to bus service will force the MTA to acknowledge the trade-offs associated with rail construction and operation. If so, the MTA will finally be positioned to weigh seriously the advantages of a number of options it has ignored in the past. None of these options will keep the myriad promises made in rail's name, but nothing can.

B. Concerns About Congestion

Traffic congestion is a complex phenomenon. Congestion is dynamic and changes its geography by the season, time of day, and by day of week. As metropolitan areas in the United States have grown and dispersed, congestion has both mitigated and become more diffuse.[15] Still, U.S. productivity losses from congestion are estimated at up to $100 billion annually.[16]

Congestion is traditionally considered an external cost of travel that occurs because drivers do not usually pay for the time costs their transportation choices impose on others. The result is a misallocation of resources, including both motorists' time and the capital invested in road capacity. Traffic congestion occurs when peak-hour traffic on expressways rises above the economically efficient level.[17] This is the level at which the average total cost per driver (including operating costs, time, and any tolls) equals the average benefits to drivers of using the roadway. When traffic surpasses this optimal level, speeds fall so that average

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[13] Rubin and Moore II, "Ten Transit Myths," Reason Foundation, 1996; and Jeffrey L. Rabin, U.S. Transit Official Assails Subway Plan, *Los Angeles Times*, April 10, 1997 p. B3.

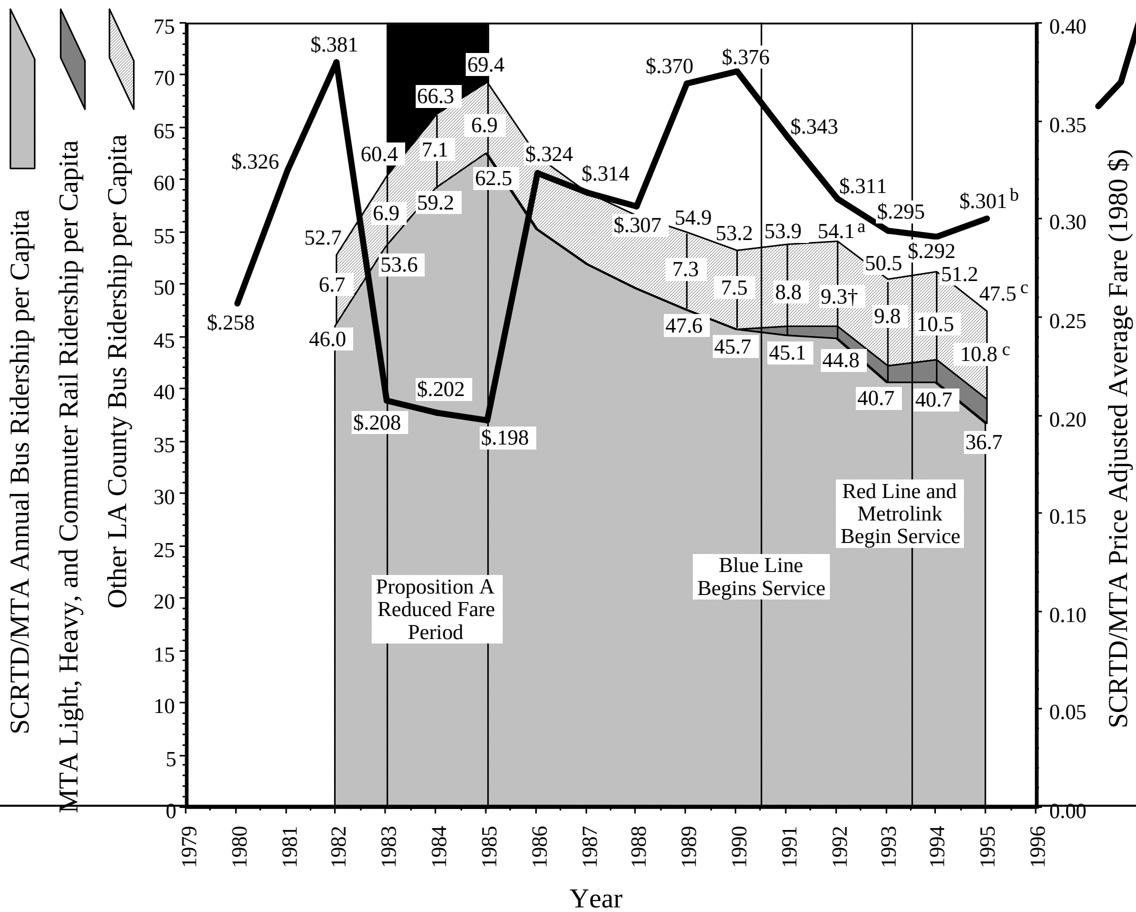
[14] Los Angeles County Metropolitan Transportation Authority, *A Plan for Los Angeles County: Transportation for the 21st Century*, Los Angeles, 1995.

[15] Peter Gordon, Harry W. Richardson and Myung-Jin Jun, "The Commuting Paradox: Evidence from the Top Twenty," *Journal of the American Planning Association*, Vol. 57, 1991, pp. 446–420.

[16] R. L. French, "Safety Implications of Automobile Navigation Systems," presented for the 46th annual meeting of the Institute of Navigation Atlantic City, NJ, June 26–28, 1990.

[17] Anthony Downs, *Stuck in Traffic: Coping with Peak Hour Congestion* (Washington, D.C.: The Brookings Institution, 1992).

Figure 2: Ridership Per Capita on SCRTD/MTA Buses and Other Los Angeles County Transit Compared to Price-Adjusted Average Fares[18]



cost rises above average benefit. At this point, drivers make individually rational but collectively inefficient choices concerning how much to travel, when to travel, where to travel and what route to take.

Downs describes four basic principles of traffic that determine the effectiveness of measures related to decreasing traffic congestion in urban areas, two of which are very relevant to policy making.[19]

1. *The imperviousness principle* states that no one suburb can adopt policies that will substantially affect the overall population or job growth of the metropolitan area. Therefore, if any one suburb limits growth within its own boundaries, the growth prevented there will just move elsewhere within or near the metropolitan area. Since traffic congestion arises because of movements throughout the metropolitan area, the local policies of individual communities cannot greatly affect the total amount of traffic.

[18] Price-adjusted average fares account for inflation and special discounts such as passes, token discounts, senior discounts, handicapped discounts, etc. LACMTA, *A Look at the LACMTA*, 1993; FTA, *Data Tables for 1993 National Transit Database Report Year*, FTA, Washington D.C., 1993; FTA, *Data Tables for 1994 National Transit Database Report Year*; LACMTA, *National Transit Database Report (Section 15 Report) Fiscal Year 1995*; LACMTA, *Section 15 Report Fiscal Year 1993*; LACMTA, *Section 15 Report Fiscal Year 1994;* U.S. Department of Commerce, Economic and Statistics Administration, Bureau of the Census, *Statistical Abstracts of the United States*, 1995; California Department of Finance, Demographic Research Unit, *California Demographic*, July 1995.

[19] Downs, *Stuck in Traffic*: *Coping with Peak Hour Congestion*, 1992.

2. *The principle of one-hundred small cuts* states that a metropolitan area can reduce its peak-hour traffic congestion only by applying many different remedies simultaneously in a coordinated manner.

These two principles summarize the difficulties associated with policy-based efforts to improve transportation service. To be effective, the policies must be coordinated regionally and institutionally; and coordination is expensive.

The Los Angeles response to congestion has been largely economic. Los Angeles' development is more recent than other large U.S. cities. Rapid growth occurred during a period in which the incentives for co-location of activities were relatively weaker than the incentives driving the land markets in older cities. At the same time, growth occurred during a period of rising income and growing demand for access to transportation services. The market for land in Los Angeles was able to respond to congestion costs by decentralizing employment to a degree unique among the largest U.S. cities. Consequently, the Los Angeles Central Business District (CBD) is of low economic importance relative to the CBDs of other large U.S. cities.

Los Angeles is perhaps the nation's weakest candidate for a downtown-focused transportation system such as rail. Transportation planning in Los Angeles requires an approach that recognizes the region's existing investment in congestion mitigation, i.e., an approach that emphasizes existing trends toward decentralization, not an approach predicated on the objective of defeating the market for urban land.

Figure 3 is a scatter plot with regression equations that estimate the rate at which CBD floor space in the nation's 20 largest cities changes with population. Excluding Los Angeles from the estimation procedure causes as a statistically significant increase in the estimate of the variation in floor space explained by the variation in population. This suggests that the Los Angeles coordinate is unique relative to the others, that it is the product of a different process.

Some scholars argue that land use in the United States is more a creature of policy-making than market responses. For example, Goldberg and Mercer identify a number of differences between Canadian and U.S. cities, suggesting policy explanations for the elevated densities in Canada.[20] Gordon and Richardson explain that the land markets in Canadian cities are behaving just like the land markets in U.S. cities, but are subject to a time lag.[21] The same argument applies to land uses in older U.S. cities relative to the Los Angeles benchmark. Los Angeles may not be so much an outlier as it is a leading indicator.

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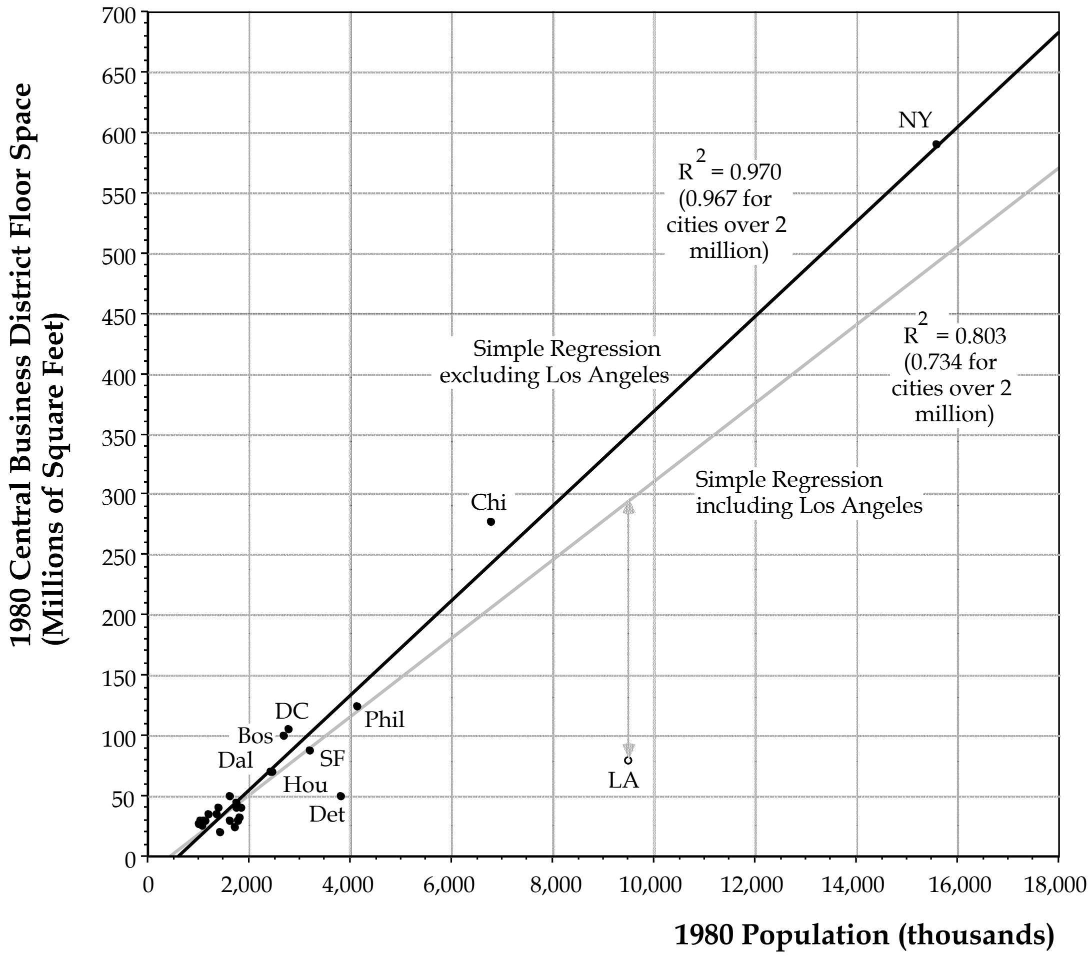
20 Michael A. Goldberg and John Mercer, *The Myth of the North American City* (Vancouver: University of British Columbia Press, 1986).

21 Peter Gordon and Harry W. Richardson, "Are Compact Cities a Desirable Planning Goal?" *Journal of the American Planning Association*, forthcoming; Peter Gordon and Harry W. Richardson, "The Case for Suburban Development," The Building Industry Association of Northern California and The Home Ownership Advancement Foundation, 1996.

Figure 3: Central Business District (CBD) Floor Space Versus Population for U.S. Urbanized Areas with Populations of One Million or More[22]



[22] *1980 Census of Population*, U.S. Department of Commerce, Bureau of the Census, December 1983, Vol. 1, Chapter C, Part 1, Table 246, "Summary of Social Characteristics for Areas and Places 1980: Urbanized Areas," pp. 1–354 to 1–359; Boris S. Pushkarev, Jeffrey M. Zupan, and Robert S. Cumella, *Urban Rail in America—An Exploration of Criteria for Fixed-Guideway Transit* (Bloomington: Indiana University Press, 1982). Exhibit 4.9, pp. 200–201, Table 4.1, pp. 202–203, and "Maps of North American Urban Rail Networks," p. 207, 1982.

Part 2

Alternative Transit Options

There are other transportation options of great importance to Los Angeles. The mainstay of Los Angeles public transit remains the bus, despite the relentlessly unimaginative ways most bus service is provided. Part of this unresponsiveness flows from limited role of the fare box in bus finances. Public buses are financed by tax revenues: the revenues provided by fares are almost irrelevant. Not even the most dedicated public transit official believes buses can compete effectively with single occupancy vehicles in the minds of those riders with sufficient income to opt for the private mode, and in most cases these experts' decisions lead to outcomes consistent with their assumptions. However, there are untapped markets for transit—markets that will remain untapped unless the level of bus service can be improved. There are a variety of ways this can be accomplished.

A. Focus on Buses

The most obvious limitation of rail, aside from its staggering expense, is its inflexibility. The exceptional capacity provided by exclusive guideways is real, but rail has no monopoly on this advantage. Buses on exclusive guideways do as well as trains in most respects, and better in others. Busway capacities meet or exceed the capacities of all rail lines except heavy rail trunk lines, in large part because busway speeds are higher. In addition, buses offer the special advantage of being able to leave the exclusive guideway, and operate at grade as collectors and distributors.

1. Busway Capacity

Busway capacities meet or exceed the capacities of all rail lines except heavy rail trunk lines, in large part because busway speeds are higher. Ottawa has the most extensive busway system in the world (34 miles), and has plans to almost double its system. Most of Ottawa's busways exclude HOVs. The longest such exclusive U.S. busway is in Pittsburgh. Houston will have 105 miles of HOV lanes by the end of the century. Most of these are reversible freeway lanes that were designed for automobiles, but to which buses were subsequently admitted. This almost doubles average bus speeds, from 26 MPH to 49 MPH.

There are at least three reasons busways are less expensive to construct than railways.[23]

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[23] Allen Biehler, "Exclusive Busways Versus Light Rail Transit: A Comparison of New Fixed Guideway Systems," *Light Rail Transit, New System Successes at Affordable Prices*, Transportation Research Board Special Report 221, 1988, pp. 89–97.

1. Busways are roadways, and there are more firms experienced in the design and construction of roadways than firms experienced in the construction of light rail;
2. Light rail lines are more likely to have subway segments; and
3. Even above ground, light rail has special design requirements associated with electrification, train control, computerization, rail alignment, weight, and other considerations.

Busways are also less expensive to operate than light rail lines. Busways do not need operations control centers, have simpler maintenance facilities, and do not require separate communication, power, signal, and propulsion systems. Broken down light rail cars present more of a problem than a malfunctioning bus.

Demonstrating the superior cost-effectiveness of busways is simple. Table 3 summarizes and compares aggregate cost and performance information for light rail systems and busways. The comparison relies on a format provided by Biehler, but includes updated cost figures.[24] The comparison includes Los Angeles' El Monte Busway/HOV(3) lane and the Long Beach Los Angeles Blue Line train. The El Monte facility consists of a dedicated lane in each direction along Interstate 10, running from Northeast of the Los Angeles CBD to just East of the City of El Monte. The transit ridership on the El Monte busway is four times greater per mile of guideway than the ridership on the Blue Line. Service is provided at more than twice the speed of the Blue Line. Details are provided in Table 4, along with comparisons to the theoretical maximum service levels achievable by rail systems and busways.

2. Common Carrier Options

The arguments for exclusive guideways are further strengthened if the buses involved are not restricted to a municipal franchise. The transit capacity delivered by the El Monte facility swamps the service provided by the Blue Line train by a factor approaching five, but transit accounts for only a small fraction of the passenger miles delivered by the El Monte. Most of the travel on this Busway/HOV facility is accounted for by HOV traffic. This suggests that throughput could greatly be increased if a larger proportion of the vehicles using the El Monte were buses. The most important reason for the paucity of buses on the El Monte busway is the difficulties associated with entering the bus business. If exclusive guideways for public buses are a better idea than exclusive guideways for trains, then guideways for public and private bus services may be the best idea of all.

The El Monte is not the only facility available to the MTA. The $498 million, 10.3 mile Harbor Transitway running above the Interstate 110 Harbor Freeway opened in June of 1996. Caltrans District 7 designed and built the facility with the intention that it provide priority bus and HOV service, but the facility receives no new use from MTA buses. Buses currently operating on the busway are serving lines that existed before the facility was constructed. No new service has been added. The agency has no buses to spare because agency's capital is tied up in rail facilities and rolling stock.

Alternatively, MTA may be avoiding more bus service on the Harbor Transitway to avoid competing with the Blue Line. The former SCRTD Planning Department forecast that expanding express bus service on the Harbor Transitway would reduce Blue Line ridership by 20 percent or more, even with zone based bus fares greatly exceeding the Blue Line fare. This predicted shift is due to reduced transfers, time savings, and access to downtown stations closer to the riders' ultimate destinations.

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[24] Biehler, "Exclusive Busways Versus Light Rail Transit: A Comparison of New Fixed Guideway Systems," 1988.

Table 3: Cost and Performance of Busways and Light Rail Systems

	Guideway Length[a]	Weekday Ridership	Ridership/ Mile	Capital Cost ($millions 1992)	Capital Cost/Mile ($millions 1992)	Annual Operating Cost ($millions 1992)	Operating Cost/ Passenger (1992 $)
Light Rail[b]							
Buffalo	6.4	29,200.	4,563.	854.4	133.5	13.7	1.8
Pittsburgh	10.5	30,600	2,914	736.1	70.1	9.6	1.2
Portland	15.1	19,700	1,305	314.8	20.8	6.9	1.4
Sacramento	18.3	14,400	788	222.5	12.2	8.2	2.2
San Diego	20.4	27,000	1,324	207.1	10.2	8.5	1.2
Los Angeles Blue Line	21.6[25]	36,669[26]	1,698	1,000+[27]	46.3	44.3[c]	3.68
Simple Average	15.38	26,262	2,097	555.8	48.9	15.2	1.91
Mile Weighted Avg.	n/a	26,132	1,708	518.4	36.1	17.0	2.05
Ridership Weighted Avg.	n/a	n/a	2,269	629.2	54.6	17.8	2.00
Busway[d]							
Pittsburgh East	6.8	29,000	4,300	156.2	23.0	3.7	.43
Pittsburgh South	4.5	18,000	4,500	42.6	9.5	3.0	.56
L.A. (El Monte)	11.5[28]	16,000[e]	1,400	103.4[29]	9.0	n/a.[f]	n/a.[f]
Simple Average	7.6	21,000	3,400	100.7	13.8	3.35	.50
Mile Weighted Avg.		20,272	2,763	107.1	13.3	3.42	.48
Ridership Weighted Avg.	n/a	n/a	3,621	110.3	15.6	3.43	.48

Notes:

a. These are bidirectional miles.

b. The data for the Buffalo, Pittsburgh, Portland, and Sacramento light rail systems are from Pickrell.[30] Costs have been adjusted to 1992 $.[31] The data for the San Diego light rail system are cost adjustments to figures provided by Biehler,[32] and are optimistic. The Blue Line data are from the MTA and Rubin and Moore II, as indicated.

c. MTA reports a Blue Line operating cost of $30,443,433 for fiscal year 1995.[33] This is incorrect because it excludes over $ 10 million in Blue Line security costs that were classified as bus expenses. The figure reported here is an average of fiscal year 1994 Blue Line costs[34] and the fiscal year 1996 Blue Line budget, ($43,943,461 + 44,700,000)/2.[35]

d. The two Pittsburgh facilities include the South Busway and the Martin Luther King Jr. East Busway. The Pittsburgh data includes price adjustments to Biehler's figures. The Los Angeles' El Monte busway consists of a dedicated lane in each direction along Interstate 10, running from the Northeast corner of the Los Angeles CBD to just East of the City of El Monte.

e. Most of the service on the El Monte busway is provided by Foothill Transit rather than MTA. This conservative estimate is based on a Caltrans survey reporting 49 buses per peak hour and an average occupancy of 31 passengers per bus. Adding two passengers per bus to account for mid-corridor boardings, and multiplying by 10 to convert peak hour totals to daily totals produces an estimate of 1,617 daily riders. This excludes HOV passengers, which is a much larger number.[36]

f. Biehler's operating cost basis is unknown, making it difficult to generate comparable values for the El Monte facility. Averages relating to operating costs are based on the two Pittsburgh facilities.[37]

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25 LACMTA, *National Transit Database Report (Section 15 Report) Fiscal Year 1995*, Form 403 LR DO.

26 LACMTA, *National Transit Database Report (Section 15 Report) Fiscal Year 1995*, Form 406 LR DO.

27 Rubin and Moore II, "Why Rail Will Fail," 1996.

28 LACMTA, *Section 15 Report Fiscal Year 1994*, Form 403/005.

29 Thomas A. Rubin and James E. Moore II, "Rubber Tire Transit: A Viable Alternative to Rail," Reason Foundation Policy Study No. 230, August 1997; U.S. Dept. of Commerce, Economic and Statistics Admin., Bureau of the Census, *Statistical Abstracts of the United States*, 1995.

30 Pickrell, *Urban Rail Transit Projects: Forecasts vs. Actual Ridership and Costs*, 1990; U.S. Department of Commerce, Economic and Statistics Administration, Bureau of the Census, *Statistical Abstracts of the United States*, 1995.

31 Rubin and Moore II, "Ten Transit Myths: Misperceptions About Rail Transit in Los Angeles and the Nation (Part 2 of a Series on the MTA)," July 1996.

32 Biehler, "Exclusive Busways Versus Light Rail Transit: A Comparison of New Fixed Guideway Systems," 1988; U.S. Dept. of Commerce, Economic and Statistics Admin., Bureau of the Census, *Statistical Abstracts of the United States*, 1995.

33 LACMTA, *National Transit Database Report (Section 15 Report) Fiscal Year 1995*, Form 301 LR DO.

34 LACMTA, *Section 15 Report Fiscal Year 1994*, Form 301 LR DO.

35 Los Angeles County Metropolitan Transportation Authority 1995–96 Budget, p. 26.

36 Rubin and Moore II, "Why Rail will Fail," Reason Foundation, 1996.

37 Biehler, "Exclusive Busways Versus Light Rail Transit: A Comparison of New Fixed Guideway Systems," 1988.

The standard arguments against privatization imply that transit is necessarily an inferior good, and that consumption decreases as income increases. But this does not have to be the case. The demand for transit is not a fixed quantity. Premium services can be provided that will compete effectively with the private automobile. The high level of service made possible by exclusive guideways is a potentially important part of this formula. Legalized private transit competing with public transit on the same exclusive guideway will greatly expand the market for transit services. The existing transit-dependent population would benefit from efficiencies induced by competition. These efficiencies would be expressed as some combination of lower fares, and increased quality and quantity of service.

Table 4: Peak Hour Ridership: El Monte Busway and the Blue Line

	Busway: Theoretical Maximum	El Monte Busway: Actual	Blue Line: Actual	Heavy Rail: Theoretical Maximum
Trains / Hour (Peak Direction)	720[a]	49	10	30[b]
Cars / Train	1	1	2	10
Average Vehicle Load	270[c]	31.2	62.6	301[d]
Average Operating Speed	55[e]	52	21	35[f]
Passenger Miles / Hour	10,692,000[g]	79,498	26,305	3,160,500

Notes:
a. This implies a headway of five seconds and vehicle separations of about 400 feet, which is feasible at speeds of 55 MPH.
b. Bay Area Rapid Transit (BART) is attempting to achieve headways as low as 2 minutes.
c. This is the passenger crush load for a double-articulated bus.
d. This is the passenger crush load for a Red Line car, which greatly exceeds the rating for BART cars.
e. This implies operating speeds of 65 MPH and skip-stop operations with full off-line stations.
f. This speed is possible if the distance between stations is large. BART operates in this range. One other U.S. operator exceeds 30 MPH, and most operate at much lower speeds.
g. This exceeds by a factor greater than four the combined capacity of all freeways serving the Los Angeles CBD.

3. Bus Tunnels

Placing a new emphasis on exclusive guideways for buses suggests a new destiny for the MTA’s light and heavy rail rights of way. The standard political perspective is that the MTA must finish the rail system to avoid wasting the resources it has already committed to the project. This is good public relations, but is gibberish from an economic point of view. The objective of the MTA (like everyone else) should be to spend the next dollar as wisely as possible, and ignore resources that cannot be retrieved from past mistakes. This approach helps firms and households maximize benefits and control costs, but leads to scrutiny of public sector failures. This scrutiny is something that agencies prefer to forego. Unfortunately, attempts to avoid scrutiny and controversy often lead to more uneconomic decisions, and larger failures.

At first glance, the MTA’s rights of way appear to be sunk costs; and as long as they remain obstructed by rail cars, they are. However, the capacity, range of services, and level of service available from these facilities can all be simultaneously increased by banishing the trains and substituting buses. This is certainly cost effective for the above ground rights of way, because these facilities could accommodate the existing bus fleet. Contrary to the example provided by the transitless Harbor Transitway, busways usually reduce vehicle requirements. The high speeds made possible by exclusive guideways, tends to reduce the size of the fleet needed to provide service, at least until the improved level of service the busway provides stimulates demand.

The existing bus fleet probably could not make use of the MTA’s underground rights of way: Vehicle emissions are too high. The MTA would have to emulate Seattle and place dual mode electric buses in the tunnels. Dual mode vehicles can operate from an external electric power source or as a standard diesel coach. Dual mode vehicles would allow bus tunnel operations to be integrated with operations on other exclusive rights of way, and to serve as collectors and distributors on streets. Even if dual mode buses were used only for collection and distribution related to underground service, this is more utility than a train can provide. Combining dual mode buses with exclusive, counter flow lanes on city streets would make even better use of these vehicles.

Converting the subway tunnels for use by electric buses would require a number of engineering changes. Facilities permitting vehicle access and egress to the street would have to be constructed. Further, most MTA rail stations are constructed with center platforms that require riders to board the left side of the vehicle. A few stations have outside boarding platforms requiring riders to board the right side of the vehicle. Tunnel buses would have to permit boardings from both sides, like trains. Alternatively, crossovers or flyovers would have to be constructed. These changes might or might not be more efficient than simply scrapping the trains and closing the tunnel, but there is reason to take the tunnel retrofit option seriously.

In 1990, Seattle opened a 1.3 mile bus tunnel running underneath its central business district. Project details are summarized in Table 5. Delivered on time and only ten percent over budget, the Seattle bus tunnel cuts transit travel time thru the CBD from 20 minutes to 8, and provides a 20 percent reduction in buses operating on the surface. About 25 percent of all rush hour bus trips through the downtown take place in the tunnel. Seattle Metro authorities predict this value will be 40 percent by the year 2000.[38] This impact is orders of magnitude greater than the Red Line's.

The Seattle tunnel includes rail track, and was constructed to eventually accommodate both buses and trains on the same right of way. The grade and clearance requirements associated with rail vehicles are more restrictive than bus requirements. If Seattle can accommodate buses in a facility built to handle trains, then so can Los Angeles. The MTA should research the option of retrofitting the Red Line tunnel for use by dual modes buses with a full scale engineering and cost study.

4. Automatic Transit Systems

Intelligent Transportation Systems (ITS) have important implications for public transit, though these are not the Advanced Public Transportation System (APTS) technologies conventionally associated with ITS/transit applications. Exclusive guideways for transit will also enhance the use of technology to further increase capacity. The institutional mechanisms for establishing technical standards needed by Automated Highway Systems (AHS) are much investigated, but remain largely unknown. The set of institutional decisions needed to implement an Automated Transit System (ATS) is no smaller, but standards are easier to establish if both the guideway and the fleet are under the control of public authority. It is technically simpler and more cost effective to establish an ATS system architecture for public transit vehicles with access to an exclusive guideway than it is establish standards for the AVCS elements required by private vehicles operating as part of an AHS.

Table 5: Cost and Performance of the Seattle Bus Tunnel[39]

[38] King County Department of Transportation, "Summary: The DownTown Seattle Transit Project," 1991.

[39] Robert Simpson, "Tunnel Notes," King County Department of Transportation—Metro Transit Division (METRO), 1994.

Capital Costs (1990 Costs Expressed in 1992 $)	
• Construction and Planning Costs[a]	$477.50 million
• Public Art	1.50 million
• 236 Dual Mode (Diesel/Electric) Buses and 2 Tow Vehicles[b]	124.00 million
Unannualized Total	$603.00 million
New or Incremental Operating Costs (1993 Costs Expressed in 1992 $)	
• Facility Maintenance	$2.66 million
• Security	1.00 million
• Operations Training	0.10 million
• Tunnel Communications	0.40 million
• Service Supervision	0.49 million
• Customer Information	0.02 million
• Vehicle Maintenance	1.51 million
Annual Total	$6.18 million
Sources of Planning and Construction Funds (1990 Sources Expressed in 1992 $)	
• Federal Government	$197.00 million
• King County / Municipality of Metropolitan Seattle (Metro)	280.00 million
• CBD Local Improvement District	2.00 million
Total	$479.00 million
Ridership	
• Observed (constrained by current fleet)[c]	40,200 / Weekday
• Theoretical (unconstrained fleet)[d]	18,000 / Hour

Notes:

a. This includes 1.3 miles of tunnels, 1 mile of which consists of twin bore 18 ft. diameter tubes; and 5 stations, 3 underground and 2 more open air, below grade facilities.

b. 173 buses are assigned to weekday tunnel service. 47 are assigned to Saturday tunnel service. The remainder are used on diesel surface routes, are used for spares and training, or are receiving maintenance.

c. Ridership is constrained by service level, which is constrained by fleet size. Current service levels consist of 843 bus trips per weekday, 250 bus trips on Saturday, and 110 buses per peak hour (55 in each direction).

d. This presumes 290 coaches per hour, 145 in each direction operating on 25 second headways.

Public transit entities have deeper pockets than households; and, at present, are less likely to be punished by the market place for taking risks than are private firms. Consequently, public transit agencies have demonstrated a willingness to experiment with alternative fuel vehicles, automatic fare payment systems, vehicle monitoring systems, new materials, and other technologies. They are equally likely to be willing to participate in ATS demonstration projects, particularly if participation is voluntary, and the on-vehicle components of the system are provided at no charge.

Thus a transit-first approach to automation circumvents the deployment problem that constraints AHS initiatives. However, once ATS technology is in the field, it will penetrate other, more risk-sensitive markets. Introducing private competition into the field provides an important intermediate step. Once technical standards have been established for public fleets, elements of these same standards can be applied to private transit fleets hoping to provide ATS services. Private fleet vehicles are more likely to be shuttle size than bus size, and thus the equipment designed for the transit entrepreneur could also be introduced into the consumer market.

B. Competitive Transit

The rationale for public transit systems is improved equity. Public resources are used to provide transit services because the objective is to serve those who would not otherwise be served, and to ensure at least a minimum degree of mobility and access for all. The objective is laudable, but the results usually are not. The goal of most bus riders is not a cleaner, faster, more timely, more responsive bus. The goal of most bus riders is automobile ownership. Public buses are usually the carrier of last resort, and the travelers who ride them are usually captives with no alternatives.

Municipal bus franchises are insulated from the economic forces that refine decisions in the private sector. Most of the income accruing to municipal operators consists of tax revenues. Because the farebox is usually irrelevant, there is no substantive way for public transit's market to punish the system for poor performance. Bus riders have no access to competing alternatives because competition is prohibited. Even if the bus rider does withhold his or her patronage, he or she is only withholding fare revenues, and these are miniscule. It is no surprise that municipal bus properties tend to be characterized by uneconomic decisions ranging from using vehicles that are too large to paying excessive wages, poor utilization of inventories, and hostility to the customer. Los Angeles is something of an exception. The MTA has been methodical about dismantling bus service, yet the system that remains is so crowded that bus capital at work in Los Angeles is achieving record efficiencies.[40]

One of the counter arguments to allowing private competition most frequently mounted by public transit agencies is that private providers of transit services will not be motivated by equity: They will be motivated by profit. If market barriers are dissolved and private enterprises are allowed to compete with public transit, these private operators will only serve profitable routes. Because the private operators will be smaller, their coordination costs will be lower, and entrepreneurs will be able to both provide a wider range of services than public transit and at the same time undercut public fares. This will effectively eliminate the fare box revenues available to the public operator, while leaving unprofitable routes unserved. Thus, the public operator would be left with fewer resources; and sole responsibility for addressing the equity objectives, i.e., for ensuring the mobility of those least able to pay.

This is a smoke screen. There is nothing new about private transit, particularly in Los Angeles. The nation's first jitneys were private Los Angeles automobiles used to provide short rides for nickel fares. The jitney innovation spread East across the U.S. before restrictive new regulations increased costs and put jitneys out of business.[41] The potential for jitney service in Los Angeles remains high: Los Angeles' ethnic immigrant community is an excellent source of both supply and demand, and the quality of the competition provided by MTA buses is low.

A wholly privatized market for transportation services would not treat the equity concerns conventional public transit was originally chartered to address. However, neither does the status quo. There is a genuine trade-off between equity and efficiency, but this does not mean that everything that is hopelessly inefficient automatically improves fairness. The MTA's performance would improve dramatically if the Authority faced the discipline imposed by competition. Private carriers should be allowed to compete with the MTA in the same market, with the rider free to select the best alternative, presumably the cleanest, most frequent, most responsive, least expensive service. Wealth transfers should not be implemented with subsidies to carriers, public or private. Instead, the subsidy should be provided to the rider in the form of a voucher.[42]

Wholesale privatization of the transit market, however desirable, is unlikely. Incremental changes are much more likely. The liberalization of the California Public Utility Commission's position with respect to airport

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[40] Rubin and Moore II, "Why Rail Will Fail," 1996.

[41] Maria Elena Lombardo "The Potential for Jitney in Los Angeles," Master of Arts Thesis, Urban Planning, University of California at Los Angeles, 1994.

[42] Rubin and Moore II, "Ten Transit Myths," 1996.

shuttle vans is an excellent example.[43] In this case, reducing unnecessary market barriers produced a burst of activity benefitting providers and consumers alike. Airport vans are an unsubsidized airport transit option that reduces congestion and subtracted 84.2 tons of emissions from the South Coast Air Basin in 1993.[44] The airport shuttle industry remains an intensely competitive, cost-effective alternative. Opportunity keeps the services available, competition keeps fares to an efficient minimum, and airport authorities keep the peace at the curb. Competition is so intense that the largest providers are beginning to call for new regulations for owner/operators. This is understandable, but undesirable. The largest operators face the highest coordination costs, and are being out competed by smaller, nimbler entrepreneurs.

The incentives for privatization reinforce the rationale for construction of High Occupancy Toll (HOT) lanes. Access to an extensive network of high occupancy lanes would greatly enhance the quality of service that could be provided by shuttle van operators. The level of service provided by public transit will never be sufficient to attract significant numbers of riders able to afford alternatives. These riders are sensitive to level of service. For them public transit is an expensive option: the level of service is too low to be acceptable. Combining an extensive network of HOT lanes with new opportunities to enter the transportation market would make it possible for transit entrepreneurs to configure new, flexible, relatively low cost, high level of service options that cannot be provided by public systems. The entrepreneurs who get it right will attract riders from single occupancy vehicles. The ones who get the formula wrong will either adjust to attract more ridership, or shift their carefully shepherded capital resources to other opportunities.

The case for reducing barriers to market entry (and exit) will almost certainly have to be made at the state and local levels: There is almost no genuine constituency for privatization in the federal Department of Transportation (DOT), quite the opposite; and most of the barriers are the product of state or local jurisdiction. Local rules are a jumble, so there is much to be learned from the changes that engendered the airport van industry. The same authority that permitted the California PUC to legalize airport vans could be used to create a private transit industry.

Perhaps the only regrettable aspect of the state legislature's decision to outlaw the SCAQMD's hated Regulation XV is the effect this has had on Transportation Management Associations and Organizations (TMA/TMO). Under Regulation XV, companies of 100 or more employees were required to file acceptable employee trip reduction plans with the SCAQMD. The plans did not have to succeed, but they were subject to District approval. Failure to achieve approval could lead to fines of up to $25,000 per day. This was an odious but compelling incentive for employers to sponsor or join active TMAs as one way of demonstrating commitment to the District's cause. Some of these TMAs were sources of considerable innovation with respect to providing private transportation alternatives to their members' employees. The legislature's weakening of Regulation XV and follow-on rules also reduced the role of the TMAs in promoting effective private transit.

Part 3

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[43] Robert Poole, Jr., and Michael Griffin, "Shuttle Vans: The Overlooked Transit Alternative," Reason Foundation Policy Study No. 176, April 1994.

[44] Poole, Jr. and Griffin, "Shuttle Vans," 1994.

Managing Congestion

Transit reform is critical for a host of reasons, but automobile-based travel will remain the first choice for a majority of Los Angeles residents for the foreseeable future. Given that no monolithic rail system is going to solve all our congestion problems, other approaches must be considered if the region is to maintain its economic vitality.

A. Short-Term Approaches: Building

1. HOT Lanes

Several models are available for introducing road pricing.[45] Successful implementation of congestion pricing in Los Angeles or anywhere else will have to include certain key elements. Public support for congestion pricing can be maximized if public authority:[46]

1. makes certain the scheme speaks to the public's largest concerns;
2. demonstrates that there are no effective alternative solutions;
3. predicts the revenue stream;
4. keeps the scheme as simple as possible;
5. anticipates technological problems and opportunities; and
6. addresses equity concerns.

Practical steps for facilitating the implementation of congestion pricing include:[47]

1. introducing charges for non-qualifying vehicles on high-occupancy vehicle (HOV) lanes which are under-utilized;
2. initiating tolls on new or improved segments with toll charges related to the cost for providing new capacity;
3. standardizing toll charges to make it simpler for the tripmaker to calculate the cost of the trip; and
4. developing compatible toll collection technology nationwide to allow nonlocal vehicles easy access to toll systems.

These steps are largely consistent with measures identified by the task force to Reduce Emissions and Congestion on Highways (REACH) and others. REACH was funded by the FHWA under ISTEA Section 102(b) in response to a proposal by SCAG and Caltrans; and included the South Coast Air Quality Management District (SCAQMD), the California Air Resources Board (CARB), MTA, LADoT, and several other foundations, agencies, and private sector groups. The Task Force has identified steps necessary to implement congestion and emission pricing in the region, and has investigated the effects of several

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[45] A. D. May, "Road pricing," 1992.; T. D. Hau, "Congestion Charging Mechanisms for Roads: An Evaluation of Current Practice," *World Bank Policy Research Paper Series*, WPS1071, Washington, D.C.: The World Bank, 1992.

[46] P. M. Jones, "Road Pricing: The Public Viewpoint," in Johansson and Mattsson (eds.), *Road Pricing: Theory, Empirical Assessment and Policy* (Boston: Kluwer Academic Publishers, 1995).

[47] DeCorla-Souza and Kane, "Peak-Period Tolls," 1992.

representative scenarios explored in an extensive telephone survey of Southern California residents by Resources for the Future (RFF).[48] The survey queried respondents about a variety of different toll schemes. Results indicated that approximately 40 percent of commuters would support congestion pricing even if no information is provided about how toll revenues might be used. This support approaches 50 percent if revenues are used to reduce taxes. Respondents tended to prefer tolls be restricted to new lanes rather than the leftmost lanes of existing freeways. Similar results apply to emissions fees. Support was disproportionately high among hispanic, asian, and less educated respondents; which is counter intuitive. The RFF survey suggests that Southern Californians are more open to congestion pricing than most researchers presume.

This is encouraging. Caltrans District 7 has scheduled many HOV lanes for Los Angeles County freeways. These lanes are to be funded in part with Proposition C funds from MTA, and are of central importance because they:

1. might yet be used to introduce an explicit pricing strategy if they are constructed as HOT lanes instead of HOV lanes;
2. present the option of conversion to HOT lanes following construction; and
3. will turn HOV lanes into a sufficiently pervasive option that travelers will be much more likely to car pool.

An HOV lane is a kind of toll lane. Users pay the toll by bearing the inconvenience of forming a car pool. Once an HOV lane and enforcement mechanism are in place, it becomes possible to consider additional pricing strategies. Eventually, existing HOV lanes might also be incrementally converted to HOT lanes. An incremental approach is important, because it introduces travelers to tolls, provides authorities with an opportunity to both demonstrate the benefits of congestion pricing and assess the circumstances under which the electorate will recognize and concur with these benefits.

2. Construction of New Facilities

As urban areas develop, the scarcity of space, high density land use, environmental constraints, the resistance of interest groups, and the presence of historical sites make planning and building new road capacity increasingly complex, expensive, and politically controversial.[49] In Los Angeles, Caltrans District 7 has no plans to undertake construction of new freeways. The agency is not anxious to entangle itself in another project likely to require the twenty years needed to complete the Glen Anderson (Century) Freeway. Instead, the agency has focused its attention on adding road capacity in incremental ways. These are

1. closing gaps in the existing freeway network, such as completion of the 710 Freeway through South Pasadena;
2. installation of new HOV lanes on the existing freeway network; and
3. better management of the existing road inventory via applications of technology, particularly Intelligent Transportation Systems (ITS).

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[48] Reduced Emissions and Congestion on Highways (REACH) Task Force, *Draft Final Report and Recommendations for Regional Market-Based Transportation Pricing*, prepared for Discussion by the REACH Task Force Strategy Committee for the Task Force Meeting on November 13, 1996; Gordon J. Fielding and Daniel B. Klein, "High Occupancy/Toll Lanes: Phasing in Congestion Pricing a Lane At a Time," Reason Foundation Policy Study No. 170, November 1993; Winston Harrington and Alan Krupnick, *Public Support for Congestion and Pollution Fee Policies for Motor Vehicles: Survey Results*, Resource For the Future, October 1996.

3. Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) is use of accurate, real-time information to the management of transportation services, and to enhance control of traffic flow and individual vehicles.[50] ITS technologies offer opportunities to

1. increase vehicle speeds and reduce travel time, thus reducing emissions, fuel consumption, and reducing congestion-related traffic accidents;
2. improve highway safety by reducing the number and severity of traffic accidents; and
3. increase highway productivity by improving equipment and personnel utilization, enhancing service to shippers, and providing better working conditions.[51]

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 includes the first national financial support for ITS programs and associated new technologies. The major element of ISTEA support is provision of a total of $659 million from fiscal years 1992 through 1997 in Federal Highway Administration (FHWA) contract authority to carry out the goals of the program; including:[52]

1. research and development;
2. field operational tests; and
3. deployment support activities in order to implement the components of ITS technologies.

Several ITS projects and operational tests are underway in Southern California, many of which are interjurisdictional. These are a mix of transit and highway projects. Examples include the following.

1. The SMART Corridor project involves Caltrans District 7, the Los Angeles Department of Transportation (LADOT), the MTA, and other partners. The corridor combines highway advisory radio, changeable message signs, emergency response, and coordinated inter-agency traffic management for the Santa Monica Freeway and five major parallel arterials running between downtown Los Angeles and the San Diego Freeway 14 miles to the west.
2. The City of Anaheim, Caltrans Headquarters, the Federal Highway Administration (FHWA), and other partners are testing an advanced second generation traffic control system in the City of Anaheim that will permit real time, automatic adjustment of the City's traffic signal timing via the Split, Cycle, Offset Optimization Technique (SCOOT).
3. Caltrans Headquarters, Caltrans District 7, the Ventura County Transportation Commission, the Federal Transit Administration (FTA), several local bus transit agencies, and other partners are proceeding with a multiphase deployment of an advanced Fare Transaction / Vehicle Monitoring System (FareTransVMS). This system combines radio frequency fare cards capable of automatic payment with automatic passenger counters and a geopositioning system capable of providing transit agencies with new information about service markets, and vehicle and line performance.
4. The City of Irvine, Caltrans Headquarters, Caltrans District 12, FHWA, and other partners are testing an integrated corridor management system designed to combine System Wide Adaptive

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49 R. Arnott and K. Small, "The Economics of Traffic Congestion," *American Scientist*, Vol. 82 , 1994, pp. 446–455.

50 G. W. Euler, "Intelligent Vehicle/highway Systems: Definitions and Applications," *ITE Journal*, Vol. 60, 1990, pp. 17–22.

51 D. K. Willis "IVHS Technologies: Promising Palliatives or Popular Poppycock?" *Transportation Quarterly*, Vol. 44, 1990, pp. 73–84.

52 E. D. Carlson, "Federal Actions to Deliver the IVHS Program," *ITE Journal*, Vol. 63 (1993), pp. 26–30.

Ramp Metering (SWARM) on freeways with simultaneous second generation traffic control of arterials via Optimized Policies for Adaptive Control (OPAC). The system is intended to be implemented on a new hardware platform defining a new national standard for traffic signal controllers.

5. Caltrans, LADoT, and the Federal Highway Administration have tested the deployment of a traffic signal controller that uses spread spectrum radio for communication rather than relying on a cable plant. This approach has the potential to expand the number of traffic signals that might be coordinated by reducing the cost of connection to the system.

6. The Southern California Association of Governments (SCAG), MTA, and LADoT are committed to a Smart Shuttle Demonstration Project. Smart Shuttles are characterized by technology supporting a flexible, demand responsive service design intended to deliver lower travel times compared to existing local bus services. Smart Shuttles may operate in different modes at different times of day, including:

    - *Route Deviation:* Vehicles operate in a defined corridor on a semi-fixed schedule. Passengers access service by calling and requesting a pick-up within the corridor, or by flag stop. Once aboard, passengers may request a drop-off anywhere within the corridor.
    - *Point Deviation:* The service schedule is semi-fixed with relatively few stops in a corridor or zone. Aside from designated time-points and stops, drivers are allowed to operate as a curb-to-curb service. Passenger requests for pick-up are generally called in to a central dispatcher, or made at a designated stop. Drop-offs are made as requested on-board or through advance reservation.
    - *Subscription:* Customers subscribe in advance for service to routine trips. A service route is developed from requests and pre-scheduled.
    - *Public Dial-A-Ride or Shared-Ride Taxi:* Customers call in and request service. Most trips can be accommodated within 15 minutes of the request. Service is curb-to-curb.

    The goal of the demonstration project is to test the market, operational, and technological feasibility of Smart Shuttle alternatives for a franchise with access to centralized scheduling, dispatching, and maintenance; but with minimum or no other operating assistance.

7. SCAG, Caltrans Headquarters, Foothill Transit, the FTA, and several cities in the San Gabriel Valley are partnering to deploy the Athena real time rideshare matching system. Athena builds on the Los Angeles Smart Traveler (LAST) system initiated by Caltrans District 7, the FTA, the MTA, and others. Unlike precursor systems, the Athena system is designed to permit real time vehicle dispatches and tour changes.

The ultimate objective of developing ITS technologies for highways is creation of advanced vehicle control systems that would make possible a fully automated highway system. There are three stages in the evolution of advanced vehicle control systems.[53]

1. Basic AVCS augments driver performance by detecting the presence of obstacles or other vehicles, and warning drivers of loss of alertness and impending collisions.
2. Second-generation AVCS will implement lateral and longitudinal vehicle control functions in such applications as high occupancy vehicle lanes. Vehicles would enter the lanes under manual control, but once there would be under full or partial automatic control, allowing for platooning.
3. Third-generation AVCS would completely automate driving functions for vehicles on specially equipped freeways.

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[53] R. K. Jurgen, "Smart Cars and Highways Go Global," *IEEE Spectrum*, Vol. 28, 1991, pp. 26–36.

Substantial congestion relief is expected to result only from the more advanced vehicle control system technologies.[54] A fully operational AHS might provide capacity increases up to 300 percent, increasing maximum volumes from 2,000 vehicles per hour per lane to 6-8,000 vehicles per hour per lane. Such capacity gains are technically feasible, but the implementation of ITS technologies will face barriers relating to financing, legislation and jurisdiction considerations, possible liability problems, standardization requirements, and user acceptance. It is unclear that deployment of this technology will overcome these various institutional, coordination, and behavioral barriers to implementation. Further, it is unclear this level of technology is affordable. The consumer market for ITS technologies is highly uncertain. The rate at which ITS technologies will penetrate the private vehicle fleet is subject to consumer sovereignty. Some ITS technologies will increase the purchase price of a vehicle.[55] Households are very sensitive to price. Individuals will invest in new vehicle technologies of only if the technologies are relatively inexpensive, and simplify driving tasks.

The major institutional obstacle to the deployment of compatible ITS infrastructure is the multiplicity of state and local governmental authorities with jurisdiction over infrastructure elements, each jurisdiction operating with its own priorities, experiences, laws and rules. City and county authorities are not necessarily in favor of making arrangements with state and federal authorities for the implementation of these technologies.[56] This impedes the development of standards. Technological standards are an important requirement for the implementation of ITS technologies, because these systems must be compatible nationally. For example, an automatic merge system can smoothly engage vehicles to form platoons only when the transmitters, receivers, and shared information are fully compatible.[57]

Some ITS technologies might also be perceived as an invasion of privacy. Law enforcement agencies might want to use ITS information to issue speeding tickets, but most Americans would resent this.[58] However, consumers might welcome these technologies as a tool to retrieve stolen vehicles, or to apprehend criminals.[59]

B. Long-Term Approaches: Pricing

The theory of congestion pricing has been illustrated repeatedly by transportation economists.[60] In 1844, the French engineer Dupuit demonstrated that the benefit of crossing a bridge was greater than the fare travelers paid. During the early 1920s, Pigou and Knight laid the groundwork for a theory of road pricing.[61] Travelers decide whether or not to use a particular facility by weighing the costs they will have to bear against the benefits to themselves. If the benefits to the user exceed or are equal to the costs to be borne by the user, the traveler will decide to use the facility. Congestion pricing involves charging drivers more to travel at times and in locations at which congestion costs are high. It provides a means of better aligning the price of

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54 U.S. General Accounting Office, *Smart Highways: An Assessment of their Potential to Improve Travel—Report to the Chairman, Subcommittee on Transportation, Committee on Appropriations*, Senate, Washington, D.C.: Government Printing Office, 1991.

55 U.S. General Accounting Office, *Smart Highways*, 1991.

56 J. Costantino, "Overcoming Institutional Barriers to IVHS," *Transportation Quarterly*, Vol. 48, 1994, pp. 3–13.

57 U.S. General Accounting Office, *Smart Highways*, 1991.

58 J. Costantino "IVHS America Two Years Later," *ITE Journal*, Vol. 63, 1993, pp. 19–22.

59 J. Costantino, "Overcoming Institutional Barriers," 1994.

60 R. L. Pretty "Road Pricing: A Solution for Hong Kong?" *Transportation Research A*, Vol. 22A, 1988, pp. 319–327; P. DeCorla-Souza and A. R. Kane, "Peak-period Tolls: Precepts and Prospects," *Transportation*, Vol. 19, 1992, pp. 293–311.

61 A. C. Pigou, *Wealth and Welfare* (London: MacMillan, 1920); F. H. Knight "Some Fallacies in the Interpretation of Social Cost," *Quarterly Journal of Economics*, Vol. 38, 1924, pp. 582–606.

automobile use with the full social cost of travel. The goal is to encourage people to avoid traveling at the most congested times or on the most congested routes. Travelers might respond by using alternative modes, by shifting to less crowded routes, or by deferring travel to a time period at which the roads are less crowded.[62]

Road pricing and congestion pricing are distinct. Road pricing corresponds to a toll collected from the drivers for using a certain facility. The toll recovers the capital, operating and maintenance costs of the infrastructure. Road prices may account for the size and weight of the vehicle, but do not account for traffic conditions. The fee is the same for both free-flow and congested traffic.

Congestion pricing refers to controlling travel demand by pricing congestion externalities.[63] The price for using a segment of the road can vary depending on the time day, or on traffic conditions. Congestion tolls and their implementation can be further classified into three categories, depending on purpose.[64]

1. If the objective is to raise revenue for road building in a politically acceptable way, then the maximum number of people should pay the minimum charge, and the charge should be uniform throughout the week.
2. If the objective is to reduce congestion in a specific area, then charges should vary by time of day to reflect congestion, being greatest at peak periods, and minimal or zero when traffic is light. High occupancy vehicles should not pay tolls.
3. If the objective is to reduce emissions over a larger area, charges would also probably be collected during a longer period of time and some preferential treatments should be afforded low emission vehicles.

Both congestion and roadway pricing face formidable challenges in moving from blackboard to implementation, but in the long-term, the likely benefits from such reforms would be well worth the efforts.

1. Benefits of Congestion Pricing

The most important advantage of congestion pricing may be that it offers the road user freedom of choice to make the trip and pay the fee, change time or route, or use an alternative transportation mode.

Congestion tolls should induce travelers to:

1. cancel their planned trip or postpone it to a less crowded time;
2. use a different route;
3. use an alternative transportation mode instead of their private automobile;
4. form a carpool instead of driving alone; or
5. change the destination of their trip to avoid the area or the road where congestion pricing is enforced.

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62 Wachs, "Learning from Los Angeles," 1993.

63 T. D. Hau, *Economic Fundamentals of Road Pricing: A Diagrammatic Analysis* (Washington, D.C.: The World Bank, 1992).

64 P. Jones and A. Hervik "Restraining Car Traffic in European Cities: An Emerging Role for Road Pricing," *Transportation Research A,* Vol. 26A, 1992, pp. 133–145.

Since tolls will generally mean less traffic on the network during the peak hours, congestion pricing also reduces emissions. Traffic flows would increase during off-peak periods, but the total traffic volume will be reduced. Improvements in peak period traffic conditions will also produce some reduction in emissions from vehicles remaining on previously congested highways. Pollution in some areas might be made worse if the network in these areas comes into use by drivers who change their routes to avoid congestion tolls.

Thus a congestion pricing program produces a combination of positive and negative effects.[65] Toll road users have to pay a fee. This is a negative consequence for this group if the use of the infrastructure was previously free. Also, trip-makers who change their behavior will experience increased inconvenience, because they are shifting to less preferred transportation modes, routes, and times. On the positive side, certain travelers will encounter less congestion, and people living in previously congested areas may face fewer environmental externalities.

This combination of positive and negative effects implies that implementing tolls is likely to create winners and losers. Anticipating these effects provides a way of establishing categories of people most directly affected by the introduction of congestion pricing.[66]

1. People currently driving alone on congested highways during peak hours will face higher user fees, coupled with an improvement in level of service. Users with very high values of time will benefit. They will find that the service improvements more than offset the new fees.
2. Those for whom the alternatives to driving during peak hours are particularly unattractive may lose because they have to pay the fee, though their trip will require less time.
3. Some others will respond to higher peak period fees by switching to alternative modes, times, routes, or destinations; or will forego the trips altogether.
4. Some might find that alternative modes such as carpool or bus become so much faster, due to reduced congestion, that they are willing to use these modes after the implementation of tolls rather than driving alone.
5. People currently using high-occupancy modes subject to congestion will mostly benefit, because they will receive the full benefit of improved travel time, but with a more modest (or zero) cost increase. However, current transit passengers will likely experience a lower level of service inside the vehicle if ridership increases during peak hours, at least until the transit fleet is expanded.
6. And people using highways outside the scope of the pricing scheme but close enough to be alternative routes will experience increases in traffic and travel time.

The REACH Task Force's Draft Report summarizes effects conservatively projected for a low-end pricing scenario that combines a charge of $.10/mile on congested freeways, $.05/mile on less congested freeways, and an emissions charge with a weighted average of $.016/mile. These charges correspond to a fee of $.74 for a 12 mile, peak period trip across representative proportions of surface streets and freeways. Effects projected include:[67]

1. an increase of 24 pecent in speeds on congested freeway segments during PM peaks;

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[65] Johansson and Mattsson, "Principles of Road Pricing," 1995.

[66] Kenneth A. Small, "Using the Revenues from Congestion Pricing," *Transportation*, Vol. 19(4) (1992), pp. 359–381.

[67] REACH Task Force, *Draft Final Report*, 1996..

2. no significant adverse impact to network regional average speed;
3. an increase of 18 pecent in High Occupancy Vehicle (HOV) use; and
4. an increase of ten pecent in transit use.

In addition, the report predicts reductions in particulates, total organic gases, oxides of nitrogen, and carbon monoxide equal to or greater than the reductions projected for the SCAQMD's regional employer commute option Rule 2202 (previously Regulation XV), and the District's unimplemented Indirect Source Rules.

More broadly, the Task Force predicts that emissions fees charged per mile of highway will:

1. reduce vehicle miles traveled and number of trips;
2. increase demand for alternative modes;
3. change trip patters by inducing trip chaining; and
4. increase demand for low emission vehicles.

The Task Force predicts congestion tolls charged per mile of congested freeway will lead to:

1. shifts to off-peak travel;
2. increases in
   - travel speeds on priced routes;
   - demand for alternative modes;
   - HOV use;
   - use of non-priced surface streets serving priced freeway corridors; and
3. benefits to travelers with high value of time.

Emission and congestion fees are predicted to contribute to:

1. long range changes in origin/destination requirements;
2. reductions in vehicle ownership; and
3. increased demand for telecommuting/compressed work weeks.

2. Challenges to Pricing Reform

Locally, the MTA's history of rail addiction remains a genuine threat to all other major transportation projects, including implementation of tolls. If the MTA does not abandon the rail plan, the Authority will have to continue to divert resources from other activities to the rail system. The consent decree makes it more difficult for the MTA to shift bus funds to rail projects. Consequently, funds currently budgeted for Regional Surface Transportation Improvement (RSTI), Transportation Systems Management and Transportation Demand Management projects are now at risk, and these are exactly the expenditures on which toll schemes depend.

Further, despite the enthusiasm of researchers and economists, the level of implementation suggested by specialists will likely be difficult to achieve in the United States. Tolls might contradict a fundamental American belief that mobility is a right.[68] Congestion pricing might be seen as a reversal of traditional U.S. transportation policy because some travelers would be priced off roads and onto less preferred modes.

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68 Genevieve Giuliano, "An Assessment of the Political Acceptability of Congestion Pricing," Transportation Research, Vol. 19A, 1992, pp. 335–358.

Congestion pricing also faces a number of additional barriers. These include the opposition of interest groups, uncertainty about equity and privacy effects, widespread misunderstanding of the concept, and other legal and political considerations.

a. Interest groups

The political feasibility of congestion pricing depends on the responses of at least the following groups.[69]

1. The traveling public can be a very large voting block, organized by groups such as the American Automobile Association (AAA). The interests of people who use the transportation system extensively include reducing congestion, and keeping taxes and user charges low.
2. State and local officials must reconcile the public's demand for services, including transportation, with strong resistance to taxes. Many of these officials have career interests in the construction of public works, whether efficient or not. Thus state and local officials are interested in the financing opportunities the revenues from congestion pricing might provide.
3. State and local officials in agencies supplying mass transit services and transit unions jointly seek increased levels of transit funding. Taxicab operators want to ensure continued demand for their services by reinforcing market barriers, and authorization to pass on any increases in their costs.
4. Trucking organizations are dedicated to higher design facilities, full access for trucks, and financing mechanisms that do not target heavy vehicles. Congestion pricing might be viewed as a restriction on truck movements.
5. Local businesses depend heavily on reliable timing of deliveries, and are very concerned about congestion delays, but also want to maintain their flexibility. Congestion pricing provides several benefits for development interests, because it provides a revenue source for financing new facilities, and because a more efficient transportation system would make it possible for existing facilities to support more intensive development.[70]
6. Other lobbying groups formed around problems of growth and environmental quality focus on problems such as air pollution, noise, water runoff, and loss of scenic values and wildlife. These groups oppose most proposals to expand the highway system, but have shown considerable sophistication in their willingness to endorse tolls intended to internalize emissions costs.[71]
7. A number of disparate organizations have successfully united to oppose tax increases. Some of these groups are amenable to higher user fees, but consistently argue that these revenues should be used to replace other taxes.

b. Privacy

Computerized vehicle tracking and toll billing systems might constitute an invasion of privacy if these systems enabled governments to trace the movements of individuals. However, privacy concerns need not be an obstacle to adopting congestion pricing systems.[72] Prepayment schemes would allow tolls to be collected without recording exactly where individuals are at any given moment. Subscribers might also choose to receive a nonitemized total bill, with details expunged from the system's central computers.

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[69] Small, "Using the Revenues," 1992.

[70] Giuliano, "An Assessment of the Political Acceptability," 1992.

[71] Michael Cameron, Letter to the Editor, *Los Angeles Times*, October 15, 1996 p. B6.

[72] Downs, *Stuck in Traffic*, 1992.

b. Complexity

Unfortunately, road users are unlikely to fully understand the principles and the benefits of congestion pricing. Many consumers do not recognize the role of the prices system as a means for allocating scarce resources, instead perceiving prices as a threat to wealth. Further, there is considerable uncertainty in predicting the results of even a very specific pricing proposal. Outcomes would depend on the level of tolls, how they vary by time of day, where they are imposed, what travel substitutes are available, and how tolls are spent.[73] Congestion tolls are immediate and tangible, while time savings are not.[74] Many people do not believe that tolls will cause people to shift to alternative transportation modes, nor that tolls could be set high enough to substantially reduce traffic congestion.[75] It is likely people will consider the individual effects of this complex measure, and may see it as a new tax instead of taking into account pricing's overall impacts on traffic congestion and emissions.

c. Legal Constraints

Federal law generally prohibits tolling roads built with federal funds, but user taxes may be allowed.[76] The distinction between a toll and a user tax relates to the timing of collection. Tolls are collected when the privilege is exercised. User taxes are not. Thus an area license scheme or an electronic system with monthly bills might be allowed on federally funded facilities, since time of collection is separate from time of passage.[77] Further, there is no federal prohibition against charging tolls on state and local roads, and these comprise a large portion of the road inventory. Total U.S. toll highway mileage was 5,176 miles in 1985. This figure includes 2,691 miles that are part of the interstate highway system, but were not built with federal support.[78] This inventory might be expanded further if transportation agencies and the U.S. DOT identify acceptable transportation asset exchanges. There are precedents suggesting federal interest in interstate facilities could be exchanged for interests in other state assets, thus turning interstates into locally funded assets free of federal restrictions.

d. Political Constraints

Introducing an abstract, market-based measure is not as politically attractive as building a new bridge or new mass transit facilities. Congestion pricing offers less political prestige, in part because its impacts are less certain and more diffuse. Thus, congestion pricing is a politically fragile initiative, particularly vulnerable to political opposition and inertia.[79] It is difficult to secure the sequence of legislative and administrative approvals necessary to implement large-scale pricing plans. Reasonably large scale demonstrations are needed to make the case that congestion pricing should play a significant role in reducing traffic congestion. But the larger the scale of the project, the more likely it is to evoke opposition.

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[73] Giuliano, "An Assessment of the Political Acceptability," 1992.

[74] K. J. Button, "Road pricing—An Outsider's View of American Experiences," *Transport Review*, Vol. 4, 1984, pp. 73–98.

[75] P. Jones and S. Harvey, "Urban Road Pricing: Dealing with the Issue of Public Acceptability—A United Kingdom Perspective," Working paper TSU669, Transport Studies Unit, University of Oxford, United Kingdom, 1991.

[76] R. Coit, *"Legal Issues Surrounding Roadway Pricing on City Streets and Bridges," Transportation Research Record*, No. 494, 1974, pp. 1–10.

[77] S. A. Morrison, "A Survey of Road Pricing," *Transportation Research A*, Vol. 20A, 1986, pp. 87–97.

[78] U.S. Congressional Budget Office, *Toll Financing of U.S. Highways*, Congress, Washington D.C.: U.S. Government Printing Office, 1985.

[79] A. M. Howitt, "Downtown Auto Restraint Policies: Adopting and Implementing Urban Transportation Innovations," *Journal of Transport Economics and Policy*, Vol. 14, 1980, pp. 155–167.

f. Incidence and Equity

The information and administrative burden of managing equity effects is the single most important barrier to the implementation of congestion pricing. Higher income travelers are more willing and able to pay congestion charges. One possible interpretation of congestion pricing is that lower income travelers would be priced off the roads so the higher income travelers could proceed faster and in greater comfort.[80] Many low-income drivers would find ways to reduce their fee payments by coming to work early, taking more roundabout routes, or sharing rides on an occasional basis.[81]

In the short run, low- and average-income travelers with long one-way commutes on congested highways and no feasible alternatives might suffer if congestion pricing is implemented.[82] In the long run, these travelers would respond to incentives to avoid heavy congestion charges by changing residences, changing jobs, or negotiating new work hours permitting off-peak travel.

Perhaps the most striking prediction provided by the REACH Task Force is the prospect that the efficiency gains associated with congestion pricing may be sufficient to suggest pricing has much smaller equity implications than most assume, particularly if tolls are rebated. Table 6 summarizes preliminary calculations summarizing the vertical and horizontal equity impacts of the REACH Task Force's base case pricing scenario. These projections are sensitive to a number of assumptions, particularly with respect to how toll revenues are rebated to individuals. These are crude bench marks at best. The Task Force calls for much further study.

3. Administration: Setting, Collecting, and Using Tolls

a. Setting Tolls

The optimal congestion charge maximizes the difference between the benefits of reduced road congestion and the loss of convenience to people priced off the roads.[83] This suggests peak-period charges should be just high enough to divert the minimum number of vehicles needed to achieve the desired level of service, but they should not be so high that surrounding roadways become clogged due to diversions.[84] Theory provides some guidance, but in many situations choosing the right tolls will almost certainly involve trial-and-error. This is an advantage. Tolls are adjustable: Toll systems can be implemented even if the best level for tolls is not known before hand.

If the toll takes into account real traffic conditions, this charge will vary according to the level of congestion measured on the network. Dynamic pricing schemes are theoretically elegant and technologically feasible, but consumers are likely to prefer simpler peak/off-peak pricing schedules to a completely variable toll.[85] Neither is it clear that a completely variable toll is optimal: Human information processing constraints may preclude travelers from making the best use of this information. Tolls will likely vary in a published way by place, day, time of day, or according to historical congestion levels, and would be subject to periodic adjustments. Initial tolls should probably be too high rather than too low: It simpler to reduce these charges than to increase them.

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80 K. U. Bhatt, *What Can We Do about Urban Traffic Congestion?—A Pricing Approach*, Washington D.C.: The Urban Institute, 1976.

81 Small, "Using the Revenues," 1992.

82 Small, "Using the Revenues," 1992.

83 Small, "Using the Revenues," 1992.

84 A. Downs, *Stuck in Traffic*, 1992.

85 Giuliano, "An Assessment of the Political Acceptability," 1992.

Based on 1990 figures for the San Francisco Bay Area, Small suggests that effective road pricing would require peak-period charges of between $.054 and $.362 per mile, depending on the location.[86] By comparison, the charge estimated for Atlanta in 1989 would be approximately $.182 per mile. Based on delay costs, DeCorla-Souza and Kane report a toll charge of $.16–.33 per mile on congested highway facilities would achieve large economic savings through reduction of congestion.[87]

The tolls considered for Los Angeles by the REACH Task Force are similar.[88] REACH scenarios include congestion tolls ranging from zero to $.05 per mile on uncongested freeways, and $.10 per mile to $.30 per mile on congested freeways. Emission fees ranged from $.01 per mile to $.05 per mile on all highways.

b. Collecting Tolls

Simple road pricing systems have been successfully introduced using manual payment systems, but such schemes have a number of limitations. Manual systems do not provide any significant opportunity to vary charges. Permits can be used to minimize transactions costs; but, once purchased, permits encourage vehicle use.

Many technologies in advanced states of development in the Europe, Japan and the U.S. will enable road charges to be collected electronically. Currently charges can be collected from the road user via:

1. automatic vehicle identification (AVI) with on-board devices;[89] or
2. electronic charging via scanning a prepaid card, with no vehicle identification needed.[90]

If an Automatic Vehicle Identification (AVI) system is used, each vehicle carries a passive electronic tag or an Electronic Number Plate that is read in motion by roadside equipment. Each vehicle has a debit account that is credited with advance payments or a credit account tied to a credit card. AVI systems have been deployed worldwide at many toll plazas since the mid-1980s. Available technologies include optical and infrared systems, inductive loop systems, and radio frequency and microwave systems. Tags are mounted in or on the registered vehicles and are programmed with unique identifiers. The reader system includes a radio frequency transceiver, an antenna, digital logic and software that are connected to antennas placed at strategic locations. When a tag on a vehicle in a read zone receives the signal, it modifies a portion of the signal and reflects it back to the antenna with the tag's identifier. The identification code is then validated against an user database.[91] A sign outside the vehicle warns the driver when the account is low or overdrawn.

Such off-vehicle equipment is only suitable for imposing cordon or point charges. The principal advantage of this approach is the simplicity of the equipment that must be placed in the vehicle. Its principal disadvantage is its perceived threat to privacy: A central record is created of each vehicle's movements.[92]

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86 Small, "Using the Revenues," 1992.

87 DeCorla-Souza and Kane, "Peak-period Tolls," 1992.

88 REACH Task Force, *Draft Final Report*, 1996.

89 Jones and Hervik, "Restraining Car Traffic in European Cities," 1992.

90 B. Johansson and L.-G. Mattsson, "Principles of Road Pricing," in Johansson and Mattsson (eds.), *Road Pricing: Theory, Empirical Assessment and Policy* (Boston: Kluwer Academic Publishers, 1995).

91 A. J. Lampe, "Effects of Road Access Pricing at the Los Angeles Airport: A Case Study," *ITE Journal*, Vol. 63, 1993, pp. 216–222; S. Yacoubi, "An Electronic Toll and Traffic Management System," *Microwave Journal*, Vol. 37, 1994, pp. 64–72.

92 Adolph D. May, "Road Pricing: An International Perspective," *Transportation*, Vol. 19, 1992, pp. 313–333.

Table 6: Net Equity Impacts of Pricing, With Selected Mitigation Measures[93]

	Income Quintile				
	1	2	3	4	5
Median Income per Capita	$4,108	$7,767	$11,923	$18,167	$37,951
Share of Income	5.1%	9.7%	14.9%	22.7%	47.5%
Share of Vehicle Miles	8.8%	15.5%	18.9%	24.8%	32.0%
Share of Transit Person Miles[94]	22.2%	20.2%	19.1%	16.7%	21.8%
Assumed Value of Time per Hour	$2	$4	$5	$8	$15
Net Annual Transportation Benefits Per Capita: 1991 Base Case	$647	$1,439	$1,988	$2,888	$3,752
Net Annual Transportation Benefits Per Capita: 1991 Priced Case[a]	$666	$1,490	$2,061	$3,034	$4,042
Percent Change: Pricing[b]	+3%	+4%	+5%	+5%	+8%
Percent Change: Pricing + Coupon[c]	+10%	+3%	+3%	+2%	+4%
Percent Change: Pricing + Enhanced Transit[d]	+7%	0%	+1%	0%	+1%
Percent Change: Pricing + Coupon + Enhanced Transit	+22%	+7%	+6%	+4%	+4%

Notes: a. 90 percent direct rebate to individuals. b. $.05/mile on uncongested freeways, $.10/mile on congested freeways, and an average emissions fee of $.016/mile on all highways.
c. $100 coupon good for vehicle maintenance and repair of public/private transportation alternatives.
d. Moderate public investment and addition market enhancements such as smart shuttles.

AVI technology also offers a large number of other possibilities, including potential for automatic collection of traffic data relating to traffic counts, trip matrices, journey times, routes and axle counts. In addition to collecting tolls, the system could also be applied to automatic payment of fuel or parking charges. Finally, introducing two-way communication between onboard vehicle computers and roadside equipment is an important step in the development of automatic route guidance and in-vehicle driver information systems.[95]

Smart card systems include an in-vehicle unit, stored value smart cards, and overhead gantry structures at each charge point. The driver pays to increase the stored value on the card. Charges are deducted as the vehicle passes charging points, permitting more elaborate charging schemes. A meter in the vehicle indicates the level of the account. Under a cordon or point charging scheme, when the vehicle approaches the charge point, a gantry antenna communicates with the in-vehicle unit via microwave transmission, informs the in-vehicle unit of the location of the vehicle, and instructs the in-vehicle unit to deduct a certain amount from the smart card. The in-vehicle unit deducts the charge from the card and communicates with an antenna on a second gantry to confirm that the charge has been made. Alternatively, charges can be based on the time spent in an area. In this case, gantry communications trigger the in-vehicle unit to start recording time and is informed of the rate at which to charge for the time spent in the area. The in-vehicle unit is triggered again to stop recording and make the charge when the vehicle leaves the area.[96]

c. Using Toll Revenues

Simultaneous consideration of implementation strategies and equity effects inevitably leads to the question of how toll revenues should be used. Implementation of congestion pricing will generate large toll revenues. The REACH Task Force projects that its base case pricing scenario might benefit close to $4 billion per year

93 REACH Task Force, *Draft Final Report*, 1996.

94 Michael Cameron, "Efficiency and Fairness on the Road: Strategies for Unsnarling Traffic in Southern California" (New York: Environmental Defense Fund, 1994).

95 J. A. L. Dawson and I. Catling, "Electronic Road Pricing in Hong Kong," *Transportation Research* A, Vol. 20A, 1986, pp. 129–311.

96 May, "Road Pricing," 1992.

by 2010.[97] Assuming system costs of ten percent, net revenues might be $3.5 billion per year. A report to the California Air Resources Board includes revenue estimates of almost $3.2 billion for an average South Coast toll of $.10/mile in 1991, and revenues of more than $7.3 billion by 2010.[98] The MTA's current total expenditures are just under $3 billion.

Economic theory suggests the most efficient use of toll revenues is the construction of new roads. If new facilities are not institutionally feasible, or if opportunities for equity improvements are deemed more important than efficiency concerns, then toll revenues might be used for other purposes. Toll revenues might be used to reduce sales, property, and other general taxes;[99] and to redress the inequities caused by congestion pricing by providing various tax advantages to lower income groups, and by improving and expanding public transportation.[100]

If revenues from congestion tolls are redistributed, one strategy is to fund such a variety of programs that nearly everyone affected will experience some compensatory benefits. Small defines other measures for redistributing congestion toll revenues intended to transfer a larger share of efficiency gains to the groups most burdened by congestion charges. [101]

- Toll revenues could be used to reduce road user taxes. Fuel taxes and motor-vehicle license fees are regressive because auto ownership and use rise less than proportionally with income. Reducing these fees helps offset the regressive effects of the congestion fees.
- Congestion fees could replace all or part of any regional sales taxes dedicated to transportation programs.
- A substantial portion of funding for highway construction and maintenance is derived from local general revenues. Tolls revenues could be used to fund a property tax rebate that would reduce this hidden subsidy to automobile use.
- Funding new highway capacity would appeal to the traveling public, the highway industry, developers, and land owners served by the new capacity. It would be viewed unfavorably by environmentalists, but there is a redeeming feature. By applying congestion pricing to any new facility, the facility's design capacity can be smaller than it would otherwise have to be.

4. From Blackboard to Blacktop: U.S. and California Initiatives

Operational tests of congestion toll schemes were considered in the United States during the 1970s. Between 1973 and 1978, the predecessor of the Federal Transit Administration, the Urban Mass Transportation Administration (UMTA), worked with several cities in the United States in an attempt to implement congestion pricing demonstrations in central business districts. Beginning in 1976, then Secretary of Transportation Coleman wrote to the mayors of about a dozen cities about the availability of a road pricing demonstration under the Office of Service and Methods Demonstration Program. The offer included funding for administration, enforcement and evaluation of a window sticker or license scheme. Half a dozen localities, including Boston, San Francisco, Berkeley, Honolulu, Madison, and Ann Harbor responded by requesting assistance with preliminary assessments. During 1976 and 1977, Urban Institute staff and

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[97] REACH Task Force, *Draft Final Report*, 1996.

[98] Elizabeth Deakin and Greig Harvey, *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy and Equity Impacts*, Draft Final Report prepared for California Air Resource Board (Deakin Harvey Skabardonis, Hillsborough NH, June 1995).

[99] Small, "Using the Revenues," *Transportation*, 1992.

[100] Giuliano, "An Assessment of the Political Acceptability," 1992.

[101] Small, "Using the Revenues," 1992.

consultants began preliminary studies for Berkeley, Madison, and Honolulu. However, opposition by interest groups was so strong that none of the sites elected to proceed to a demonstration project. As a result, UMTA effectively abandoned congestion pricing in the late 1970s.[102]

Government interest in congestion pricing renewed in the 1980s because of shrinking fiscal resources, rising construction costs, growing environmental concerns, and increasingly effective community resistance to major infrastructure development.[103] The most significant impetus for the congestion pricing still comes from the federal government. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 establishes a congestion pricing pilot program under the auspices of the Federal Highway Administration. Section 1012(b) of the act authorizes the Secretary of Transportation to create a congestion pricing pilot program by entering into agreements with up to five states, local governments, or other public authorities to establish, maintain, and monitor congestion pricing projects. The Act allows federal funding up to $25 million for each of the fiscal years 1992 through 1997 for both public and private toll highway projects, significantly relaxing restrictions on the use of tolls to finance federally funded projects. Three of these agreements might involve the use of tolls on the Interstate highway system. The program is expected to be retained in the 1997 ISTEA reauthorization.

President Clinton has recently proposed changes in law that would permit states to charge tolls on interstate freeways and to use these revenues to improve transportation. The proposal is part of the administration's legislative submission for reauthorization of the federal transportation budget. Other elements of the President's proposal are less impressive, including the diversion of highway trust funds to other purposes. Ideally, the federal government would devolve Interstate highway revenues and responsibility for maintaining Interstate highways to the states.

New toll roads have been constructed or are in the planning stages in many areas of the United States. The nation's most advanced implementation of congestion pricing began on Orange County's new State Route 91 Express Lanes toll road in December 1995. This $126 million, ten-mile toll facility extends from State Route 55 to the Riverside County line, includes two lanes in each direction, and is located in the freeway median of the Riverside Freeway in Orange County, California. It is the world's first fully automated toll road, and the first privately funded toll road to be constructed in the United States in 50 years, and the first private toll road to be built under California law. The State Route 91 Express Lanes rely on an AVI system. The one-way fare collected for using this facility ranges from $.50 during off peak periods to $2.75 during rush hours. Peak and far off-peak rates are scheduled to be increased in October of 1997. The static toll structure accurately reflects the level of congestion that a motorist would expect to encounter at any given time. Carpools of three or more use the facility without charge.

All other motorists must have a toll account and are issued a dashboard transponder, or "FasTrak," encoded with the individual motorist's account number. These accounts may be prepaid with a credit card. Traffic speeds and vehicle counts are accurately recorded by means of inductive loop detectors. Variable message signs provide the traffic condition information, and display the current fare. Upon entering the toll lane, an antenna marks the time of entry to the toll lane. When exiting the lanes, another sensor reads the transponder, computes the toll, and transfers the account number to a business management system that debits the motorist's account.

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[102] T. J. Higgins, "Road Pricing Attempts in the United States," *Transportation Research A*, Vol. 20A, 1986, pp. 145–150; B. Arrillaga, "U.S. Experience with Congestion Pricing," *ITE Journal*, Vol. 63, 1993, pp. 39–43.

[103] Giuliano, "An Assessment of the Political Acceptability," 1992.

The FasTrak transponder is also in service on Orange County's State Route 73. The San Joaquin Hills Transportation Corridor is a new, 15-mile extension of State Route 73 that connects with Interstate 5. The facility opened in 1996. The Corridor is one of the four Transportation Corridors being built in Orange County by Transportation Corridor Agencies (TCA). Others include the Foothill North, Foothill South, and Eastern Transportation Corridors. A TCA is a private/public partnership that exists only until the construction is complete and construction bonds have been repaid. Upon completion of construction, Caltrans assumes ownership of and maintenance responsibility for the Corridors.

The Corridor is designed with an electronic road toll collection system that allows FasTrak subscribers to enter the facility at full speed. The one way toll rate is $2 for the entire length of the Corridor. Tolls vary by entry and exit points. Staffed or automatic coin machine toll plazas are provided as alternatives.

The road tolls collected on State Route 73 are intended to recover costs, not reduce congestion. But if the facility is as successful as the TCA hopes, using tolls for congestion management will eventually become an attractive option, and the technology to do so will already be in place. The construction cost of the Corridor, including deferred work, is $823 million. Nonconstruction cost include costs for right of way, finance, and administration costs. About $1.2 billion in tax exempt, nonrecourse, toll revenue bonds were issued to fund construction of the Corridor. Other funds for design, administrative and construction costs have come from development impact fees, California general funds, and gasoline taxes.

Part 4

Conclusion

There is much the MTA can and should do to improve public and private transportation in Los Angeles without further wasteful investment in rail systems.

There are ways to leverage the current investment in the Los Angeles rail system that are likely to be both economically and politically sensible. Exclusive rights of way do not have to be dedicated to trains. The MTA can build busways instead, facilities with greater flexibility, lower costs, and higher capacities than rail lines.[104] Existing rail rights of way can be retrofitted for use as exclusive busways. Buses can be granted priority access to city streets along the Blue Line right of way and elsewhere.

The new federal interest in tolls can be both leveraged and refined by drawing on Southern California's technological experience and expertise.[105] Southern California is fast becoming a leader in the construction, franchising, and operation of toll roads. Tolls can be used to pay for new facilities, but the real payoff is the opportunity they provide for controlling congestion by requiring drivers to pay the cost of the delay they impose on others. An electronically collected toll turns price into a lever for controlling demand and managing level of service. And electronic toll collection technology is just the tip of the ITS iceberg. The potential benefits from ITS technologies are substantial, but the systems are difficult to deploy, largely for institutional reasons. These institutional barriers suggest that the prospect of an operational automated highway system is remote. The institutional climate is better for automated transit system deployments, particularly if exclusive guideways are available for buses.

Many of the MTA's services might be privatized to improve efficiency. Alternatively, entrepreneurs can be allowed to enter the transit market and compete with the MTA, allowing the Authority to remain a public entity, but forcing it to accept the discipline imposed by market decisions. Los Angeles' existing, planned, and potential investments in HOV and HOT lanes would provide important opportunities for private transit, if such enterprises were legal.

At minimum, the MTA should proceed aggressively to meet its obligations under Judge Hatter's consent decree to the court and the Bus Riders Union. The consent decree provides the best sort of institutional latitude for doing the right thing without publicly reversing itself. The MTA should stop manipulating the definitions of funding categories to permit rail expenditures, and vigorously fund construction of more HOV and HOT lanes. In the longer term, the MTA can develop funding sources unburdened by the agency's "rail only" tag. The MTA doesn't have to ask local voters nor the federal government for rail funds. The agency can ask instead for bus capital and operating funds.

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[104] Thomas A. Rubin and James E. Moore II, "Rubber Tire Transit: A Viable Alternative to Rail," Reason Foundation Policy Study No. 230, August 1997.

[105] Elizabeth Shogren, "Clinton Offers Plan for Tolls on Interstates," *Los Angeles Times*, March 13, 1997, p. A1; David Haldane, "Tolls Seen as Road to Expansion," *Los Angeles Times*, March 23, 1997, pp. A3, A29.

Part 5

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We dedicate this paper to the memory of Greig Harvey and his work.

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