TRANSIT COOPERATIVE RESEARCH PROGRAM

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TCRP Report 27

Building Transit Ridership

An Exploration of Transit's Market Share and the Public Policies That Influence It

Transportation Research Board
National Research Council

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An Exploration of Transit's Market Share and the Public Policies That Influence It

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Boston, MA

Subject Areas

Planning and Administration
Public Transit

Research Sponsored by the Federal Transit Administration in Cooperation with the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY PRESS
Washington, D.C. 1997

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academy of Sciences, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

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The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP REPORT 27

Project H-4A FY'93
ISSN 1073-4872
ISBN 0-309-06252-7
Library of Congress Catalog Card No. 97-62202

Price $41.00

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Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

and can be ordered through the Internet at
http://www.nas.edu/trb/index.html

Printed in the United States of America

FOREWORD

By Staff
Transportation Research Board

State and local transportation officials constitute the primary intended audience for TCRP Report 27, *Building Transit Ridership: An Exploration of Transit's Market Share and the Public Policies That Influence It.* This includes elected and appointed board members who deal with local transportation policy, transit agency officials, transit agency professionals, and metropolitan area transportation planners. The report addresses transit's ridership and its share of the travel market. The research explored a variety of different public policies and transit management actions that can potentially influence transit ridership, particularly in comparison to local travel by private vehicle. The policies are presented through case studies, which are summarized in the report and documented in greater detail in the accompanying appendices.

TCRP Project H-4A addressed transit ridership and its share of the local travel market. The research examined a number of different policies that might be pursued at a local or metropolitan area level, with or without federal or state government encouragement, that have some potential for increasing or maintaining transit's market share.

The policies examined in this project were diverse, ranging from transit system pricing and service adjustments (which can be carried out unilaterally by a transit agency) to initiatives that would affect land use development and the cost of automobile travel (which require significant interagency and possibly private sector cooperation). The strategies included in this project were ones viewed as having some potential for affecting transit ridership positively, but did not include certain promising policies—such as parking management and pricing—that are being addressed through other, concurrent TCRP studies.

The report presents the current context for transit's market share, describes public policies that affect the market share, and reviews traveler behavior and its implications for transit. Having provided this framework, the report examines initiatives that may help to maintain or improve transit ridership, and summarizes the major research findings. The report includes 14 appendices that present the research results in greater operational detail. Eight of the appendices are case studies of initiatives, carried out by transit systems in the United States and Canada, for which ridership gains were one of the explicit or implicit objectives.

Each case study describes the transit system, presents a program or strategy, evaluates its impacts, and presents a summary and conclusions. The case studies were Metro-North's *Hudson Rail Link*, GO Transit's (Ontario) fare and service integration policies, the Twin Cities' *Team Transit* program, Tidewater Regional Transit's timed transfer system, Seattle's *U-Pass* and *Flexpass* programs, Portland's *Fareless Square* program, land use and transit coordination in Metropolitan Toronto, and pricing of road use (and other traffic limitation) strategies. Chapter 6 of the report presents cross-cutting impressions and observations drawn from the case studies. This chapter also addresses the transferability of the results to other locations.

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AUTHOR ACKNOWLEDGMENTS

This work was sponsored by the Federal Transit Administration and was conducted in the Transit Cooperative Research Program (TCRP), which is administered by the Transportation Research Board of the National Research Council.

The research reported herein was performed under TCRP Project H-4A by Charles River Associates Incorporated, UMA Engineering Ltd., and Dr. Mark D. Hickman of the Partners for Advanced Transit and Highways program at the University of California at Berkeley. Charles River Associates is the contractor for this study. UMA Engineering Ltd. is under subcontract to Charles River Associates, and Mark Hickman is a consultant to Charles River Associates.

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BUILDING TRANSIT RIDERSHIP: AN EXPLORATION OF TRANSIT'S MARKET SHARE AND THE PUBLIC POLICIES THAT INFLUENCE IT

SUMMARY

TCRP Project H-4A is concerned with *transit's ridership* and its *share of the market*. The project has examined a number of different policies that might be pursued at a local or metropolitan area level—with or without federal or state government encouragement—that have some potential for increasing transit's market share, or at least maintaining it under otherwise unfavorable market conditions.

The set of policies examined is a diverse and somewhat idiosyncratic one: it ranges from quite micro-level service adjustments made unilaterally by a transit operator, through initiatives requiring significant interagency cooperation, to strategies that would markedly affect the travel conditions of the whole metropolitan area, whether using transit or a private vehicle. The choice of policies was influenced, in part, by a wish to avoid otherwise promising options (such as parking management and pricing) that are the subject of more intensive investigation in ongoing TCRP peer studies.

The main elements of the study are a survey of local areas (in the United States and Canada) identified as pursuing potentially interesting policies from a transit ridership viewpoint, and subsequent detailed case study investigations of a small subset of the ones thought most promising. It was originally hoped that *quantitative* measures of success could be derived for each strategy, but the data necessary for detailed causal analysis were lacking in many cases. Consequently, the report is short on general conclusions about the conditions for "success." Nevertheless, each case study provides valuable insights into the workings of particular types of policies in a particular local setting.

The primary audience visualized for this report is the state or local transportation official, with the hope that it will stimulate local thinking and (possibly) debate.

SETTING THE CONTEXT

Transit's Current Market Share

The most recent available evidence—the journey-to-work data from the 1990 Census of Population—confirms yet again the conventional wisdom about transit's primary role. Table 1 shows that 1990 ridership levels and market shares are very strongly associated with development densities, and are therefore highest in the core areas of the nation's most densely developed cities.

TABLE 1 Transit share of work trips in major metropolitan areas, 1990

	Population density (persons/ sq. mi.)	Transit share to work (%)
New York City	2,446	26.9
4 MSAs with population 3+ mn., density 1,000+ per sq. mi.	1,238	10.5
6 MSAs with population 3+ mn., density < 1,000 per sq. mi.	573	5.8
10 MSAs with population 2 to 3 mn.	522	4.6
18 MSAs with population 1 to 2 mn.	470	3.3
All 39 MSAs with population 1+ mn.	664	8.7

Source: Charles River Associates, derived from data in Rossetti & Eversole (1993).

Table 2 shows that transit's traditional markets of relative strength—commute trips *within* the core area, and trips from the suburbs to the central area—have been growing at a much slower rate than have intrasuburban, "reverse commute," and exurban trips. Moreover, by all measures, transit market share appears to have fallen quite markedly for all types of area between 1980 and 1990 (at least for travel to and from work). In most places the increase in the employment base was not able to compensate fully for the dropoff in transit shares, and the volumes of transit work trips consequently declined.

TABLE 2 Transit market share for work trips by metropolitan area residents, 1990 and 1980

	1990	1980	Change, 1980 to 1990
Commute trips by all modes (millions)			
central city to central city	24.3	22.9	+6.2%
suburbs to central city	15.3	13.9	+9.6%
suburbs to outside MSA	6.8	3.9	+72.3%
suburbs to suburbs	35.4	27.7	+27.5%
central city to suburbs	6.0	4.6	+29.8%
central city to outside MSA	1.9	1.3	+48.1%
all commute trips by MSA residents	89.6	74.4	+20.5%
Transit share of commute trips (%)			
central city to central city	13.2	16.1	-18.0%
suburbs to central city	5.3	8.0	-33.2%
suburbs to outside MSA	6.4	7.6	-15.4%
suburbs to suburbs	1.2	1.6	-28.0%
central city to suburbs	5.1	5.6	-8.5%
central city to outside MSA	8.3	7.3	+13.7%
all commute trips by MSA residents	6.0	7.9	-24.9%
Distribution of transit commute trips by geography (%)			
central city to central city	60.2	62.5	
suburbs to central city	15.0	18.9	
suburbs to outside MSA	8.1	5.1	
suburbs to suburbs	8.0	7.5	
central city to suburbs	5.7	4.4	
central city to outside MSA	3.0	1.6	
all commute trips by MSA residents	100.0	100.0	

Source: Charles River Associates, using data from the 1990 Census journey to work questions and from tables developed by Pisarski (1996).

However, there were some cities that apparently experienced an increased volume of transit trips to work between 1980 and 1990, as shown in Table 3. Most notably, these were New York, Washington DC, and Los Angeles, where the job growth outpaced transit's loss of market share. Also notable were the performance of the bus systems in a few sunbelt cities (Houston, San Diego, and Phoenix) that were able to withstand the decline in transit share experienced elsewhere.

Outside the New York CMSA, which alone accounts for over one-third of the nation's transit trips, transit riders are often thought to be markedly skewed toward women, minority racial groups, and lower-income households. The 1990 Census data summarized in

TABLE 3 Changes in transit work trip market shares, 1980 to 1990

	% change in market shares			Change in trips (thousand		
	bus	rail	bus & rail	bus	rail	bus &
Houston CMSA	29%		29%	21	0	22
Phoenix MSA	3%		3%	7		7
San Diego MSA	-1%		-1%	12	0	12
New York CMSA	-7%	-10%	-9%	52	93	145
Los Angeles CMSA	-10%		-10%	45	1	46
Miami CMSA	-23%	1800%	-11%	-1	8	7
Washington DC MSA	-37%	50%	-11%	-20	78	59
Chicago CMSA	-23%	-13%	-19%	-45	-11	-56
Boston CMSA	-33%	-2%	-20%	-14	26	13
San Francisco CMSA	-32%	32%	-20%	-31	37	6
San Antonio MSA	-20%		-20%	0		0
Philadelphia CMSA	-15%	-26%	-20%	3	-15	-13
Tampa MSA	-22%		-21%	2	0	2
Seattle CMSA	-24%		-24%	1	0	1
Baltimore MSA	-35%	352%	-26%	-19	11	-8
Buffalo CMSA	-36%		-29%	-10	2	-8
Denver CMSA	-31%		-31%	-9	0	-9
Pittsburgh CMSA	-32%	100%	-31%	-31	1	-30
Indianapolis MSA	-31%		-31%	-4		-4
Milwaukee CMSA	-31%		-31%	-13	0	-13
Dallas CMSA	-33%		-33%	-5	0	-5
Sacramento MSA	-39%	2300%	-33%	-1	2	0
Detroit CMSA	-34%		-35%	-17	0	-17
New Orleans MSA	-35%		-35%	-16		-16
Portland CMSA	-37%	1300%	-36%	-11	1	-10
Cincinnati CMSA	-36%		-36%	-9		-9
Atlanta MSA	-47%	54%	-38%	-11	9	-2
Minneapolis-St. Paul MSA	-39%		-39%	-22		-22
Columbus MSA	-41%		-42%	-4		-4
Cleveland MSA	-42%	-40%	-42%	-35	-2	-37
Providence MSA	-49%	3800%	-44%	-8	1	-8
Kansas City MSA	-49%		-49%	-9		-9
St. Louis MSA	-49%		-49%	-24		-24

Source: Charles River Associates, based on 1990 Census data in Rossetti & Eversole (1993)

Table 4 partially confirm these generalizations, but perhaps less forcefully than might be expected. While private vehicle availability and race/ethnic background appear very important, and larger proportions of women than men do take transit to work, the market shares for the lowest income categories are not markedly higher than those for the general population.

The Role of Public Policies

Consumer Choices in Urban Transportation

Travel is usually viewed as a "derived demand," undertaken because the traveler wishes to engage in certain other activities that require his or her presence at a particular physical location. There are in fact many related decisions involved in any specific travel choice.

Figure 1 posits a hierarchical structure for these various interrelated decisions. The most fundamental, least frequently reconsidered, most pervasive impact decisions appear at the top of the figure. As one moves down the page, the decisions progress from macro to micro choices, culminating in the choice of mode for a specific trip.

The arrows in the figure chart the *general flow* of causal influence from the macro to the micro decisions, but the arrows should not be thought of as implying a one-way street. Short-term choices can strongly influence the longer-term choices. The key point here is that mode choice decisions—the micro behavior that, in aggregate, determines transit's market share—are the result of a very broad range of related consumer choices, some of which are being made every day and others of which may be reconsidered once a decade (or even less frequently).

Analysis of Mode Choice Decisions

Quantitative analysis of the factors influencing urban mode choice has been undertaken using a number of different methods, including both cross-sectional analysis of the effects of variations in price or service levels across a metropolitan region and time-series analy-

TABLE 4 Traveler characteristics and transit market share for work trips, 1990

	Total USA	New York CMSA	Rest of USA
Overall transit market share	5%	26%	4%
Groups with high market shares			
no-vehicle households	39%	64%	29%
black, non-hispanic	15%	45%	11%
asian, pacific islander	11%	38%	7%
hispanic	11%	40%	7%
renters	9%	40%	6%
one-vehicle households	8%	32%	6%
females	6%	27%	4%
individuals earning $75k+ (1989)	6%	27%	2%
Groups with low market shares			
four-vehicle households	1%	6%	1%
three-vehicle households	2%	9%	1%
two-vehicle households	2%	12%	2%
homeowners	3%	17%	2%
white, non-hispanic	3%	18%	2%

Source: Census of Population, 1990.

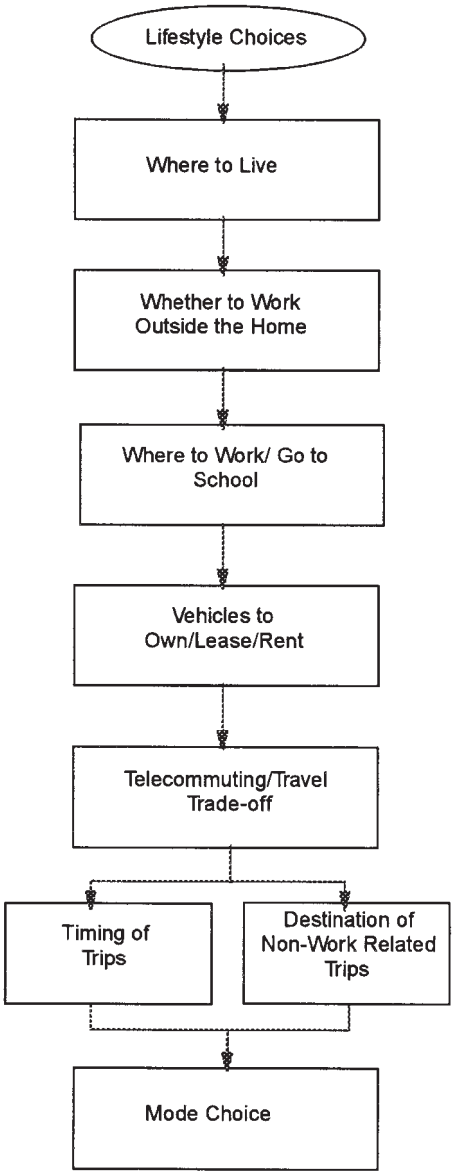

Figure 1. A hierarchy of the consumer decisions influencing mode choice.

sis of changes in usage levels of one or more modes over time. This research has shown that transit ridership, in particular, is influenced by five general types of factors:

- *Levels of travel-inducing activities*. Since travel is predominantly a derived demand, as the levels of those activities that require passenger transportation change, so can the demand for transit service be expected to change.
- *Price and other characteristics of the service*. The price and various aspects of the level of service provided by the transit system have been shown by substantial previous research to affect the level of ridership. At a national level, variations in fares and vehicle miles operated "explain" about 80 percent of the year-to-year variation in transit trips made.
- *Other transportation options*. The price and service characteristics of substitute and complementary modes of travel may also be expected to influence transit passenger volumes.

- *Characteristics of the population served*. The market for transit services comprises individuals with heterogeneous tastes, and the level of demand can be expected to vary between different demographic and socioeconomic subgroups of the population.
- *Other factors.* Other determinants of transit patronage levels that are not easily classified into the above four categories include, for example, variations in the weather and changes in public tastes over time.

From the quantitative analysis of local travel behavior, using both observed behavior in the real world ("revealed preferences") and opinion survey responses ("stated preferences"), a number of reasonably robust "rules of thumb" have emerged:

- ***Travel times* are relatively important.** The studies uniformly show that the travel time implications of travel alternatives are a highly important determinant of consumer choices.
- **Not all time savings are equal.** The time spent getting to and from motorized transport, or waiting for the vehicle to arrive or depart appear to be more onerous than the time spent actually traveling in the vehicle.
- **Prices do matter.** While out-of-pocket costs are less important than travel time, other factors being equal, people will choose the least expensive alternative.
- **However, demand is usually inelastic with respect to price.** For all aspects of urban travel demand (gasoline consumption, toll road usage, transit patronage, and so on) price increases will typically lead to revenue increases.
- **"Comfort" and "convenience" are usually important.** In studies that have made serious attempts to measure the effects of "comfort," "convenience," and other hard-to-quantify influences, they often prove to have a significant impact on consumer choices.

Public Policies That Potentially Affect Travel Choices

While the mode choice process may be driven most strongly by consumers' lifestyle choices, every stage of this process is nonetheless affected by public policies at all levels of government. Table 5 summarizes the most significant of these polices, highlighting how they may affect mode choice decisions.

Implications of the Understanding About Travel Demand for Public Policies

Transit managers and other local agency officials in the 1990s must be responsive to a wide range of objectives and influences, including (very importantly) concerns about maintaining established services; balancing budgets (in which user revenues are usually a minority component); legal constraints; public safety; and social equity and political considerations. Responding to marketplace signals about demand is often well down the list of management priorities, for understandable reasons. Nevertheless, in balancing the many competing objectives, the factors affecting transit ridership cannot (and should not) be ignored completely. The policy prescriptions that can be inferred from the research into travel demand can be characterized, over simply, as

- Stick to traditional transit territory (that is, dense corridors within the central city, or from the suburbs to the central city).
- Concentrate good service on the most responsive areas and groups.
- Don't be overly concerned about fare levels, but rather focus on providing good service where you can best compete with private vehicle travel. Another very important

TABLE 5 Summary of mode choice impacts of public policies

Transportation Investment Policy • Infrastructure spending directly affects the relative attractiveness of each mode • Transit operating assistance can help to maintain, improve, or expand services • Research and development funding provides innovations in the provision of transportation services
Transportation Pricing Policy • Taxes and tolls make automobile use more expensive • Fare policy determines cost of transit trips • Local policies dictate taxi fare, and indirectly, service levels • Local parking pricing and availability are very important components of the cost of driving
Environmental Policy • Federal/state emissions standards increase new car prices • Local air quality mandates require programs to reduce single-occupant vehicle use • Local policies influence development patterns and transportation planning
Energy Policy • Minimum average fuel economy standards increase new car prices, decrease operating costs • Alternative fuel vehicle and research and development provisions of Energy Policy Act are unlikely to affect choices made by consumers/households
Tax Policy • Income taxes affect economic activity and disposable income, thereby influencing the affordability of various travel choices • Preferential parking cost deductions promote automobile commuting over transit • Sales taxes affect automobile costs, and may support public transit • Mortgage interest deductions influence housing location choice • Property taxes may support local roadway infrastructure
Land Use Policy • Provisions of zoning laws (lot size, use) affect the viability of public transit • Design reviews and other restrictions can require definitive plans for addressing transportation issues in new developments

insight that emerges from the understanding about demand is that policies that focus on *making private vehicle use less attractive* are likely to spur transit ridership to a more marked extent than those that *make transit more attractive*, in situations (like many commuting corridors) where the two modes can offer reasonably comparable service.

SEARCHING FOR TRANSIT MARKET INITIATIVES

Telephone Survey of North American Agencies

Table 6 lists a range of specific strategies that the study team identified as having potential for increasing transit ridership or market share, classified into five categories of interest.

TABLE 6 List of potential strategies for study

Category	Type	Strategies
Service improvements	General	Increased route structure Increased frequency Service cutbacks Dynamic scheduling Increased speed Improved security Improved comfort Increased capacity
	Suburb to suburb	High-occupancy vehicle lanes and facilities Transportation demand management programs Suburban activity centers
	Suburb to central city	Feeder services Fare integration Service coordination (timed transfers) Unitickets Station parking provisions
	Within central city	Core services
Information to customers	Real-time information services	Location Schedules
	Low technology	Tailored schedules Bus stop information
	Medium technology	Computerized information systems Kiosks
Marketing and promotion		Fare incentives Education New resident promotion Image advertising Cooperative promotions
Public policy changes		User-side subsidies Parking pricing/regulation Income taxes Fuel/carbon taxes Dedicated operating support Land use policy Local area bus services
Road pricing		Various

In the first phase of the study, we conducted detailed telephone interviews with close to 50 U.S. or Canadian transit agencies and other organizations, identified as having current or relatively recent experience with any of the strategies identified in Table 6. The agencies and people selected for interview (listed in Table 7) were developed from a review of the trade press and from discussions with other experts in the field. These interviews were designed to fulfill three objectives:

- Provide a better understanding of the extent of North American experience with each of the types of strategies for increasing transit market share;
- Provide evidence for a preliminary assessment of the relative promise of each type of strategy; and
- Identify possible candidates for more detailed study, analysis, and documentation as part of the subsequent research.

Because of this third objective, any respondents who were unable to identify the impacts of their program, or to provide supporting information about the specific conditions under

TABLE 7 List of agencies contacted in initial telephone interviews

US - East Coast	Canada
Ann Arbor TA	BC Transit (Vancouver)
Baltimore MTA	Calgary Transit
Beaver County (PA) TA	Canadian Urban Transit Association
Boston MBTA	City of Mississauga Transportation Planning
Metropolitan Washington COG	GO Transit
New York MTA, LIRR, MNCR, MSBA	Metro Toronto Transportation
Potomac-Rappahannock (Virginia) TA	Mississauga Transit
Tidewater (Virginia) Regional Transit	Montreal Transit
Winston-Salem TA	MTO Public Transportation Office
	MTO Community Transportation Review
US - West Coast	MTO Passenger Mobility & Services Office
	MTO Passenger Modal Policy Office
Bellevue, Washington	MTO Provincial Planning Office
California DoT (District 12)	MTO Public Transportation Office
Los Angeles City DoT	MTO Transport Demand and Forecasting Office
Orange County TA	MTO Urban and Regional Planning Office
Portland Tri-Met	MTO Vehicle Technology Office
Rogue Valley (Oregon) TA	OC Transport
San Francisco BART	City of Winnipeg Transit System
San Francisco Bay Area MTC	Toronto Transit Commission (TTC)
Southern California Association of Governments	University of Toronto
	York Region
US - Central	Peter Dallon (transit specialist)
	Precursor Ltd. (transit specialist)
Chicago TA, METRA	
Dallas DART	
Denver RTD	
Houston METRO	
San Antonio VIA	
Twin Cities MTDB	

which the program was implemented, were screened out. The remaining contacts were asked more detailed questions, designed to ascertain the following information:

- Background information (details of the implementation, timing and duration of the program, etc.);
- Results (participation in program, ridership, or mode shift impact);
- Problems or issues arising in the course of implementation;
- Political, institutional, or economic feasibility issues;
- Any marketing and promotional efforts made before and during the program;
- Relationship of the initiative to any local idiosyncrasies; and
- Reasons why the particular strategy was chosen, and the potential alternatives from the respondent agency's point of view.

In our contact interviews, we found successful and unsuccessful implementations in each of the four categories of strategies (leaving aside, for now, the obviously different situation

of road pricing). We identified relatively many programs that fall into our broad "service improvements" category. In the area of marketing and promotion, we steered our contact interviews toward innovative marketing strategies such as fare-free zones and innovative fare-media techniques. Finally, we identified a few examples of local public policy initiatives that appear to have an indirect positive impact on transit ridership, including trip-reduction ordinances implemented through an employer-based transit pass.

Selection of Case Studies

In sifting through the evidence collected in the telephone interviews, our goal was to identify the types of strategies and examples that most warranted more detailed and thorough examination. To do this, we considered the following:

- *The **relevance of the strategy** for our study.* Does it appear to have a good potential for increasing or retaining transit ridership? How does it appear to rate on several other criteria:
  - The timeframe over which benefits accrue,
  - The political acceptability,
  - Equity and distributional considerations,
  - Implementation flexibility,
  - Legal and liability considerations,
  - Jurisdictional issues, and
  - Costs?

  Is it a strategy that has some other type of interest, such as current popularity within the industry, or novelty with regard to specific aspects of its implementation?
- *The quality of **this specific example** of the strategy.* What is the quality of local evaluations and/or relevant data? How typical is this example likely to be of other settings or operating environments? Are there other features of this particular example that make it of wider interest?

Table 8 summarizes the application of the above considerations to each of the strategies and examples for which we found adequate information to warrant an extended telephone interview, and presents our determination of the best candidates for further analysis.

The project panel discussed these recommendations at a mid-project meeting, and selected for further investigation the eight case studies summarized in Table 9.

SUMMARY OF FINDINGS

Some Cross-Cutting Impressions and Observations

Even after focussing attention on situations with relatively good monitoring, in many of the cases the lack of good data describing changes and outcomes severely limited our ability to draw robust general conclusions about the results of the policies, or about the factors influencing the results. Nevertheless, we made several cross-cutting general (albeit mostly impressionistic) observations:

- *Ridership growth is not a necessarily high priority for transit agencies.* We noticed several commonalities in this regard across the case study agencies:
  - A focus on *existing* customers rather than attracting new customers.
  - *Operational* concerns receive more attention.
  - Limited local interest in identifying the ridership impacts of the initiatives.

TABLE 8 Summary of preliminary evaluation and selection of case studies

Agency/Location	Program	Relevance of this Strategy	Suitability of this Specific Example	Candidate for Case Study?
GO Transit	Service/fare coordination	High	Good	Yes
San Francisco Bay Area	Fare integration	Moderate	Fair	Maybe
GTA transit federation	Weekly pass	Moderate	Fair	Maybe
Ann Arbor TA	Smart fare card system	High	Poor	No
Los Angeles	Metrolink commuter rail	High	Poor	No
Metro Toronto	Rapid transit expansion	Moderate	Poor	No
Tidewater Regional Transit	Timed transfer system	High	Excellent	Yes
Beaver County TA	Quality of Service Measures	Moderate	Poor	No
Metro–North Railroad	Reverse commute service	Low	Excellent	No
Southern California	Regional HOV lane experience	Moderate	Fair	No
Houston	HOV and park and ride experience	High	Poor	No
Metro Toronto	HOV lanes	Moderate	Fair	No
Los Angeles	Circulator services	Moderate	Fair	No
Potomac-Rappahannock TA	Feeder service to VRE	High	Fair	No
Metro–North Railroad	*Hudson Rail Link* feeder service	High	Good	Yes
Denver RTD	Privatization experience	Moderate	Poor	No
MTA (New York)	"A" line service improvements	Moderate	Fair	No
Minneapolis-St. Paul	Travel Link project	Moderate	Poor	No
Minneapolis-St. Paul	*Team Transit* improvements	High	Moderate	Yes
Potomac-Rappahannock TA	Real-time flex route system	High	Poor	Maybe
Bellevue	Real-time info. demonstration	Low	Poor	No
Winston-Salem, NC	Service coordination	Moderate	Fair	Maybe
Winston-Salem, NC	Mobility Manager	Low	Poor	No
Rogue Valley	Mobility manager demonstration	Low	Poor	No
King County Metro	Student/employer pass programs	High	Excellent	Yes
Portland Tri-Met	*Fareless Square*	High	Good	Yes
VIA, San Antonio, TX	Rider Programs Division	Moderate	Fair	Maybe
GO Transit	Customer Oriented Program	Moderate	Poor	Maybe
Minneapolis-St. Paul	Frequent Rider Program	Moderate	Poor	No
GTA transit federation	Integrated service map	Low	Poor	No
Metro Toronto	Land Use	High	Excellent	Yes
California	California Rule 1501 (Reg. 15)	Moderate	Fair	No
San Diego	Congestion pricing demonstration	High	Poor	No

- *Transit-side strategies alone are insufficient to achieve a large modal shift*. This result is consistent with our understanding of the mode choice process:
  - The private vehicle's quality of service is valued very highly.
  - The range of transit service improvements is quite limited.
  - The automobile *ownership* decision dominates the mode choice hierarchy.
- *Land use and related factors are very important*. We identified three critical factors affecting the interrelationship between land use and transit ridership:
  - Urban expressway capacity,
  - Urban core density, and
  - Downtown parking availability.
- *Institutional cooperation is often essential*. This aspect was found to be essential to almost all of the case studies, in one way or another.

Case Study Evaluations

It had been our original intention to use the following eight criteria to appraise each of the selected strategies in light of the additional information obtained from the case study research:

- The potential for affecting transit market share,
- The timeframe over which benefits accrue,

TABLE 9 Initiatives selected as case studies

Case	Description
MTA Metro-North *Hudson Rail Link*	This innovative feeder bus service was designed, implemented, and operated by the railroad itself, in order to improve access to (and therefore ridership from) two poorly accessible stations within New York City.
GO Transit fare and service coordination	This program involved the effort on the part of GO Transit, the commuter rail operator for the Toronto area, to coordinate both services and fares with the many local agencies whose transit systems provide access to commuter rail stations.
Minneapolis *Team Transit* Improvements	This program has implemented several low-cost improvements to the transit system, making use of the existing highway infrastructure. It is made possible by an innovative intergency panel comprising representatives from both the transit- and highway-related agencies.
Tidewater Transit timed transfer system	The agency has redesigned its entire service network around a series of transfer centers to better serve its low density, mostly suburban- and rural-oriented service territory.
Seattle *U-PASS* and *Flexpass* Programs	The *U-PASS* program is a cooperative effort with the University of Washington involving unlimited-ride transit passes for students. The *Flexpass* program involves employer-based passes offering unlimited transit use for all employees for one price.
Portland *Fareless Square*	This program is a fare-free zone for transit in downtown Portland, a city with a history of being one of the more transit-oriented cities in the US.
Metro Toronto land use policies	Toronto has long been thought of as a model of a pro-transit city in North America, and this orientation is in large part due to land use policies.
A synthesis of relevant road pricing experience	The case provides a synthesis of the experience with, likely effects of, and issues surrounding the implementation of congestion-sensitive road pricing in the US.

- The political acceptability,
- Equity and distributional considerations,
- Implementation flexibility,
- Legal and liability considerations,
- Jurisdictional issues, and
- Costs.

While the case study research did not generally yield data adequate for a more rigorous *quantitative* analysis, nevertheless the criteria were used to assess and compare at least the *qualitative* differences among the cases. Table 10 provides an overall summary of the application of the evaluation criteria.* Each column in the table presents a graphical depiction of the qualitative rating we have assigned to a case on each evaluation criterion. Reading across in the table, each row compares the eight evaluation criteria for a given case study.

While the table provides a highly summarized view of the results of the research, there are a few conclusions that can be drawn from such a broad overview. For example, this exhibit makes clear that there are certainly strengths and weaknesses to be traded off in considering each strategy. It also appears that, perhaps not unexpectedly, those strategies that appear most promising in terms of their effect on mode share also have the most formidable barriers to implementation. In general, we really found no strategies that provide "ideal solutions" to the problems motivating this study.

* The graphical representations should ***not*** be used to infer quantitative values for any of the criteria.

TABLE 10 A summary appraisal of the case studies

Case study	Effective-ness of mode shift	Time frame	Political acceptabil-ity	Equity	Implemen-tation flexibility	Legal/ liability issues	Costs	Jurisdic-tional issues
Hudson Rail Link					+++		$	++
U-PASS/ Flexpass					++++		$$	+
Team Transit					++++		$$$	+++++
Tidewater timed transfers					++		$$$	+
Fareless Square					++		$$$	+
GO Transit FISC					++		$$$$	++++
Toronto land use					+		$$	++++
Road pricing					++		$	++

TABLE 11 Summary of transferability evaluation

Case Study	Ridership Impact	Special conditions	Other positive factors	Need for further study
Hudson Rail Link	Moderate	Atypical topography		
GO Transit FISC	Poor	A few		
Team Transit	Very limited; may have stemmed further declines	Atypical existing infrastructure and institutional environment	Multi-agency cooperation Innovative use of existing infrastructure	Need more data to determine true ridership potential
Tidewater timed transfers	Probably very limited; may have stemmed further declines	A few	Method of serving low density service territory	Need more data to determine true ridership potential
U-PASS/Flexpass	High	None		Promising new strategy deserves more attention
Fareless Square	Probably limited	Dedicated funding; coordinated planning	Coordinated planning effort	Much is known about fare-free transit
Toronto land use	Potentially very high	Political and institutional differences	Toronto is "model" city	Deserves much additional research
Road pricing	Potentially very high			Political nature will require even more study

Application of Results to Practice

Table 11 provides a summary of our appraisal of the *transferability* of each of the case studies. The table shows that most of the selected strategies would benefit from additional research. Several of the case studies incorporate and illustrate interesting aspects that are themselves worthy of consideration for application elsewhere. However, some of the other initiatives may have little potential for reapplication in other contexts because of unique local conditions of topography or of existing infrastructure, for instance. Perhaps the strongest prospects for transferability lie with the Seattle pass programs.

CHAPTER **1**

INTRODUCTION AND OVERVIEW

PROJECT OBJECTIVES

Successive decennial Censuses of Population since 1960 have indicated that, despite some growth in national transit ridership in the United States since its low point in the early 1970s, in many cities transit is having a hard time in retaining and building market share in its traditional core market—commuting trips to and from work.

TCRP Project H-4A is concerned with transit's ridership and its share of the market. We explore a variety of different public policies and transit management actions that can influence ridership and can make transit more or less attractive to commuters by comparison with competing modes, most saliently the private vehicle.

The policies and actions that we survey in most detail vary quite markedly in their focus, scale, and impact. At one end of the spectrum, we include very micro-level actions—fare adjustments, scheduling adjustments, promotional activities, and so on—that individual local transit properties may take, often from a variety of motives, among which ridership growth per se may not rank particularly high.

At the other end of the spectrum, our purview includes public policies that are much longer range in their time horizon, more pervasive and influential in their impacts, and require a much stronger political will (and consensus) to bring them about. Controls and incentives to encourage transit-friendly urban design, and congestion-sensitive pricing of roadway use, are good examples of this latter type of policy.

In analyzing and discussing a variety of different policies drawn from this spectrum, we have visualized as our primary audience *state or local transportation officials*: lay members of elected or appointed boards dealing with some aspect of local transportation policy, transit agency professionals, metropolitan area transportation planners, and so on. One of our aims has been to include a diverse set of *ideas* for local consideration, with examples of where and how those ideas have been tried or researched, what the outcomes have been, and where to look for more detailed information. Much of what we report may already be familiar territory for many transportation professionals, but it is hoped that the report will provide a resource that is useful in stimulating local thinking and (possibly) debate.

While our focus throughout, and our unifying theme tying together such a diverse set of policies, is concerned with *transit ridership* and *market share*, it is important to recognize that few of these policies are likely to be adopted because of their ridership effects *alone*. At the "micro" end of the spectrum, today's transit managers have to juggle a very broad set of objectives, not all of which may be articulated explicitly by the public sector directors and funders of the system, and some of which may be contradictory. It isn't surprising that in surveying a set of transit properties to find out what they had been doing "to increase ridership," gaining riders often ranked low on the list of priorities, and for good reasons.

At the "macro" end of the spectrum, the potential scale of impact of, for example, the effective integration of land use and transit planning considerations, or the introduction of congestion-sensitive road pricing, is so broad that a much larger vision is required to bring them about. Increasing transit's share of the commuter traffic may well be a very important component of the motivation, but it usually isn't an end in itself: it is a stop on the way to reducing time losses in traffic congestion, or improving the local air quality, for example.

EVOLUTION OF THE PROJECT

A cooperative research project of this nature typically changes shape somewhat, in its scope and focus, between conception and culmination. Part of that mutation takes place in utero, as it were, before a contractor is selected and starts work. A work statement is first drafted by one party, and panel of people is appointed to guide the project. Their first act is to mold and refine the work statement, and to select a contractor in part on the basis of further ideas that he or she brings to the table. As the work progresses, of course, further discoveries and discussions help to shape the final scope and emphases.

Such an evolution helps to explain, in part, the diversity and somewhat eclectic selection of public policies surveyed in most detail in this report. Several questions or issues about transit's market share have been part of this project from very early days:

- Have *inconsistencies* between various aspects of public policy—at federal, state, and local levels—hampered transit's ability to compete effectively in the market-

place? What existing public policies appear to be at cross-purposes with the most recent legislative articulation of federal transportation goals and objectives—the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and the 1990 Clean Air Act Amendments (CAAA)?

- Given that the aggregate travel patterns are the result of millions of individual *marketplace* choices by travelers, what can be done by transit authorities and governments to improve transit's offerings and standing in the marketplace?

This project is one of a related series of policy-oriented studies being undertaken simultaneously under the aegis of the TCRP. Consequently, the choice of policies and actions for detailed examination was in part influenced by a wish not to duplicate efforts on policies that are being examined in greater depth by peer studies. For this reason, for example, we have given relatively low priority to transit pricing initiatives, to parking management and pricing policies, and to transit-friendly urban design at the very local or building level. All of these are strategies that, under conducive circumstances, may be very effective influences on transit ridership, and the interested reader is directed to the reports of those studies for more details.[1]

A model in the mind of at least some of the original shapers of this work was that the project could survey very systematically the various factors at play in determining the outcomes of different types of policies, so that *quantitative* measures of success could be related to various influences. In this way, a formalized procedure could be developed for selecting policies by objectives and by potential effectiveness.

The problem with this model is that the basic building bricks—the empirical evidence from the field describing the experience accrued in using a particular policy—are very rarely of the shape and size necessary to construct the edifice that the architect visualized. As an overly broad generalization, transit agencies or local transportation authorities don't often put significant effort into evaluating the success or failure of their policies in a way that can clearly identify cause and effect. They have little incentive (or, often, resources) to do so.

Our study included a survey of local areas identified as doing (or having done) interesting or innovative things from a transit ridership viewpoint, and subsequent detailed case study investigations of a small subset of the most promising ones in several major categories. We looked for internal evaluations of the policy/action in question, or data that would allow the study team to make an independent evaluation. We found it rare that whatever documented data or analysis was made available to us was adequate to draw strong *general* conclusions about the relative efficacy of the policy in varying settings and circumstances. The data are too thin and too disparate.

In a sense, this isn't surprising, given the drivers of innovation, particularly in the public sector. So often, outcomes are influenced by factors that are difficult to characterize and quantify, such as the creativity, drive, and persuasiveness of key officials. The UMTA Service and Methods Demonstration Program that, between 1974 and 1982, laudably invested significant resources into a program of disciplined *learning* about transit innovations, found that peer-to-peer qualitative interaction and a chance to see the innovation in situ were more effective forms of dissemination than were piles of analytical research reports seeking causal insights.

In consequence of the nature of the information we discovered, our report is necessarily short on general conclusions about the conditions for "success." However, we believe that the story told by each case study, seen within the context of a general understanding of the factors influencing the local travel choices of urban residents, provides valuable insights into the workings of particular types of policies in one particular local setting. In each case, we address transferability, and usually offer opinions—as distinct from tightly determined research findings—about the applicability of the policy to other areas.

STRUCTURE OF THIS REPORT

The following three chapters review three different strands of context-setting information, intended to be helpful in understanding the level and trends in transit's market share.

In Chapter 2, we use Census journey-to-work (and other) data to explore the current levels of market share, and the trends over the past 20 years. Transit remains strongest in its traditional markets, the relatively old, largest, highest-density cities of the Northeast, Mid-Atlantic, and Midwest regions. Development density is the most significant determinant of market share variations across cities.

Moreover, *within* the metropolitan area, transit is still strongest in its traditional markets: first, trips that are entirely within the central city, and second, trips between the suburbs and the central city. Unfortunately, however, there are two pieces of bad news about the dynamics of these markets:

- The suburb-to-central city trip is the market segment for which transit's share has been falling most markedly; *and*
- Both of these traditional transit markets (within central city and between city and suburbs) have been growing more slowly than have other types of trips.

[1] These studies include TCRP Projects A-1: Fare Policies, Structures, and Technologies, B-7: Strategies to Assist Local Transportation Agencies in Becoming Mobility Managers, H-1: An Evaluation of the Relationships Between Transit and Urban Form, H-3: Policy Options to Attract Auto Users to Public Transportation, H-4D: The Role of Transit in Creating Livable Metropolitan Communities, and H-6: Transit Fare-Pricing Strategy in Regional Transportation Systems. At this writing, publication of the reports for Projects B-7 and H-4D is expected in 1997, a Research Results Digest is being prepared for Project H-6, and a publication decision is pending for the final report of project H-3. Reports for Projects H-1 and A-1, respectively, have been published as:

Parsons, Brinckerhoff, Quade & Douglas, Inc., *TCRP Report 16: Transit and Urban Form, Volumes 1 and 2*. Transportation Research Board, Washington, DC (1996).

Multisystems, Inc., *TCRP Report 10: Fare Policies, Structures, and Technologies.* Transportation Research Board, Washington, DC (1996).

In Chapter 3, we examine a wide range of public policies, at all levels of government, to explore how they are known or (more usually) hypothesized to influence transit's market share. As a basis for identifying potential impacts on transit, we summarize briefly the range of choices involved in a decision to make a transit trip, and the factors known to influence the individual traveler's decisions. As a basis for identifying inconsistencies, we review the relevant provisions of the 1991 ISTEA legislation and the 1990 CAAA.

As part of the analysis of public policy impacts, we were asked specifically to address the question of whether governmental policies favor one mode over another through overt or hidden subsidization. In particular, the literature is replete with studies that purport to show large hidden subsidies to the use of the private vehicle/highway system, or to refute the existence of such subsidies. In Chapter 3, we opine that this diversity of findings is inherent in the nature of the question. This is not an issue, in other words, for which one new, more objective study can be expected to point out "errors" in previous studies and discover an answer that will be universally accepted by virtue of its superior reasoning. Rather, at heart, the different answers reflect differences of opinion on matters for which there is no strong theoretical reason to favor one approach over another. In Appendix C, we have reviewed a number of recent analyses of highway and transit costs, sponsored by diverse interest groups, to highlight the nature of the underlying conceptual issues on which there is disagreement, and to support the case that the question can have no single, completely objective answer.

Chapter 4 provides the third context-setting element: a summary of what is known about the factors underlying the travel behavior of individuals, and (consequently) the aggregate demand for transit services. We survey briefly the evidence about transit demand elasticities with respect to key influencing factors, and summarize what these mean for transit properties seeking to increase ridership.

Against this background, we move to present new information collected in the course of this study. Chapter 5 describes a survey of roughly 50 different agencies and individuals in the United States and Canada that were contacted for information about purported innovations of relevance to this project, and the winnowing that was done to select cases for more detailed investigation. Canadian examples were thought to be particularly worthwhile for inclusion, because Canadian cities tend to have higher transit ridership levels than their U.S. counterparts, despite often comparable development patterns and standards of living. It was for this reason that we included a Canadian subcontractor on the project team.

The eight detailed case studies themselves appear as Appendices G through P of the report. The cases (and their primary investigators) are:

Appendix G.	MTA Metro-North Railroad: the *Hudson Rail Link* [Charles River Associates]
Appendix H.	GO Transit service and fare integration [UMA Engineering]
Appendix J.	Minneapolis *Team Transit* express bus improvements [Charles River Associates]
Appendix K.	Tidewater Regional Transit timed transfer system [Charles River Associates]
Appendix L.	Seattle *U-Pass* and *Flexpass* programs [Mark Hickman]
Appendix M.	Portland *Fareless Square* program [Mark Hickman]
Appendix N.	Toronto's land use and transit coordination policies [UMA Engineering]
Appendix P.	Congestion-sensitive road pricing policies [Charles River Associates].

This last case is somewhat different in content and structure from the other cases. The early years of the current decade saw a growth of federal interest in the prospect of congestion pricing as a palliative for traffic congestion, as evidenced (for example) by authorization of a pilot program in the ISTEA legislation. In consequence, the amount of written material on the topic has mushroomed. Appendix P provides a brief overview of key concepts and issues—an entry point and guide to the larger literature—and summarizes some of the most recent developments. It examines information that is beginning to emerge from European initiatives that began in the late 1980s, but concludes that this experience has only limited relevance to the deployment of congestion-sensitive roadway pricing within U.S. metropolitan areas.

Finally, Chapter 6 presents a synthesis of the study findings, based on the information gathered in the detailed case studies. As noted earlier, the ability to draw tightly reasoned, quantitative, nationally representative conclusions is quite limited. Nevertheless, this investigation has resulted in a number of findings which it is hoped will prove valuable to transportation policymakers at the federal, state, and local levels.

CHAPTER **2**

SETTING THE CONTEXT: TRANSIT'S CURRENT MARKET SHARE

TRANSIT'S PRIMARY MARKETS: THE CORE AREAS OF DENSE CITIES[1]

There are several truisms about the market for transit services that have long been documented and are well known to urban transportation analysts. The first is that the larger and most densely developed metropolitan areas are the ones with the highest transit shares. A second is that the primary market for transit services, in cities of any size, tends to be the residents of the *central city* of the metropolitan area, traveling to and from jobs also located in the central city.

It isn't hard to rationalize such observations. First, there is a historical supply-side effect. The most densely developed central cities—New York, Chicago, Philadelphia, and Boston, for example—tend to be the nation's oldest cities, many of which built rail-based transit systems in the early years of the twentieth century. As a result, today these cities have the geographically most pervasive rail transit networks and the highest transit capacities.

Moreover, the densely developed, older central cities are the ones least conducive to travel by private vehicle. Long-established street networks may reflect times when population levels and distances traveled were both much lower. River crossings create bridge and tunnel bottlenecks. As a result, twentieth-century traffic capacity is highly constrained, and congestion is relatively severe. High urban densities typically imply higher land values, driving up the costs of central area parking, whether at home or near the workplace. Consequently, both the ownership and use costs of private vehicles tend to increase markedly with development density. Fewer central city residents own cars than do suburban residents, and the more densely developed the central city the more pronounced are these variations. Differences in income and crime rates between the core area and the suburbs help to reinforce such effects.

Transit Use and Density of Development

How well does this received wisdom hold up *today*, after a half century's continuous steady dispersion of both jobs and homes—in relative terms—from the central city to even further reaches of the metropolitan area? There are two data sources that allow one to examine this question: the journey-to-work data gathered from a random sample of about 8 percent of all households in the decennial Census of Population, and the federal government's *Nationwide Personal Transportation Survey* (NPTS), carried out five times since 1969. The most recent published data from both sources relate to 1990.*

Both sources of information confirm that transit's market share is still strongly related to development density. For example, Table 12 summarizes the use of transit for travel to work in the 39 metropolitan areas whose 1990 populations exceeded 1 million. Between them, these metropolitan areas account for seven out of every eight of the nation's transit trips.

New York City is always an extreme outlier in any discussion of the national transit picture. While completely atypical of the situation throughout the rest of the country, it is nevertheless an extremely important outlier. New York alone accounts for over one-third of the nation's transit trips. The population density in the New York metropolitan area is over 70 percent greater than that in the next most dense metropolis (Chicago), and transit's share of trips to work in New York (27 percent) is about twice as high as for the nearest contenders (Chicago and Washington DC).

Four other metropolitan areas had 1990 populations of over 3 million and residential densities exceeding 1,000 people per sq mi: Chicago, Boston, Philadelphia, and Miami. With the exception of Miami, transit's share of work trips exceeded 10 percent in each of these cities.

A simple linear regression of the 1990 transit work trip share against metropolitan area residential density for these 39 largest cities shows that density alone "explains" about two-thirds of the total variation in transit share, or about 37 percent of the variation when New York City is excluded from consideration. The effect of population density is highly significant statistically, whether or not New York is included; there is much less than a 0.05 percent probability that the observed association is ascribable to chance.

About 47 percent of the variation in transit share for metropolitan areas other than New York can be "explained by" just two variables: population density, and whether or not the city has a significant element of commuting by *rail*.† The

[1] The treatment here of current transit markets and commuting flows is intentionally limited to those key aspects that are most germane to the purposes of this study. A considerably more detailed discussion is provided in
Pisarski, A. E., *Commuting in America II*. Lansdowne, VA, Eno Foundation for Transportation, Inc. (1996).

* As of this writing, data were not yet available from the most recent replication of the NPTS, in 1995.

† For the purposes of this analysis, rail was deemed to be a "significant" mode if more than 0.1 percent of metropolitan area workers traveled to work by rail transit or commuter rail. Of the U.S. cities with heavy or light rail transit services in 1990, only San Diego (at a 0.04 percent rail share) failed to meet this criterion.

TABLE 12 Transit share of work trips in major metropolitan areas, 1990

	Population density (persons/sq. mi.)	Transit share to work (%)
New York City	2,446	26.9
4 MSAs with population 3+ mn., density 1,000+ per sq. mi.	1,238	10.5
6 MSAs with population 3+ mn., density < 1,000 per sq. mi.	573	5.8
10 MSAs with population 2 to 3 mn.	522	4.6
18 MSAs with population 1 to 2 mn.	470	3.3
All 39 MSAs with population 1+ mn.	664	8.7

Source: Charles River Associates, derived from 1990 Census data in Rossetti & Eversole (1993).

effect of each of these variables is significant at (at least) the 1.5 percent probability level.

Importance of Core Area Travel

The importance of *central city* trips to transit is also still very apparent in the 1990 Census journey-to-work data, although the story is necessarily a more complicated one. The statistics in Table 13 show that in 1990 about three-quarters of all transit trips made to work by metropolitan area residents were made to central city workplaces, and that three out of every five transit work trips were ascribable to central city residents commuting to central city jobs. These proportions appear to represent significant declines from 1980, however.

TABLE 13 Transit market share for work trips by metropolitan area residents, 1990 and 1980

	1990	1980	Change, 1980 to 1990
Commute trips by all modes (millions)			
central city to central city	24.3	22.9	+6.2%
suburbs to central city	15.3	13.9	+9.6%
suburbs to outside MSA	6.8	3.9	+72.3%
suburbs to suburbs	35.4	27.7	+27.5%
central city to suburbs	6.0	4.6	+29.8%
central city to outside MSA	1.9	1.3	+48.1%
all commute trips by MSA residents	89.6	74.4	+20.5%
Transit share of commute trips (%)			
central city to central city	13.2	16.1	-18.0%
suburbs to central city	5.3	8.0	-33.2%
suburbs to outside MSA	6.4	7.6	-15.4%
suburbs to suburbs	1.2	1.6	-28.0%
central city to suburbs	5.1	5.6	-8.5%
central city to outside MSA	8.3	7.3	+13.7%
all commute trips by MSA residents	6.0	7.9	-24.9%
Distribution of transit commute trips by geography (%)			
central city to central city	60.2	62.5	
suburbs to central city	15.0	18.9	
suburbs to outside MSA	8.1	5.1	
suburbs to suburbs	8.0	7.5	
central city to suburbs	5.7	4.4	
central city to outside MSA	3.0	1.6	
all commute trips by MSA residents	100.0	100.0	

Source: Charles River Associates, using data from the 1990 Census journey to work questions and from tables developed by Pisarski (1996).

There are a number of complexities involved in characterizing the geography of work trips and in measuring changes over time. First, the central city boundaries may not necessarily provide a good characterization of the core area of the metropolis; they may be more a function of historical happenstance. Secondly, boundary changes can confound comparisons over time. In Table 13, we have (following Pisarski) adjusted the 1980 data to reflect revised 1990 Bureau of the Census procedures in redistributing the data for people with inadequately specified workplace locations.

It can be seen from Table 13 that the two geographical markets of greatest importance to transit—intra-central city commutes and suburb-to-central-city commutes—are the ones showing the least proportional growth over the 1980s, 6.2 percent and 9.6 percent, respectively. Moreover, transit's market share fell most heavily (by almost one-third of the 1980 level) for the suburb-to-central-city work trips, and the loss in market share for the intra-central city commutes, while proportionately much less, was still quite marked.

As a result, the number of intra-central city transit work trips fell by almost 13 percent (or 475,000 trips per day), and from the suburbs to the central city the decline was over a quarter of all 1980 trips (or a loss of about 300,000 trips per day).

The 1990 Census journey to work responses indicated a marked growth in commuting to workplaces *outside the home metropolitan area*, either to exurban locations or (more frequently) to jobs in another metropolitan area. Such work trips increased by almost two-thirds of the 1980 level, and while transit's share of this market declined slightly, the growth in the total number of these trips created an additional 200,000 transit trips per day.

Similarly, while transit's share of reverse commute (central city to suburb) work trips declined, the growth in the number of such trips was proportionately greater; in net, transit added almost 50,000 reverse commute trips each day.

Intrasuburban work trips by transit declined by about 8 percent. A pronounced dropoff in transit market share for these trips was partly compensated for by the growth (by over 25 percent) in the volumes of people who both live and work at suburban locations.

GROWING AND DECLINING TRANSIT MARKETS SINCE 1980

Transit's *share* of work trips grew between the 1980 and 1990 Censuses of Population in only two of the 31 metropolitan areas that had 1980 populations of over 1 million. The two cities were Houston—where the transit share grew from 2.9 percent in 1980 to 3.7 percent in 1990—and Phoenix, with only a very small change in share from 1.95 percent to 2.00 percent.

Table 14 shows that in the remaining 29 metropolitan areas—which are ranked in descending order of percentage increase in work trip market share‡—the transit market share fell.

The ranking permits a few broad generalizations:

- High on the list are a number of rapidly growing sunbelt cities where relatively small bus systems managed to attract a good proportion of the expansion in commute trips.
- The largest, most dense cities—New York, Chicago, Boston, Philadelphia, for example—also did reasonably well as a group. While experiencing moderate losses in share, the growth in employment was such that several of them experienced growth in the absolute numbers of work trips carried.
- Those metropolitan areas with heavy rail transit systems established in the 1970s and early 1980s—San Francisco, Washington DC, Atlanta, and Baltimore—saw a growth in *rail* market share that went some way to offset their losses in bus share.§
- At the bottom of the list, medium-sized "rust belt" cities predominate.

It is interesting to observe that the increase in jobs over the decade was such that 11 of the 31 metropolitan areas achieved a growth in the absolute number of work trips carried by transit, despite experiencing a loss in transit's market share. The New York CMSA added 145,000 transit work trips a day, while transit's market share there fell from 29.6 percent of work trips to 26.9 percent by 1990.

Exploratory simple linear regressions of the 1980-1990 change in transit's work trip market share (with and without the inclusion of New York City) resulted in relationships that were all statistically significant at the 1 percent level. Other factors equal, the *decline* in market share was inversely correlated with both

- Metropolitan area size (as measured by the number of 1980 jobs), at the 3.5 percent level; and
- Percentage growth in jobs between 1980 and 1990, at the 10 percent level.

A variable identifying the cities that have a rail transit component did not appear to be a significant influence on the change in market share.

POPULATION GROUPS WITH HIGH TRANSIT MARKET SHARES

Table 15 examines some of the demographic and socioeconomic characteristics that are associated with particularly high or low market shares for commuting to work. In examining the characteristics of transit riders nationally, it is particularly important to separate the figures for New York City from those for the rest of the country. As we saw earlier, New York dom-

‡ The percentage change figures in Table 14 represent the *proportional* change in transit's share of work trips, not the *absolute* change in the market share percentage.

§ For ease of interpreting the table, no rail percentage changes are shown for any city for which the 1990 rail market share was less than 0.1 percent.

TABLE 14 Changes in transit work trip market shares, 1980 to 1990

	% change in market shares			Change in trips (thousands)		
	bus	rail	bus & rail	bus	rail	bus & rail
Houston CMSA	29%		29%	21	0	22
Phoenix MSA	3%		3%	7		7
San Diego MSA	-1%		-1%	12	0	12
New York CMSA	-7%	-10%	-9%	52	93	145
Los Angeles CMSA	-10%		-10%	45	1	46
Miami CMSA	-23%	1800%	-11%	-1	8	7
Washington DC MSA	-37%	50%	-11%	-20	78	59
Chicago CMSA	-23%	-13%	-19%	-45	-11	-56
Boston CMSA	-33%	-2%	-20%	-14	26	13
San Francisco CMSA	-32%	32%	-20%	-31	37	6
San Antonio MSA	-20%		-20%	0		0
Philadelphia CMSA	-15%	-26%	-20%	3	-15	-13
Tampa MSA	-22%		-21%	2	0	2
Seattle CMSA	-24%		-24%	1	0	1
Baltimore MSA	-35%	352%	-26%	-19	11	-8
Buffalo CMSA	-36%		-29%	-10	2	-8
Denver CMSA	-31%		-31%	-9	0	-9
Pittsburgh CMSA	-32%	100%	-31%	-31	1	-30
Indianapolis MSA	-31%		-31%	-4		-4
Milwaukee CMSA	-31%		-31%	-13	0	-13
Dallas CMSA	-33%		-33%	-5	0	-5
Sacramento MSA	-39%	2300%	-33%	-1	2	0
Detroit CMSA	-34%		-35%	-17	0	-17
New Orleans MSA	-35%		-35%	-16		-16
Portland CMSA	-37%	1300%	-36%	-11	1	-10
Cincinnati CMSA	-36%		-36%	-9		-9
Atlanta MSA	-47%	54%	-38%	-11	9	-2
Minneapolis-St. Paul MSA	-39%		-39%	-22		-22
Columbus MSA	-41%		-42%	-4		-4
Cleveland MSA	-42%	-40%	-42%	-35	-2	-37
Providence MSA	-49%	3800%	-44%	-8	1	-8
Kansas City MSA	-49%		-49%	-9		-9
St. Louis MSA	-49%		-49%	-24		-24

Source: Charles River Associates, based on 1990 Census data in Rossetti & Eversole (1993)

inates the national transit statistics, accounting for over a third of the trips. Yet because the transit market share in New York is much greater than in any other part of the country, the New York transit riders will more closely resemble the demographic/socioeconomic makeup of the general population there. Conventional wisdom has it that, outside the New York CMSA, transit riders are markedly skewed toward women, minority racial groups, and lower-income households.

It can be seen that Table 15 partially confirms these generalizations, but perhaps less forcefully than might be expected. Certainly, private vehicle availability levels are a powerful correlate with transit market share for commuting, and race/ethnic background appears to be almost as important. It is also true that larger proportions of women than men take transit to work, both in New York and elsewhere.

The "personal earnings" variable provides some surprises, however. The market shares for the lowest income categories are not markedly higher than those for the general population. For example, among the people earning less than $10,000 per year, the work-trip transit share in 1990 was 25 percent in New York and 4 percent elsewhere, compared with shares for all income groups of 26 percent and 4 percent, respectively. The market share in New York does increase somewhat for the next higher annual earnings categories: $10,000 to $14,999 (28 percent), and $15,000 to $24,999 (28 percent). Similar increases are not apparent in the data for elsewhere, however,

TABLE 15 Traveler characteristics and transit market share for work trips, 1990*

	Total USA	New York CMSA	Rest of USA
Overall transit market share	5%	26%	4%
Groups with high market shares			
no-vehicle households	39%	64%	29%
black, non-hispanic	15%	45%	11%
asian, pacific islander	11%	38%	7%
hispanic	11%	40%	7%
renters	9%	40%	6%
one-vehicle households	8%	32%	6%
females	6%	27%	4%
individuals earning $75k+ (1989)	6%	27%	2%
Groups with low market shares			
four-vehicle households	1%	6%	1%
three-vehicle households	2%	9%	1%
two-vehicle households	2%	12%	2%
homeowners	3%	17%	2%
white, non-hispanic	3%	18%	2%

Source: Census of Population, 1990.

* The figures for New York City in this table differ slightly from those in Table 14. The New York data in Table 14 are for people who both live and work in the CMSA, whereas the data in this table also include workers living in the CMSA but with jobs ouside it.

where the conventional wisdom would lead us to expect a more pronounced use of transit by low-income groups.**

A more notable effect is seen for relatively *high* earners in the New York CMSA. A slightly higher-than-average proportion of the workers earning $75,000 or more per year commute by transit in New York (26.6 percent, compared with 25.8 percent overall). Elsewhere, the usage of transit by this high-income group is markedly lower than the overall share (2.2 percent compared with 3.5 percent).

SUMMARY

The most recent available evidence (from 1990) confirms yet again the conventional wisdom about transit's role: that ridership levels and market shares are very strongly associated with development densities, and are, therefore, highest in the core areas of the nation's most densely developed cities.

Transit's traditional markets of relative strength—commute trips *within* the core area and trips from the suburbs to the central area—have been growing at a much slower rate than have intrasuburban, reverse commute, and exurban trips. Moreover, by all measures, transit market share appears to have fallen quite markedly for all types of area between 1980 and 1990 (at least for travel to and from work). As a result, in most places, the increase in the employment base was not able to compensate fully for the dropoff in transit shares, and the volumes of transit work trips consequently declined.

There were some cities that apparently experienced a transit work-trip ridership growth between 1980 and 1990, however. Most notably, these were New York, Washington DC, and Los Angeles, where the job growth outpaced transit's loss of market share. Also notable was the performance of the bus systems in a few sunbelt cities (Houston, San Diego, and Phoenix) that were able to withstand the decline in transit share experienced elsewhere.

** However, the analysis of transit share by personal earnings level may be confounded by the 3 percent of workers who failed to provide information about their personal earnings. These people reported significantly higher levels of transit commuting (33 percent in New York, 6 percent elsewhere) than did everyone else. If unwillingness to provide income information is inversely associated with earnings level—a credible hypothesis—this may explain why the reported transit shares for low-income workers are not higher.

CHAPTER 3

SETTING THE CONTEXT: PUBLIC POLICIES AND TRANSIT MARKET SHARE

From our examination of the recent trends in transit's market share, we next turn to address how public policies—pursued at the federal, state, and local levels—are likely to influence transit's role in the transportation mix. In doing so, we will be less concerned with recounting the *history* of past policies (that have brought us to the current point) than in examining the policies in place *today*, and their potential effects on the consumers' marginal travel choices.

The discussion in this chapter develops in three stages:

- First, we review the salient provisions of the most important federal legislation currently affecting urban transportation—the 1991 ISTEA and the CAAA of 1990*—as the most authoritative examples of the present goals and priorities of federal urban transportation policy;
- Next, we summarize the general understanding about how local travelers choose to use a particular mode for a particular trip, rather than any of the alternative modes available; and
- Finally, we survey the wide range of public policies that potentially affect consumer travel choices, with a commentary on the ways in which the goals and impacts of different policies may well diverge.

ISTEA AND CAAA AS INDICATORS OF NATIONAL GOALS AND PRIORITIES

The round of major federal legislation concerning transportation enacted in the early 1990s has many implications for local area transportation. With passage of the CAAA in 1990, significant legislation was enacted to reduce mobile source emissions. Also, the ISTEA, signed into law in 1991, reshaped the landscape of federal transportation policy and funding through 1997. As we shall describe, the requirements, policy statements, and funding arrangements stipulated by the CAAA and the ISTEA have potentially important implications for the choice of travel mode in urban areas throughout the United States.

Brief descriptions of the most relevant aspects of the CAAA and the ISTEA legislation have been provided in Appendix B of this report. We conducted a review to identify the particular areas of these laws that appear most likely to have an impact on the individual traveler's *mode choice* decisions. In summary, the primary implications of the CAAA for travel mode choice include:

- Strong incentives for states and localities to emphasize HOV and transit projects to meet air quality requirements;
- Voluntary and mandatory transportation control measures in non-attainment areas to reduce vehicle miles of travel or to encourage modal shifts; and
- Increased cost to purchase and maintain vehicles, due to mandatory use of emissions control equipment and cleaner fuels.

In summary, the implications of the 1991 ISTEA for travelers' mode decisions include:

- Greater flexibility for local decisionmakers in use of funds, including use of highway funds for transit- and other HOV-related projects;
- A greater federal share of funding for transit capital projects;
- Direct CMAQ funding to MPOs for congestion management and air quality improvement projects that discourage SOV use and enhance transit and other modes;
- Additional funding for state and local transportation planning;
- A required link between regional and state air quality and transportation planning; and
- An initial measure of political and financial support for congestion and market-based road pricing projects.

CONSUMER CHOICES IN URBAN TRANSPORTATION

In order to decide which public policies are potentially important in influencing transit's role, and in what ways, it is first necessary to review the factors that influence local travel patterns. In particular, our starting point is with the *individual traveler*, and what is understood about his or her motivations when choosing which mode to use for a specific local trip.

* Because of the technical nature of the material presented, this chapter abounds in acronyms and abbreviations. See Appendix A for definitions.

A Hierarchy of Choices

Such local travel is rarely an end in itself, undertaken solely for the enjoyment, thrill, or other gratifications of the travel experience per se. Rather, travel is usually viewed as a "derived demand," undertaken because the traveler wishes to engage in certain other activities that require his or her presence at a physical location (the destination) that differs from the location of the previous activity (the origin). *Whether* travel takes place at all will depend on the strength of the wish to undertake the activity, and whether alternate means of satisfying the same objectives exist (for example, by communicating electronically rather than face-to-face, or by making a mail-order purchase rather than going to a store). The *destination* of the travel will be determined in part by the extent to which the same objective can be achieved at alternative locations (different stores, for instance). The *timing* of the travel will be influenced by the extent to which the activity must be carried out at specific times as well as at specific locations.

Which activities a person decides to pursue will obviously be a very important influence on the amount and nature of his or her travel. For most people, decisions about employment outside the home are very fundamental determinants of their lifestyles. Not only can one's occupation strongly affect one's need to be at particular places at particular times, but the income derived from employment can also determine what activities one is able to pursue during nonworking hours.

So, for example, when Jane chooses to travel to work on the 8 a.m. bus, a complete inventory of the related decisions that have brought her to the bus stop may include, at a minimum:

- Where to live,
- Whether to work outside the home,
- Where to work (or go to school),
- How many private vehicles to own or lease,
- How to allocate the use of these vehicles among the members of Jane's household,
- What time to go to work, and
- How to get to work.

Of course, these choices are constrained in all sorts of ways—by income (or wealth), by skills and training, by the demands of Jane's job and private responsibilities, by the available transportation services (and their time and money implications), by habit, and so on. Depending on her financial circumstances and the regularity of her behavior, Jane may not even recognize many of these factors to be current "choices," or possibly even past "choices."

Indeed, it can be fairly argued that for significantly large segments of the population, many of these larger choices—of where people can live, if and where they can find jobs, what means are available for travel, for instance—are precluded (or greatly limited by) financial resources, education, personal ability, opportunity, family ties, societal discrimination, and other often immutable external forces. However, that fact does not negate the main point of this discussion: that observed travel patterns are in large part the complex result of marketplace consumer decisions made about a wide range of different, interrelated activities.

Travel demand analysts tend to believe there is at least some type of hierarchy (or ordering) associated with these travel-related decisions. The rationale for such a hierarchy of decisions derives from the following general observations:

- Some fundamental travel-related decisions are made (or reconsidered) much *less frequently* than others. For example, decisions about where to live or what career to pursue are reconsidered relatively infrequently.
- Some decisions have much *greater impact* than others on an individual's lifestyle and associated activity patterns. For example, the decision about where to live has a far greater impact than where to shop for groceries on a particular day.
- Some decisions will have a *direct influence* on subsequent decisions. For example, decisions about vehicle ownership affect the options available for day-to-day decisions about travel mode.

From considerations like these, a hierarchy like that pictured in Figure 2 can be developed. The most fundamental, least frequently reconsidered, most pervasive impact decisions appear at the top of the figure. As one moves down the page, the decisions progress from macro to micro choices, culminating in the choice of mode for a specific trip.

The arrows in the figure chart the *general flow* of causal influence from the macro to the micro decisions, but the arrows should not be thought of as implying a one-way street. Short-term choices can strongly influence the longer-term choices. Certainly, decisions about vehicle ownership determine what modal options are available for specific trips—but those vehicle ownership decisions may result from a strong desire to drive to work, for example. Similarly, the residential location decision may be influenced in part by a wish to be near good public transportation services.

The key point here is that mode choice decisions—the micro behavior that, in aggregate, determines transit's market share—are the result of a very broad range of related consumer choices, some of which are being made every day and others of which may be reconsidered once a decade (or even less frequently).

Analysis of Mode Choice Decisions

Given the wide range of influencing factors at every level of the travel choice hierarchy, and given the probable feedbacks of causality from one level to another, it is not surprising that most quantitative models of urban travel behavior have been built from a much more restricted view of the choices than that summarized in Figure 2. To develop

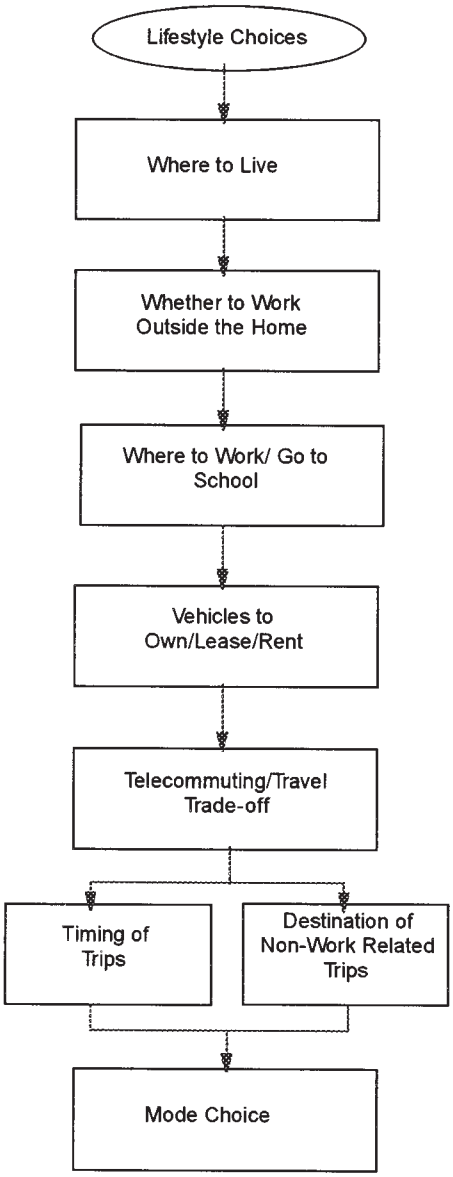

Figure 2. A hierarchy of the consumer decisions influencing mode choice.

tractable models, it is generally necessary to focus on just one section of the hierarchy, assuming that other things are being held constant. The traditional four-step "urban transportation planning" (UTP) approach, for example, assumes (in its basic form) that household travel behavior can be modeled as the end product of four sets of hierarchical decisions:[1]

- The *volume of trips* generated, given geographical, demographic, and socioeconomic factors about the household;
- The *origins and destinations* of those trips, given information about the city's spatial characteristics and travel times (and possibly out-of-pocket costs) on transportation networks;
- The *choice of mode* for the trips between a particular origin/destination combination, given the most important characteristics of the principal modes available; and
- The *choice of route* on the highway (and sometimes transit) network, given all the prior choices in the hierarchy and the speed and capacity characteristics of the network links.

Choice of mode specifically has been investigated using a number of different methods. Most typically, analysts have studied the mode choice behavior of a sample of different people who, because of geographical variations across the metropolitan region (or for other reasons), face different prices or service conditions for the modes available to them (cross-sectional analysis). Other studies have explored how the usage levels of one or more modes followed over time can be related to changing features of the modes and to other factors (time-series analysis). There is also evidence about mode choice from a battery of different survey research methods, ranging from the purely qualitative (focus groups, for example), through fairly simple direct questioning techniques, to sophisticated "tradeoff analysis methods" (such as conjoint measurement, or discrete choice models developed from conjoint-type datasets) in which the questions posed to respondents attempt to simulate as closely as possible the tradeoffs involved in the various choices they must make in the real marketplace.

Some relevant results from these varied types of mode choice analysis are summarized in Chapter 4. For the purposes of this current discussion, however, we need only summarize the *range* of different factors that have been found empirically to influence mode choice decisions. Transit ridership, in particular, has been found to vary with five general types of factors:

- *The levels of travel-inducing activities*. Since travel is predominantly a derived demand, as the levels of those activities that require passenger transportation change, so can the demand for transit service be expected to change.
- *The price and other characteristics of the service*. The price and various aspects of the level of service provided by the transit system have been shown by substantial previous research to affect the level of ridership.
- *Other transportation options*. The price and service characteristics of substitute and complementary modes of travel may also be expected to influence transit passenger volumes.
- *The characteristics of the population served*. The market for transit services comprises individuals with heterogeneous tastes, and the level of demand can be

[1] For a short review of the salient features of typical UTP models, see Beesley, M. E. and Kemp, M. A., "Urban Transportation." Mills, E. S. (ed.), *Handbook of Regional and Urban Economics*, Vol. 2: Urban Economics, Amsterdam, Neth., North Holland (1987) pp. 1026-1033.

expected to vary between different demographic and socioeconomic subgroups of the population.
- *Other factors.* Other determinants of transit patronage levels that are not easily classified into the above four categories include, for example, variations in the weather and changes in public tastes over time.

The quantitative models of transit ridership have focused primarily on those factors for which it is relatively easy to find quantitative measures. Fortunately, many of these are the factors that influence mode choice most strongly:

- The prices or perceived costs of alternative modes,
- Service frequencies and waiting times for public transportation modes,
- Access and egress times for public transportation modes,
- Line-haul (or in-vehicle) travel times,
- Transit transfer times,
- The number of transit transfers, and
- Trip distance.

Many of the other factors that may influence an individual's choice of mode are less easily defined or measured. The factors typically associated with the *quality of service* of a travel option are often of this type:

- Comfort—this includes such considerations as the space and seating arrangements afforded to a traveler, privacy, entertainment possibilities, and so on;
- Convenience—associated inversely with the level of effort required to access and navigate the transportation network (for example, the need to change vehicles);
- Service reliability—associated with how predictable the travel time and other aspects of the travel experience will be from day to day;
- Security—the overall level of personal safety afforded by each travel mode; and
- Other quality-of-service attributes, including the "image" of each travel alternative.

Analysts have sometimes been able to include some of these quality-of-service considerations explicitly in quantitative studies of mode choice.

Other measurable influences on mode choice behavior include the demographic or socioeconomic characteristics of the traveler and the nature of his or her trip:

- Household size,
- Household or personal income,
- Nature of the activity undertaken at the origin and destination points of the trip (that is, the "trip purpose"),
- Availability of a private vehicle for the trip, and
- Time of day of travel.

Finally, other elements of the choice hierarchy act directly or indirectly to influence the choice of travel mode. These might include, for example:

- Housing location,
- Employment status and location of work (or school),
- Household vehicle stock, and
- Destinations of (nonwork-related) trips.

PUBLIC POLICIES THAT POTENTIALLY AFFECT TRAVEL CHOICES

Given the range and diversity of influences on local travel choices in general, and on the choice of mode in particular, the potential for these choices to be affected by public policies is obviously very great. Figure 3 outlines the varying types of public policies that are potentially relevant, and indicates how they may have an impact on different levels of the choice hierarchy.

The salient characteristics of each of the various types of public policies identified in Figure 3 are briefly reviewed below.

Transportation Policies

The policies with the most direct and pervasive impacts, of course, are those that pertain specifically to *transportation*. Federal, state, and local governments exercise two basic roles with regard to transportation, one regulatory and the other fiscal. Regulation has shaped the forms of urban public transport that are available today, and public financing policies have strongly influenced priorities for investment in transportation facilities.[2]

Regulation of Public Transport

There are many ways in which government regulation impinges on urban transportation. Over the last quarter century, for example, federally imposed standards concerning safety, fuel consumption, and emissions have increasingly influenced aspects of private vehicle design and performance, and consequently the *costs* of owning and operating a private vehicle. States and municipalities regulate road usage through traffic laws and by requiring, for instance, driver licensing, vehicle registration, and safety inspections. And importantly, state and local governments regulate the provision of public transportation.

Past and present regulation has done much to shape the forms of public transport *available* in cities today. When electric streetcars replaced horse-drawn vehicles, beginning in the closing years of the last century, a competitive form of public transportation was superseded by a mode technologically superior, but generally provided by no more than one or two companies in most cities. With monopolization came local public regulation of fares and entry into the industry. When, between 1914 and 1920, growing private vehicle ownership led to the substantial emergence of jitney services

[2] This brief review draws on Kemp, M. A. and Cheslow, M. D., "Transportation." Gorham, W. and Glazer, N. (eds.), *The Urban Predicament.* Washington, DC, The Urban Institute (1976) pp. 294-295.

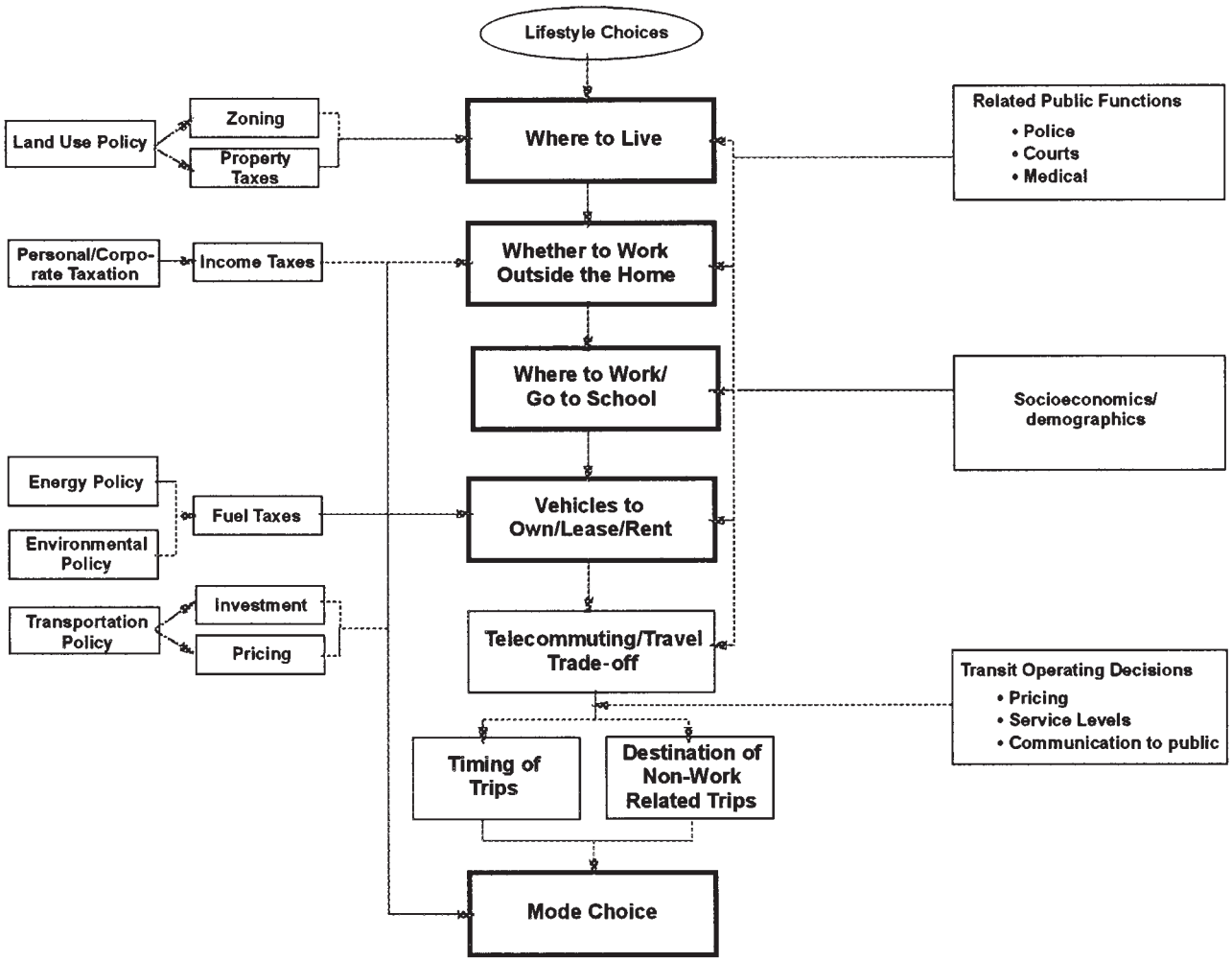

Figure 3. Relationships between public policies and traveler choices.

to compete with the street railways, the railways managed to have anti-jitney legislation enacted in virtually every city of the country. By the early 1920s, very few jitneys survived. The most significant residue of this period was the enhanced monopoly status of the streetcar companies. When the street railways were replaced by motor buses, often operated by the same companies, the monopoly status survived. Although in the 1990s public *ownership* of the transit system has replaced public *regulation* in all major cities, bus transit is still essentially organized on a monopoly basis operating along linear routes.

The "jitney craze" also had a spillover effect on another important mode of urban transport—the taxicab. The desire to prohibit jitney service strengthened the public regulation of taxis, particularly with regard to entry into the industry and the legality of carrying more than one group of passengers simultaneously. In most cities today, the ordinances allow cab service to be provided only by franchised firms or by a limited number of vehicles, and "shared riding" is expressly prohibited.

Fiscal Role of Governments: Money with Strings Attached

Just as local regulation has had a lasting impact on urban transportation, so have government financing policies, particularly those of the federal government. The end result of financing legislation is that the federal government has effectively set local urban transportation policy.

The federal government has been providing funds for highway construction since 1916, and for *urban* highways specifically since the Depression years. The Highway Trust Fund, established in 1956, introduced at the federal level of government the concept of dedicating receipts from user taxes (on gasoline, tires, and cars) for road construction. Transit, on the other hand, received no significant federal support until 1965, when a program of grants for approved capital expenditures was introduced.

The federal role that has evolved has several noteworthy features. The federal government is concerned with fundraising by taxation and with financing by grant-in-aid programs.

These functions are explicitly laid out in legislation and are administered by the executive branch. The legislation includes matching ratios for funds required from local sources, and allocation formulae that specify the geographic distribution of the funds expended in the grant programs. The formulae are usually compromises between rural and urban interests for highways, and between cities with extensive rail transit systems and other cities for transit programs.

The legislation has also always included some *standards* that states or localities must meet to receive the grants. These standards are both organizational—requiring, for instance, the establishment of state highway departments or metropolitan "clearinghouse" agencies through which all of a city's requests for capital grants must be channeled—and functional, requiring certain planning activities by the local agencies. In setting guidelines for the legislated standards, the agencies of the executive branch can further constrain the actions of the states or localities. The standards approach has been used by Congress in an almost commonplace way to require activities from states and localities over which the federal government has no *direct* legal authority. In this way, federal funding programs have mandated, for example, state highway speed limits, maximum off-peak transit fares for elderly riders, and transportation control measures in cities with air quality problems.

Federal Transit and Highway Support Levels

The provision of federal funds to states and localities also affects their consideration of the *costs* of alternative transportation programs. For instance, a local government must pay 100 percent of the cost of most routine highway and transit maintenance, at least 50 percent of the operating subsidy for approved transit services, 20 percent of the cost of construction of non-Interstate highways, and 20 percent of transit capital expenditures, but only 10 percent of the costs for construction of Interstate highways. To the state governments, therefore, the Interstate system has been a relatively inexpensive alternative compared with constructing or maintaining other roads.

Not only has the federal provision of grants influenced the choices for highway spending; it has also affected the expenditures on public transit. Federal transit assistance has always been considerably below the total for highways. For example, in fiscal year 1994, federal transit assistance totaled about $4 billion, compared with expenditures of federal highway funds of approximately $17 billion. State and local government funds for transit in the same year were about $11.6 billion, compared with roughly $67 billion for highways. The nation's annual capital expenditures for transit total less than $6 billion, while those for highways total about $40 billion.[3]

Of course, such comparisons only tell half the story, and may be quite misleading. Substantially all direct governmental expenditures on highway construction, maintenance, repair, and administration result from highway *user fees*; the public sector is acting primarily as a collection and disbursement agency, rather than as a benefactor. Government payments to transit, in contrast, are *in addition to* the $8.8 billion (in 1994) of fares, other operating revenues, dedicated taxes, and internal cross-subsidies generated and retained by the transit operating agencies. The public disbursements for highway expenditures, therefore, mostly reflect a *marketplace-derived value* of highway services, while those for transit reflect a *policy judgment* that the mode warrants public subsidization because net social benefits are believed to accrue from such an investment of general revenue funds.

Dollar for dollar, straight highway and transit comparisons of funds received from governments tend to neglect another market-based consideration: that transit services appear to account for less than 3 percent of the total metropolitan area passenger miles.† Nonetheless, such comparisons are perhaps in part invited by the way in which the federal government has leveraged its role as trustee and treasurer of highway user payments. Through the use of standards to set and enforce national transportation policies, and by allowing the highway and aviation trust funds to build up as a device for manipulating the federal budget deficit, the connection between user fees and investment has been diminished. The perception that highway program expenditures represent a direct public subsidy like that to transit has been thereby reinforced.

As part of this project, we were asked specifically to review whether governmental fiscal policies regarding urban transportation create distortions and/or inconsistencies in public policy, particularly between transit and private vehicle use. We have reviewed a number of notable recent attempts to assess the full social costs of transit and private vehicle travel, and to gauge the magnitude of any overt and "hidden" governmental or societal subsidies to the two modes.

Our detailed review and commentary is presented in Appendix C of this report. We focused on a number of recent studies supported (and/or published) by a range of different stakeholder interests, in order that the selection of studies should highlight all of the primary points of technical contention. We opine that it is wrong to expect that there can be a single, completely objective assessment of this question, one to which all interested parties would be forced to agree by dint of the purity of its reasoning or its technical merit. Rather, by its very nature, the question of nondirect public

[3] These data were derived from U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 1994.* Washington, DC, US Government Printing Office (1995) tables HF-10, HF-2, FA-3, SF-21, and LGF-21. American Public Transit Association, *1996 Transit Fact Book.* Washington, DC, American Public Transit Association (1996) Exhibits 23, 30, and 34.

† This estimate, derived by Altshuler and his co-workers in the mid-1970s, is probably now too high, judging by journey-to-work trends revealed by successive decennial censuses of population. To the best of our knowledge, however, it remains the most recent, reasonably careful estimate of transit's national market share of *person-miles*. And though 3 percent is a relatively small *proportion*, it should not be forgotten that, in *absolute* terms, in excess of 6 million U.S. residents are using transit, many on a daily basis.

subsidies to transportation modes requires many value judgments and assumptions, when consensus on theory falls short or when good empirical information about cause and effect is lacking or shrouded in uncertainty. Because of these inherent limitations, we suggest that the debate of this topic can only remain essentially a sterile one, not very helpful to the formulation of good public policy.

Competition for Federal Transit Funds

Moving on, then, from the issue of the relative magnitudes of governmental financial assistance for different modes to focus more closely on the *federal transit program*, the discretionary nature of the capital assistance element (to build new infrastructure, modernize old infrastructure, or purchase vehicles) creates difficult allocation decisions between the claims of competing cities. For the last 20 years, the demand by localities for federal capital support has exceeded the authorized funding levels of the discretionary grant funds, and the U.S.DOT has been responsible for making the rationing decisions. In recent years, however, Congress has played an increasing role in these allocation decisions, first by specifying more detailed allocation criteria in the authorizing legislation, and, perhaps more significantly, by *earmarking* various funds for specific recipients in the legislation that authorizes the program. This trend pushes national policy in two opposing directions. While the more detailed guidelines on allocation criteria signal an interest in supporting those proposals that can demonstrate they will best meet *national* objectives for federal transit investments, earmarking effectively removes certain lucky recipients from the need to prove their merit in an open competition among their peers.

In any case, whether determined by Congress or the executive branch, major capital investment policy for transit has effectively been set at the federal level. *Operating* policy decisions, in contrast, are generally made at the local level—that is, at metropolitan area or sometimes state levels.

In contrast, highway capital investment decisions are more decentralized, and the states play a much more important role that is reflected in both the disbursement policies for federal funds and the states' own revenue-raising power from fuel taxes. Much operations and management expertise for highways resides at the state level, whereas for transit the equivalent experience is typically found within the local transit properties or in consulting firms operating at national or international levels. In the last 20 years, most state "highway departments" have become "transportation departments," but this is typically a very unequal marriage. Given the relative geographic scale of the investments, the economies of scale for technical expertise, and the nature of the federal funding programs, the states appear likely to continue to play a much more important role in highway policy than in transit policy.‡

‡ A notable exception is in those states with the largest metropolitan areas, where the state legislature may provide the only effective forum to resolve disputes between central city and suburban interests.

Investments Help Shape Urban Travel

Although most transportation investment policy does not affect mode decisions *directly*, it is nevertheless very important to the process. The amount and quality of highway facilities serving a metropolitan area will have a major influence on more than just the attractiveness of the driving option. Transportation investments in general will also affect where in the metropolitan area businesses and households choose to locate, and hence the geography of travel patterns.

In addition, the amount of available highway and transit capacity affects congestion levels, which in turn affect travel times and travel time predictability. Likewise, the investment in transit facilities may determine if a practical alternative to the private car exists at all. The construction of additional rail lines or the purchase of additional buses may allow the extension of transit service to new areas. In areas that already have some service, services may be improved to more competitive levels.

Operating assistance provided to transit agencies will also affect service levels, since without those subsidies operators would have to reduce frequencies or hours of operation, or raise fares, to meet their budgets.

A portion of federal and state highway funding is dedicated to research and development (R&D) activities. Since its inception, the federal transit program has always provided money for support of planning and R&D functions, with most of the planning money controlled at the state and local levels, and most of the R&D funds deployed at the national level. To the extent these activities produce efficiency gains or other benefits, they may be able to affect mode decisions.

Public Policies Concerning the Pricing of Transportation Facilities

Transportation policy also deals with *pricing* the use of the transportation infrastructure. For road use, these policies generally take the form of taxes, tolls, or other fees, but pricing policy also involves setting fares for public transportation and the availability and cost of taxis and publicly owned parking spaces.

The main pricing instrument of the federal government is the federal gasoline tax, currently an 18.4 cents per gallon surcharge that is constant across all regions and grades of gasoline. The "gas guzzler" tax, also a federal measure imposed by the 1978 Energy Tax Act, is a graduated excise tax (ranging from $1,000 to $7,700) assessed on cars with EPA average fuel economy below 22.5 mi per gallon, meant to discourage the purchase of less fuel-efficient vehicles. The federal government also imposes a 10 percent luxury tax on automobiles, assessed currently on the amount of the purchase price that exceeds $34,000. Similar luxury taxes on boats, planes, jewelry, and furs were repealed in 1993, and there is speculation that the automobile tax may also be amended significantly or repealed in the near future.

All 50 states also have gasoline taxes, ranging (at the end of 1994) from a low of 7.5 cents per gallon in Georgia to a high of 31 cents in Connecticut.[4] All but three of the states charged 15 cents or more per gallon. States also set the fees charged for automobile registration, and many states and localities also have annual *ad valorem* excise or personal property taxes that apply to vehicles registered there. In California, for example, such fees can be significant: the charge is normally 2 percent of the car's book value, and cars not equipped with California emissions equipment are assessed an additional one-time fee of $300 when the car is initially registered. State turnpike authorities can also set tolls on major highways, thereby controlling access to those facilities.

At the local level, transit agencies—or the local or state governments that own them—determine the fare policy for the public transportation system. The fare policy involves the setting of both fare *levels* and fare *structure*: that is, the various types of cash payments, multiride tickets, unlimited ride passes, concessionary fares, and other fare options that are offered. The fare policy may incorporate a structure that varies the price depending on trip distance, time of day, or some other measure, as well as determine the pricing and availability of transfers to other modes within the system.

Local authorities are also responsible for setting tolls on local access facilities such as roads, tunnels, and bridges. In addition, the availability and pricing of publicly owned or street parking, often in the downtown area, are determined by local governments. Some cities impose a tax on parking in privately owned facilities. The number of taxicabs available is also under the control of the local governments through the issuing of taxi medallions, as is the regulation of taxi fares.

Generally speaking, pricing policy influences mode choice directly by affecting the user costs of each mode. To the extent that governmental price impacts contribute significantly to the costs of a mode, the effect on mode choice can be potentially large. For example, the cost of daily parking in some cities is so high as to encourage ridesharing or preclude commuting by automobile for many employees, while in other cases it is so low that transit finds it difficult to compete effectively.

Environmental Policies

The environmental policies most pertinent to mode choice are generally those that deal with vehicular emissions and fuel economy. These policies are typically implemented through regulations requiring minimum standards for the sale of new cars or the continued operation of existing cars. They may also take the form of programs to restrict vehicle use more directly in areas of particularly poor air quality.

Current federal policy regarding vehicular emissions is codified through the 1990 CAAA, reviewed earlier in this chapter. At the state level, relevant environmental policy is essentially concerned with controlling vehicular emissions. The states are charged with the responsibility of enforcing the standards established by the CAAA through periodic reinspection of vehicles, and some states also have their own, more stringent emissions standards. The state of California requires the installation of special emission control equipment for all new cars sold in the state, and imposes stiff extra charges for the registration of out-of-state vehicles not equipped to the state standard. In addition, some states have recently adopted requirements for the sale of "cleaner" vehicles. Typically these requirements mandate that a certain percentage of all vehicles sold by a target year must qualify as low-emission vehicles (LEVs), ultra low-emission vehicles (ULEVs), or zero emission vehicles (ZEVs). LEVs and ULEVs are generally conventional cars powered by alternative fuels such as methanol-blended gasoline (M-85) or natural gas, whereas ZEVs are more advanced vehicles employing electric power or fuel cell technology.

A particular focus of local policy is on *ambient air quality*, a component of the federal mandates and often a local problem of particularly high priority. Programs designed to mitigate local air quality problems may therefore serve both objectives. At the local level, environmental policy may be implemented in ways that most directly influence mode choice in the urban setting. In pursuing ambient air quality goals, a municipality may restrict traffic flows into or out of a particular area, or impose mandates on employers (for example) to discourage employees from commuting in SOVs. As we have seen, current federal standards require that environmental considerations serve as an input into the local planning process, affecting the course of development and transportation planning.

Energy Policies

Energy policy is concerned with the consumption, conservation, and supply of energy-producing resources. Of particular interest are the economic, strategic, and environmental implications of the mix of fuels used in producing energy, and the sources of these fuels. While energy policy is motivated by these macroscopic issues, it could nevertheless have the potential to influence mode choice decisions. Because transportation accounts for about one-fourth of all U.S. energy consumption, and about one-third of all U.S. petroleum consumption,[5] it figures prominently in the implementation of energy policies concerned with energy demand, and the environmental issues associated with energy consumption.

The 1975 Energy Policy and Conservation Act mandated minimum fuel economy standards for cars sold in the United States. Under this law, the sales-weighted average fuel economy of all new passenger cars sold by a manufacturer must

[4] U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 1994.* Washington, DC, US Government Printing Office (1995), Exhibit MF-121T.

[5] U.S. Department of Energy, *National Energy Strategy.* Washington, DC, US Government Printing Office (1991) p. 60.

now be at least 27.5 mi/gal, while the average for light trucks must be no less than 20.7 mi/gal. Although the Corporate Average Fuel Economy (CAFE) standards were designed primarily to mitigate concerns over the macro (or even global) level of air pollution, by increasing the price of new cars they potentially create financial disincentives to purchase newer, more fuel-efficient vehicles. Hence, they may actually exacerbate state and city efforts to control local air quality, while failing to address problems of local congestion.

Other aspects of the current federal energy policy are outlined in the Energy Policy Act of 1992. The specific sections of the law most pertinent to transportation are Titles III through VI, which deal with alternative fuel vehicles, and Title XX, which involves reductions in oil vulnerability. Although the measures contained in these sections of the legislation are aimed directly at the transportation-related sources of energy consumption, in practice they are likely to have little influence on the consumer decisionmaking process for individual trips. The mandates for alternative fuel vehicle sales and use pertain for the most part to the federal fleet, and where they do involve the private sector, they are aimed at fleet vehicle owners rather than individual consumers. Sections 2021–2023 of Title XX involve reductions in the demand for oil from the transportation sector, but they are generally restricted to the enactment of R&D programs for new technologies rather than specific measures aimed at reducing current petroleum use. Consequently, they seem unlikely to affect the choices that consumers currently make in the marketplace.

Taxation Policies

Taxation policies at all levels of government can potentially have an effect on mode choice, some *indirectly* by influencing macroeconomic conditions and household disposable incomes, and others *directly* by providing more incentives.

The most obvious and important aspect of tax policy at the federal level is the income tax. Changes in personal income taxes can affect overall economic activity and directly affect disposable personal income, which in turn can influence the demand for new automobiles in particular, or for transportation more generally. Provisions of the personal income tax code also provide indirect incentives that can be a potential factor in the mode choice decision.

Home Mortgage Interest Deductions and Urban Form

Tax deductions for home mortgage interest, for example, will influence the cost of housing, thus potentially affecting the traveler's choice of where to live. Indeed, there has long been an argument that allowing such a deduction has encouraged significant shifts in residential location over the past 50 years, helping to result in what is now characterized derisively as "suburban sprawl." Such a shift in residential location, whatever its impetus, can clearly affect the cost of travel, as there are significant challenges to providing public transportation services to low-density suburban areas.

As we remarked in the introductory chapter, however, the issue for this paper is not how *past* public policies have shaped urban travel patterns, but rather how *today's* policies are influencing current consumer choices. In an era in which housing price trends have encouraged medium-density condominium apartment and townhouse developments, filling core areas as well as expanding at the fringes of metropolitan areas, we suspect that any *current* relationship between locational patterns and housing-related tax expenditures will be a very tenuous one, at best. Public zoning and local governance policies, or local and state mandates about (for example) rent control or provision of "affordable housing," seem likely to have a much more direct effect on influencing urban form through residential location decisions.

Employer Defrayal of Commuting Costs

Another tax policy that has drawn particularly high attention of late is the federal tax provisions regarding employer subsidization of employee commuting expenses. Historically, the provision of a parking space at the workplace, or financial support for commercial parking at the workplace, was not considered taxable income to the employee. Just as different employees may be provided different sizes and qualities of working space or different eating arrangements without tax implications, the provision of parking space has been regarded as what the IRS calls a "working condition fringe benefit," one not seen as part of the remuneration.

In recent years, the IRS regulations have evolved gradually, such that in 1996 up to $65 per month could be provided tax-free to employees to support expenses incurred in commuting by transit, while any parking support with a market value exceeding $165 per month was taxable to the employee. As far as the *corporation*'s taxes are concerned, all such fringe benefits (whether within the limits that are tax-free to the recipient or not) are valid business expenses that are deductible from income, but employer payroll (Social Security) taxes must be paid on any amounts that are taxable to the employee.

There has been much discussion in the transportation community of the equity and cost implications of these federal tax policies. A 1992 study by the U.S. General Accounting Office—made at a time when all parking subsidies were tax-free, transit fare support of up to $21 per month was tax-free, and transit fare reimbursements that exceeded the $21 threshold were regarded (*in their entirety*) as taxable income—concluded that disparities in treatment created significant incentives in favor of drive-alone commuting.[6]

[6] U.S. General Accounting Office, *Mass Transit: Effects of Tax Changes on Commuter Behavior*. Report GAO/RCED-92-243, Washington, DC, US General Accounting Office (1992).

The subsequent change in the law has moved part way to redress the imbalance and has established the position that some part of employer-provided parking may be taxable income. However, differences in the levels of tax-free parking and transit fare support still remain, along with a few less obvious disparities.§ There have been proposals that would require those firms that offer a parking benefit to allow eligible employees to receive a taxable cash equivalent of the market value of the parking benefit.[7]

The GAO's 1992 report, while identifying the taxation policy bias in favor of drive-alone commuting, and providing evidence that it did have an effect on commuting behavior, also concluded that it was difficult to predict how changes in tax policy would influence both employer and traveler behavior.

Other Tax-Related Impacts

Most states also have income taxes. While they may contribute (albeit less markedly) to the same kinds of macroeconomic effects as the federal income tax, more important from the consumer choice perspective is the state sales tax. Sales taxes are assessed on all cars (whether new or used), as well as on car parts and accessories. As observed earlier, some states also impose annual personal property or excise taxes on automobile ownership. By increasing the cost of purchasing and maintaining an automobile, such taxes may have an indirect influence on mode choice.

While there are some income taxes at the local level (in large cities generally), the most important local tax policies involve sales and property taxes. In some cities (San Francisco, for example), a portion of the local sales tax is dedicated exclusively to the funding of public transportation. Local property tax revenues may contribute to the establishment, repair, and maintenance of local streets and bridges, but any influence on mode choice is likely to be quite remote.

Land Use Policies

Land use policy is generally local in nature, and consists mostly of zoning laws and related regulations that govern the development and use of property. Although not a direct influence on mode choice, some elements of land use policy, it has been argued, have the potential to affect some of the "higher level" choices in the consumer decision-making process that precipitate mode choice. For example, to the extent that local planning laws limit the density or principal activity of a development, either directly through such provisions as minimum lot size requirements, or indirectly by restricting the use of an area to residential purposes, they can make conditions much less conducive to a viable public transit system.

However, it is perfectly feasible for the same legal powers to be used, if local sentiment is in favor, to promote more transit-friendly development patterns. For example, through design reviews and other requirements imposed locally on developers, the installation or augmentation of transportation facilities can be made a condition for the approval of proposed projects. Indeed, the environmental impact statements required by the National Environmental Protection Act have created a mechanism whereby the proposers of major private developments need to address the transportation implications of their proposals explicitly, and develop mitigation plans for negative environmental impacts. Moreover, that same legislation's requirements for public consultation and comment have been, in a large number of instances, a catalyst for vocal citizen opposition that has killed or significantly modified public or private proposals.

It would appear that such provisions, coupled with powers to develop trip reduction ordinances and employer-based commute trip programs, give local governments adequate leverage to emphasize public transportation methods of access and egress *if they so wish*. It can be fairly argued that the local authorities' land use control powers have not been a major *cause* of low-density suburban development, as much as a *reflection* of local marketplace behavior and public preferences.

SUMMARY

This chapter has explored how various public policies work to influence the mode choice process. We began by examining in some detail the most prominent recent legislation concerning the goals and priorities of transportation planning at the federal level. This legislation, the ISTEA and CAAA, attempts to address at a national level the communal deleterious effects of mode choice decisions, most notably congestion and urban air quality. As we have discussed, however, the decision-making processes that result in the individual's mode choice decision are complicated ones, involving many different consumer choices, each made with different frequency and with different motivations. We have attempted to order these choices, concluding that the mode choice process is best described as a *hierarchy* of choices, that lifestyle-related decisions drive a host of other significant and somewhat permanent choices such as housing and vehicle ownership, and that only within the context of these initial decisions does the mode choice arise.

While we have argued that this choice process is primarily motivated by lifestyle choices,** every stage of the process is nonetheless affected by public policies at all levels of government. Table 16 summarizes the most significant of these polices, highlighting the key points in their interac-

§ For example, parking provided at locations *at or near* the workplace is viewed by the IRS as a working condition fringe benefit, whereas employer reimbursement of parking at a suburban commuter rail station (to access the train) presumably would not qualify as tax-free income.

[7] See, for example, Shoup, D., "Cashing Out Free Parking," *Transportation Quarterly*, Vol. 36, (1982) pp. 351-364.

** For example, Jim may drive to work because he wants to live in the suburbs and have the prestige and gratification of owning a smart new car; once he has the car, why take the bus?

TABLE 16 Summary of mode choice impacts of public policies

Transportation Investment Policy • Infrastructure spending directly affects the relative attractiveness of each mode • Transit operating assistance can help to maintain, improve, or expand services • Research and development funding provides innovations in the provision of transportation services
Transportation Pricing Policy • Taxes and tolls make automobile use more expensive • Fare policy determines cost of transit trips • Local policies dictate taxi fare, and indirectly, service levels • Local parking pricing and availability are very important components of the cost of driving
Environmental Policy • Federal/state emissions standards increase new car prices • Local air quality mandates require programs to reduce single-occupant vehicle use • Local policies influence development patterns and transportation planning
Energy Policy • Minimum average fuel economy standards increase new car prices, decrease operating costs • Alternative fuel vehicle and research and development provisions of Energy Policy Act are unlikely to affect choices made by consumers/households
Tax Policy • Income taxes affect economic activity and disposable income, thereby influencing the affordability of various travel choices • Preferential parking cost deductions promote automobile commuting over transit • Sales taxes affect automobile costs, and may support public transit • Mortgage interest deductions influence housing location choice • Property taxes may support local roadway infrastructure
Land Use Policy • Provisions of zoning laws (lot size, use) affect the viability of public transit • Design reviews and other restrictions can require definitive plans for addressing transportation issues in new developments

tion with the mode choice process. As the table makes clear, some of these effects are more direct than others. Those policies which directly affect the prices or service levels of the competing modes tend to enter the choice process at or closer to the level of the mode choice decision itself, and therefore are likely to be very important. On the other hand, policies which enter the process less directly can nonetheless be quite significant—land use policies, for example, can affect the housing and workplace location choices that are often important influences on mode choice.

While the most visible *federal* polices regarding investments in highway and public transit infrastructure (including those discussed in detail at the beginning of this chapter) may seem at first glance to be the dominant factors in the policy process, it is often *at the local level* that the mode choice decision can be affected most significantly. As we will begin to see in the next chapter, those policies that directly affect the level and quality of service afforded by the private vehicle, rather than the public transit mode, have the strongest potential to affect mode choice.

CHAPTER **4**

SETTING THE CONTEXT: TRAVELER BEHAVIOR AND ITS IMPLICATIONS FOR TRANSIT

COMPLEXITIES INHERENT IN THE STUDY OF TRAVEL PATTERNS

The volumes of travel observed on any transportation facility (measured in, for example, trips, vehicle miles, or passenger miles) are obviously the aggregate result of decisions made by many individual travelers to move from one place to another. However, understanding and analyzing the demand for travel, both local and longer distance, is inherently more complicated than understanding the demand for commercial products, such as cans of Coca Cola, Mercury Sables, or seats at a ball game, for several reasons:

- **Travel is predominantly a *derived* demand.**
  Relatively little travel is undertaken as an end in itself, and this is particularly true of transit travel. Almost all travel is made to allow the traveler to fulfill some other purpose at the destination. Accordingly, variations in the demand for these very diverse destination activities will strongly influence how much travel occurs.
- **Travel involves decisions in many different "dimensions."**
  Travelers are not making just a simple "buy or don't buy" decision. Rather, as described in Chapter 2, they must decide
  – *Whether* to make a trip at all ("trip frequency");
  – *Where* to travel to ("destination choice");
  – *When* to travel ("schedule choice");
  – *How* to travel ("mode choice"); and
  – By which *route* to travel ("path choice").
  Sometimes, many or several of these choices are reconsidered each time a new trip is made. Much travel is habitual, however, and new alternatives may be reconsidered relatively rarely.
- **The more you buy, the worse it gets.**
  The level of service provided by a transportation facility is not constant, but (*for a fixed level of supply*) it declines as demand increases. This fall-off in the quality of the product becomes most marked when the demand is approaching the capacity of the facility. The congested highway and the crowded bus or plane offer slower speeds and/or more uncomfortable traveling conditions as the demand increases.*

* Common carrier services like transit may often respond to increased demand by adding an extra vehicle departure, thereby increasing the frequency of service. In that sense, systems with relatively high demand may be able to offer relatively high service levels. This does not negate the (different) point made above, however.

It is because of inherent complexities like these that forecasting future travel is such a difficult undertaking. People have many different ways in which they can react to conditions or circumstances that do not meet their liking, both *before* making a trip and *while* making the trip. They can decide to go at a different time, or not to go at all. They may be able to satisfy their purpose at a different destination. They may switch modes, or go by a different route.

But despite the many different ways in which *individual* travelers may respond to the travel conditions, when looked at *in aggregate*, current travel volumes on existing transportation facilities have many regularities that (as we shall see) can be explained by a relatively small number of influencing factors.

WHAT HAS THE RESEARCH INTO CONSUMER TRAVEL DECISIONS SHOWN?

The evidence available that can be used to study all aspects of traveler behavior—trip choice, destination choice, schedule choice, mode choice, and path choice—can be usefully classified into the following categories:

"Revealed preference" (or behavioral) evidence, in which observations of what people actually do (or report that they do) is related to characteristics of the people and the travel conditions (or choices) available to them. In order to find situations most conducive to understanding what motivates travelers, analysts look at two types of variations in behavior:
– *"Cross-sectional" variations*, whereby (at any particular time) different people or households face different travel conditions by virtue of (for example) living or working at different locations, or having different resources of money or time; and
– *"Time series" variations*, whereby the circumstances of, or the travel conditions experienced by, the same group of people change over time, and they react to that change.

Both of these sources of variation—which can be characterized imprecisely as variations "over space" and "over time"—provide opportunities to infer how differences in potential influencing factors affect travel behavior. Sometimes, the two sources of variation can be "pooled" and analyzed together.

"Stated preference" evidence, which is derived from *opinion surveys*; that is, what people *say* motivates their travel behavior, in response to explicit questions about their requirements and preferences, or inferred from questions regarding hypothetical travel choices.

Opinion survey responses are very prone to many different forms of *response bias*: that is, people giving inaccurate or misleading answers out of (for instance) incomprehension, impatience, politeness, or self-interest. The responses can be very sensitive to the survey context, or to small variations in the wording of the questions.

For this reason, most analysts prefer to work with *revealed preference* information—describing actual choices made in the real marketplace—rather than with the potentially more volatile *stated preference* evidence. However, there are circumstances where no good revealed-preference information exists, and consequently only stated-preference evidence can be used. This is the case, for example, when predicting the demand for a new class of product that has capabilities (or a combination of features) not currently available in the marketplace.

Several different genres of revealed and stated preference studies that are concerned with travel choices *in general* (that is, with no specific transit emphasis) are summarized in Appendix D. There is now a substantial body of accumulated evidence about urban travel demand drawn from a variety of settings and analysis methods, both in general terms and in forms specifically oriented to assessing the implications for transit operations. For example, there are syntheses of the evidence about the price elasticities of transportation fuels[1] and for urban modes generally.[2] There are comprehensive surveys of the elasticity of transit demand with respect to prices and service attributes, both for the United States[3] and for a wider group of developed countries.[4]

A number of generalizations, or "rules of thumb," have emerged from these investigations, all consistent with the consensus evidence from both attitudinal surveys and aggregate times series analysis:

1. ***Travel times* are relatively important.**
   The studies uniformly show that the travel time implications of travel alternatives are a highly important determinant of consumer choices. *Other factors being equal*, people are very likely to choose the option with the lowest *origin-to-destination* travel time.

   For urban area travel to and from work, people behave as if they value travel time savings at roughly a third to a half of the wage rate, on average. This can vary depending on the choice situation involved (for instance, mode choice, path choice, and so on). Non-work travel time savings are usually valued less highly.
2. **Not all time savings are equal.**
   The time spent getting to and from motorized transport, or waiting for the vehicle to arrive or depart—components of the complete trip that are often referred to as the *excess* or *access/egress* components—appear to be more onerous than the time spent actually traveling in the vehicle (the so-called *line-haul* component). Travelers typically value reductions in excess times more highly than reductions in line-haul times.

   Moreover, the excess time spent in *waiting* for service—at a bus stop or subway station, for instance—is judged more onerous than the excess time spent walking or riding to or from the line-haul mode.
3. **Travel prices do influence consumer choices.**
   While the out-of-pocket costs of travel options are *less important* than travel *time* considerations in influencing behavior, this isn't the same as saying that they are *not important* at all. Other factors being equal, people will choose the least expensive alternative. The results of cross-sectional studies of travel behavior reinforce the attitudinal and time series evidence: prices do influence choices, but a 10 percent change in travel times is likely to have a greater impact than a 10 percent change in costs.
4. **However, demand is usually inelastic with respect to price.**
   Virtually all estimates of market direct and cross-elasticities with respect to price—for all aspects of urban travel demand (gasoline consumption, toll road usage, transit patronage, and so on)—are inelastic at customary price levels. This means that, despite a fall in the *amount of travel*, price increases will typically lead to increases in *revenues*.
5. **Aspects of "comfort" and "convenience" that are quantified usually prove to be very important.**
   It is difficult to develop quantitative measures of such amorphous travel attributes as (for example) *comfort*, *convenience*, *flexibility*, or *control* that do justice to the full scope of each of these concepts. In multivariate studies, it is often assumed that the unquantifiable characteristics are basically *inherent* to each of the travel choices (modes or routes, say) being examined. Consequently, these "residual" characteristics are represented in the analysis essentially by using a dummy variable to represent each of the choices. Typically, the coefficients for these dummy variables ("choice-specific constants") turn out to be significantly different from each other. This says that unquantifiable aspects do differ between the alternatives, and do indeed influence consumer choices.

   Sometimes, some small component of one of these concepts can be quantified relatively easily. A good example for common carrier travel is the *need to trans-*

[1] Charles River Associates, "Price Elasticities of Demand for Transportation Fuels." Cambridge, MA, Charles River Associates (1976).

[2] Pucher, J. and Rothenberg, J., "Pricing in Urban Transportation: A Survey of Empirical Evidence on the Elasticity of Travel Demand." Cambridge, MA, Massachusetts Institute of Technology (1976).

[3] Mayworm, P., Lago, A. M., and McEnroe, J. M., *Patronage Impacts of Changes in Transit Fares and Services*. Washington, DC, US Department of Transportation, Urban Mass Transportation Administration (1980).

[4] Bly, P. H. and Webster, F. V., *eds.*, *The Demand for Public Transport: Report of the International Collaborative Study of the Factors Affecting Public Transport Patronage*. Crowthorne, UK, UK Transport and Road Research Laboratory (1980).

fer between vehicles. It is common in studies of mode choice between transit and private vehicles, for example, to include a variable indicating the number of transit transfers required. Analysis has shown that such transfers are judged to be particularly onerous. To explain travel patterns, it is necessary to posit a "transfer penalty"—typically equivalent to between 5 and 15 min of travel time savings per transfer—*in addition to* the extra travel time involved in making the transfer. This helps us understand why few transit passengers are prepared to transfer more than once in the course of making their trips.

Evidence About the Demand for Transit Services in Particular

Since the 1960s, the literature has periodically included surveys of transit elasticity evidence: that is, the sensitivity of transit ridership to variations in fares, service levels, and other major influences.[5] Although for *detailed* planning and policymaking purposes elasticity estimates alone are of only limited value when divorced from the demand model from which they have been derived—and indeed may lead to erroneous conclusions—in practice the robustness of certain key elasticity values reduces the risks of problems.[6]

Fare Sensitivity

Indeed, the level of "regularity" in estimates of short-run, direct transit fare elasticities is such that the consensus findings can be summarized quite succinctly. These estimates tend to vary within the range −0.1 to −0.7, with most estimates clustering between −0.2 and −0.5. The elasticities are numerically small when the purpose of travel is a relatively "strong" one, or when alternative means of travel are unavailable, highly priced, or provide markedly inferior travel times.[7]

So, for example, transit fare elasticities tend to be low (numerically) for *work-related journeys, peak-period services*, and services in *dense central city areas*. Patronage is most sensitive to price at *off-peak* times, for *short journeys*, in *relatively affluent markets* (who typically have private vehicle alternatives), and *places without much traffic congestion*.

Moreover, transit demand is often observed to be more sensitive to changes in the price of *private vehicle travel* than it is to *transit fare* changes per se. This is, in part, because the base of private vehicle trips that can potentially be diverted to transit is so much larger than the base of existing transit trips.

The most recently published review of U.S. transit fare elasticity evidence—that undertaken by Linsalata and Pham of APTA—applied a Box-Jenkins transfer function (ARIMA) model to systemwide time series data for each system in a sample of 52 responding systems.[8] Ideally, 4 years of monthly data for the mid-1980s were sought for each system, for a period incorporating a fare change. The general form of the model was largely common across systems, although the particular variables used to characterize such influences as the level of transit service, local employment, or the price of travel by private vehicles necessarily varied from one city to another. The functional form used most frequently was such that the fare elasticity was assumed to be constant at all fare levels.

Linsalata and Pham's results are largely in line with the general findings from previous transit fare elasticity studies, summarized earlier. However, the individual system estimates did exhibit a much greater degree of variability than has sometimes been appreciated.† The systemwide, all-period fare elasticities varied from −0.12 (Riverside, CA) to −0.85 (Toledo, OH). While the authors note a city size effect—the mean for urbanized areas of over one million population was significantly lower (numerically) than the mean for less populous areas—they were unable to rationalize any other sources of the inter-system variability.

In part, the variability may reflect the scale of the project. When trying to estimate both peak and off-peak models for each of 52 systems it is difficult to get heavily involved with the idiosyncrasies of any one system, and some estimates may be biased by the inadvertent omission of a key, locally influential variable. Nevertheless, the statistical properties of most of the models appear to be respectable.

The APTA sample contains relatively few large cities, and in particular, it omits services in and around New York City, responsible for a large proportion of the nation's transit riders. Charles River Associates has responsibility for making independent farebox revenue forecasts for the New York MTA services, that have been used since 1982 to support the periodic issuance of revenue-backed bonds. Monthly time series models have been developed for subway, bus, and commuter rail ridership and revenues, and these are updated at regular intervals. The estimates of systemwide direct real fare elasticities have not changed much over this long period of monitoring, however. CRA's most recent fare elasticity estimates—developed using data through December 1995 or January 1996‡—are as follows:

[5] Such surveys include, most notably, Mayworm, Lago, and McEnroe (1980), *op. cit.* Bly and Webster, *eds*. (1980), *op. cit.* Cervero, R., "Transit Pricing Research: A Review and Synthesis," *Transportation*, Vol. 17, (1990) pp. 117–139. Linsalata, J. and Pham, L. H., *Fare Elasticity and its Application to Forecasting Transit Demand*. Washington, DC, American Public Transit Association (1991).

[6] Kemp, M. A., *Planning for Fare Changes: A Guide to Developing, Interpreting, and Using Fare Elasticity Information for Transit Planners*. Research Paper 1428-05, Washington, DC, The Urban Institute (1981).

[7] Kemp, M. A., "Some Evidence of Transit Demand Elasticities," *Transportation*, Vol. 2, (1973), pp. 25–52.

[8] This approach follows that of Kyte, M., Stoner, J., and Cryer, J., *Development of Time-Series Based Transit Patronage Models* (2 volumes), Iowa City, IA, University of Iowa (1985).

† From the late 1950s through the early 1970s, many transit systems projected their revenues from potential fare increases by assuming a common −0.33 fare elasticity value, a mean derived from simple before-and-after studies for a range of mostly small- and medium-sized bus systems.

‡ This period included the most recent fare increase, but not for an adequately long time afterwards to allow the full effects of that increase to be reflected in the elasticity estimates. However, MTA officials are on record as stating that the revenue impacts of the 1995 fare increase were in line with expectations.

- For the MTA New York City Transit subway services, −0.15;
- For the MTA New York City Transit bus services, −0.36;
- For the MTA Long Island Rail Road services, −0.22; and
- For the MTA Metro–North Railroad services, −0.20.

Sensitivity to Service Levels

Notwithstanding the amount of intersystem variability implied by the APTA report, *fare* elasticities are usually found to be the most uniform and rationalizable transit demand elasticities measured by analysts. This is likely to be, in some part, an artifact of certain definitional and data considerations. There are, to be sure, a number of technical issues inherent in deriving a measure of the mean fare—particularly for systems with complicated fare structures—but the measurement of fare level changes is usually a much simpler matter than the measurement of service level changes. This is because, on the demand side, there are so many different dimensions in which passengers value service—line-haul speeds, waiting times, reliability, crowding levels, and so on—and on the supply side, the measures of service routinely collected by transit operators—vehicle miles, car miles, vehicle hours, and the like—are very blunt indicators of the service as experienced by passengers. It isn't surprising, therefore, that estimates of direct demand elasticities with respect to (say) vehicle miles or vehicle hours are often much more variable than are the fare elasticity estimates.

Nonetheless, the service elasticity estimates are usually higher (numerically) than the fare elasticity values derived from the same datasets, in line with our earlier generalization. Indeed, for the national aggregate U.S. transit industry annual data collated by APTA,[9] simple linear regression of the trends between 1970 and 1994 (using a constant elasticity functional form) shows that the variations in mean real fare and in vehicle miles operated can together "explain" about 80 percent of the total variation over these 25 years in the unlinked passenger trips.§ The implicit elasticities are −0.29 (±0.10)** with respect to the real fare and +0.45 (±0.08) with respect to vehicle miles. While such an analysis, at this very high level of aggregation, has no necessary relevance to policy or planning for any individual transit service, nevertheless the absolute and relative magnitudes of the elasticity estimates are quite representative of those observed at lower and more useful levels of aggregation.

There are now a number of studies that have developed relationships between transit ridership and more detailed and/or consumer-oriented descriptors of aspects of service quality. Most of these have taken advantage of variations in service across routes (or other segments of the system), since this variation may well exceed that observed over time for the whole system, and "standard" time series operating statistics are rarely sufficiently rich in detail about the service quality anyway.

However, the findings of these studies are often peculiar to the particular context of the analysis—the transit system setting, a specific operating policy change, or the nature of the detailed data collected, for example—and detecting generalizable patterns is frequently elusive. In Appendix E, we have presented brief summaries of some key studies, most of which have been undertaken since the comprehensive FTA[10] and TRRL[11] surveys of transit demand evidence were published in 1980.

WHAT DOES THE UNDERSTANDING ABOUT TRANSIT DEMAND IMPLY FOR POLICY?

This report is concerned with increasing transit's market share. Superficially, it is very easy to condense the material reviewed so far in this report into a set of general prescriptions for governments and transit agencies interested in boosting transit ridership. Such a list is a very naive one, however, in that it ignores many of the realities of transit management in the last few decades of the twentieth century, under public ownership.

No transit manager can any longer follow just a single objective, in a single-minded way, even if he or she *ever* could. Rather, the job requires a delicate balancing of a wide range of different objectives—not all of them articulated explicitly by the agency's Board of Directors or by the state and local agencies that provide funding. Moreover, some of the objectives are directly or indirectly in conflict with each other. And as we shall see, building ridership *per se* tends to be relatively low on the priority list for many transit systems, below the imperatives of keeping the buses and trains running safely, and obtaining the funding to maintain services at current levels.

However, with that proviso about the *naiveté* of the exercise in mind, just what lessons can be drawn about building ridership? Three generalizations stand out:

- **Stick to traditional transit territory.**
  Since demand is highly associated with development density, concentrate services on the areas and corridors that have the highest residential and employment densities. These are likely to be mostly in the metropolitan area core, and along major corridors leading to the core or to major suburban activity centers.
- **Concentrate good service on the areas and groups that respond to it the most.**
  Good service, in the areas with adequate demand density to warrant it, means

[9] American Public Transit Association, *1996 Transit Fact Book*. Washington, DC, American Public Transit Association (1996).

§ In reality, the causality is obviously more complicated than that implied by such a simple model. Investigation of the effects of including annual variations in the national jobs total in the regression revealed no significant association. Also, changes in vehicle miles operated are in part caused by changes in the demand for trips, as well as *vice versa*. Using more appropriate (and complex) simultaneous equations techniques in transit time series models rarely negates the general pattern observed in the simpler models, however.

** The range in parentheses represents the 90 percent confidence level.

[10] Mayworm, Lago, and McEnroe (1980), *op. cit.*

[11] Bly and Webster, *eds.* (1980), *op. cit.*

- *Frequent* service (to minimize waiting times);
- *Through* service (to reduce the inconvenience of needing to transfer);
- *Coordinated* schedules (to reduce the inconvenience for those who must transfer);
- *Reliable* service (to reduce the uncertainty of arriving late); and
- *Easily accessible* service (to reduce the burden of the particularly onerous access and egress elements of the trip).

In other words, focus attention on *travel times*, and particularly on the times associated with getting to and from transit, waiting for service, or transferring *en route*. Line-haul speed improvements, except for longer trips such as those served by commuter rail, are less important to customers.

- **Don't worry about fare levels.**
  While there have been many cases where fare increases have created great political furor, you'll drive more people away by service deficiencies than by higher fares. And don't automatically accompany fare increases with service cutbacks on the grounds that with fewer passengers you "need" less service to carry them; the service cutbacks themselves will exacerbate the ridership loss significantly.

Deliberately putting these prescriptions in such stark terms emphasizes how the demand evidence *alone* cannot provide good policy guidance for today's transit managers. For example, *where* a transit service decides to provide service is as much (or often more) a matter of who is paying the bill than it is of maximizing ridership. Metropolitan area transit authorities frequently require suburban and state participation in providing financing; consequently, they need to be seen to be providing commensurate service to suburban residents, not just in the urban core.

Similarly, the extent to which a system is able to provide widely disparate service levels, tailoring service to the areas and groups that are most responsive, is equally constrained by political and legal realities. And the transit manager who has been in the middle of a political or media storm over fares would laugh at the recommendation to downplay the furor. But while these demand-side messages must surely be *balanced* against many other considerations and objectives, that is no rationale for ignoring them completely.

There is a final policy prescription that emerges from the understanding about demand. Policies that focus on making private vehicle use *less attractive* are likely to spur transit ridership to a more marked extent than those that make transit *more attractive*, in situations (like commuting) where the two modes are reasonable substitutes for each other. Although the cross-elasticity of transit demand with respect to private vehicle characteristics (travel times, costs, etc.) may be numerically smaller than the corresponding direct transit elasticities, the base volume of existing travelers is so much larger. Even a very small percentage diversion of private vehicle trips may translate into a much larger percentage growth in transit trips.

Consequently, policies that can increase positive service advantages of transit relative to private vehicles are likely to be particularly advantageous. Preferential treatment for buses in already-congested corridors, or parking pricing and management policies favoring HOV commuters at employment sites, are likely to have positive impacts (directly or indirectly) on transit ridership, as (importantly) are highway facility toll increases.

However, the very disparity in constituency size that produces this effect also points up the difficulty of deliberately making conditions worse for private vehicle users. The challenge is to package groups of interrelated initiatives so that a politically palatable mix of policies results.

CHAPTER 5

SEARCHING FOR TRANSIT MARKET INITIATIVES

INITIAL AREAS OF FOCUS

In reviewing the accumulated evidence about the factors that most strongly influence transit demand, and in appraising the contribution of this study to the range of related projects currently underway as part of the TCRP program, the study panel decided to focus attention on five general types of strategies potentially available to transit and local government agencies:

- Transit *service improvements*,
- Provision of *information* to transit patrons (or potential patrons),
- *Marketing and promotion* activities,
- Local *public policy changes*, and
- *Road pricing* initiatives.

Some other possible strategies that may have a strong influence on transit market share were not included on this list because they are the primary focus of interest in other current TCRP projects: for example, *transit fare policies* and *parking management/pricing initiatives*. Nonetheless, when our own sifting of recent transit industry experience revealed potentially interesting examples that overlapped with these categories, we retained them within our scope of interest.

Table 17 lists a range of specific strategies that the study team identified in each of the four categories of interest. The strategies highlighted with an asterisk in the table are the subjects of other ongoing TCRP projects.

SIFTING RECENT LOCAL INITIATIVES AND EXPERIENCE

The largest component of new research conducted in the first phase of the study involved detailed telephone interviews with approximately 50 transit agencies and other organizations. These interviews were designed to fulfill three main objectives:

- Provide a better understanding of the extent of North American experience with each of the types of strategies for increasing transit market share;
- Provide evidence for a preliminary assessment of the relative promise of each type of strategy; and
- Identify possible candidates for more detailed study, analysis, and documentation as part of the subsequent research.

A list of U.S. and Canadian agencies and organizations having current or relatively recent experience with any of the strategies identified in Table 17 was developed from a review of the trade press and from discussions with other experts in the field. Where possible, the study team also obtained the names of the individuals most closely responsible for the implementation, direction, or oversight of the strategy at each agency.

A structured questionnaire was not used for the interviews because we knew that the diversity of both the strategies themselves and the amount of information available at each agency would preclude such a rigid format. However, the study team did develop a broad protocol for the interview process, to ensure that the important information was collected when available and that the results of the interviews could be compiled in a way that allowed comparison across the many agencies.

Since one of the main objectives of the interviews was to identify possible case studies for further attention, the early part of the interview was devoted to a series of questions used to screen each contact:

- What are the details of the program?
- How widely and for how long was it implemented?
- Was there a significant impact on transit ridership or on market share? If so, what was it? How do you know?
- Has the agency performed any analysis of the results which they could share with us?
- Is there detailed relevant data available that we could use to perform our own analysis?

Although these questions still leave room for personal judgment regarding the usefulness of the contact as a case study, the objective was to screen out contacts that were unable to provide *data* or *analysis* that would help *identify* or *quantify* the impacts of their program, or unable to provide supporting information about the *specific conditions* under which the program was implemented. Contacts who met these (somewhat subjective) criteria were given a more detailed interview, while those who did not were simply

TABLE 17 List of potential strategies for study

Category	Type	Strategies
Service improvements	General	Increased route structure Increased frequency Service cutbacks Dynamic scheduling Increased speed Improved security Improved comfort Increased capacity
	Suburb to suburb	High-occupancy vehicle lanes and facilities Transportation demand management programs* Suburban activity centers
	Suburb to central city	Feeder services Fare integration Service coordination (timed transfers) Unitickets Station parking provisions
	Within central city	Core services
Information to customers	Real-time information services	Location Schedules
	Low technology	Tailored schedules Bus stop information
	Medium technology	Computerized information systems Kiosks
Marketing and promotion		Fare incentives Education New resident promotion Image advertising Cooperative promotions
Public policy changes		User-side subsidies Parking pricing/regulation* Income taxes Fuel/carbon taxes Dedicated operating support Land use policy Local area bus services

* Subjects of other TCRP projects.

asked if we could follow up the call at a later date if we needed additional information.

The second part of the interview was designed to obtain, at a minimum, the following information:

- Background information
  - Details of the strategy implementation (What changes were made? Where? Why?)
  - Timing and duration of the program
  - Scope (how extensively the program was implemented);
- Results
  - Participation in program (where applicable)
  - Ridership or mode shift impact;
- Problems or issues arising in the course of implementation;
- Political or institutional feasibility issues;
- Economic feasibility (What did it cost? How much did that matter?);
- Any marketing and promotion efforts before and during the program; and
- Relationship of the iniative to any specific local objectives, constraints, or other idiosyncracies that might limit or enhance the transferability.

We also discussed why the particular strategy was chosen, as well as the potential alternatives from the respondent agency's point of view, to gain further insight into the factors determining effectiveness at the local level. To facilitate further contacts and to make our understanding of the strategy as comprehensive as possible, we also asked if the agency were aware of other similar programs or strategies, and how their own experience might differ from that observed elsewhere. A list of the agencies and organizations contacted is provided in Table 18.

FINDINGS FROM OUR SURVEY OF RECENT LOCAL INITIATIVES

In our contact interviews, we found successful and unsuccessful implementations in each of the four categories of strategies (leaving aside, for now, the obviously different sit-

TABLE 18 List of agencies contacted in initial telephone interviews

US - East Coast	Canada
Ann Arbor TA	BC Transit (Vancouver)
Baltimore MTA	Calgary Transit
Beaver County (PA) TA	Canadian Urban Transit Association
Boston MBTA	City of Mississauga Transportation Planning
Metropolitan Washington COG	GO Transit
New York MTA, LIRR, MNCR, MSBA	Metro Toronto Transportation
Potomac-Rappahannock (Virginia) TA	Mississauga Transit
Tidewater (Virginia) Regional Transit	Montreal Transit
Winston-Salem TA	MTO Public Transportation Office
	MTO Community Transportation Review
US - West Coast	MTO Passenger Mobility & Services Office
	MTO Passenger Modal Policy Office
Bellevue, Washington	MTO Provincial Planning Office
California DoT (District 12)	MTO Public Transportation Office
Los Angeles City DoT	MTO Transport Demand and Forecasting Office
Orange County TA	MTO Urban and Regional Planning Office
Portland Tri-Met	MTO Vehicle Technology Office
Rogue Valley (Oregon) TA	OC Transport
San Francisco BART	City of Winnipeg Transit System
San Francisco Bay Area MTC	Toronto Transit Commission (TTC)
Southern California Association of Governments	University of Toronto
	York Region
US - Central	Peter Dallon (transit specialist)
	Precursor Ltd. (transit specialist)
Chicago TA, METRA	
Dallas DART	
Denver RTD	
Houston METRO	
San Antonio VIA	
Twin Cities MTDB	

uation of road pricing). Appendix F comprises tabular summaries of the key characteristics of each of the local initiatives for which we found adequate information to warrant an extended telephone interview. The various columns in those tables reflect the main criteria used in deciding whether to select the program as a case study for further investigation.

In overview, our preliminary findings about each of the four types of strategies, on the basis of the first round of interviews, are discussed below.

Service Expansion and Improvements

We found comparatively many programs that fall into our broad "service improvements" category. Given the evidence about the relatively high sensitivity of urban travel to travel times, from a *demand* viewpoint alone improving service is the most obvious way to attract new customers and to increase the usage of a system by its existing customers. The problem with improving or expanding existing services, however, is that the strategy may also be one of the most *costly*. Transit agencies are faced with stiff budget limitations, and improving service through major capital improvement or significant expansion of operations requires a large financial commitment. Thus we consciously included *incremental* service improvement strategies, with a special alertness for those likely to have a significant positive effect on those service aspects known to influence mode choice.

Incremental expansions or improvements of service can be implemented by agencies of any size, and can be easily tailored to fit any agency's circumstances. These include

improving the *quality* of the offered services (better on-time performance, reduced transfer time, coordination with neighboring systems, and so on), as well as improving the *quantity* of service (such as adding feeder bus services or expanding reverse commute services).

Large-scale projects typically rely heavily on the local circumstances of the metropolitan area in which they are implemented, and therefore one area's experiences with a project may be difficult to transfer to other metropolitan areas. For example, the local political will to fund a startup commuter rail network in Southern California was a direct result of the region's poor air quality and extremely heavy traffic congestion. Similarly, Houston appears to have had great success with its park-and-ride system on HOV lanes, but those lanes could be constructed at reasonable cost because there was sufficient right-of-way available in Houston's freeway corridors.

Finally, almost all service improvements and expansions that rely on *high technology* are still in the planning stages. A few transit properties have automatic vehicle location (AVL) systems in place, but in many cases these are restricted to demand-responsive paratransit services or to a small part of the total bus fleet. There are definite plans to incorporate intelligent transportation systems (ITS) technology into daily transit operations, such as improving on-time performance through coordinating bus location and real-time traffic control systems, but for the most part these systems are still in the planning stage, or at best just reaching the implementation stages. If this project were to be repeated 5 years from now, it is very likely that an entirely new generation of high technology service improvement strategies would be within reach.

Information Dissemination

Examples of transit information dissemination activities reviewed in our survey ranged from putting route schedules and maps into an information stand to real-time transit route planning. They included such initiatives as dedicated route planning telephone services and setting up computerized information kiosks in busy pedestrian areas. Unfortunately, while a range of transit agencies have adopted these or similar programs, almost none of them appears to have any information on the impact of these services on transit ridership. Consequently, few of these programs were judged good candidates for a detailed case study.

Disseminating information about the services offered by transit to potential and existing customers could potentially be an important strategy for transit agencies wishing to increase their ridership. However, there are few innovative, high technology information delivery methods currently being used. As we found for high technology service improvement strategies, the most innovative and potentially revolutionary ideas have yet to reach the implementation stage.

Marketing and Promotional Policies

Although historically the transit industry has given short shrift to marketing activities, in the last quarter century marketing and promotions have been increasingly recognized as a possible means of attracting patrons to transit services. To try to get more use out of their services, transit properties have begun to experiment with innovative marketing strategies that go beyond advertising on the system itself or in the mass media. Effective marketing may also be an important tool for promoting a service expansion or improvement. The difficulty for this study was to find marketing strategies and promotions that are well documented *and* appear to have had a significant positive impact on transit mode share.

For the purposes of this study, we decided that generic advertising campaigns and promotions alone were not sufficiently innovative to warrant a detailed case study. Instead, we steered our contact interviews toward innovative marketing strategies such as fare-free zones and innovative fare-media techniques.

Finally, marketing and promotion can also encompass customer service. Because transit properties provide a public service, they should naturally be concerned with how their customers view and evaluate their supplied services. However, we found only a few agencies with well-defined, *proactive* customer service programs integrated into their operations and planning. These agencies actively seek out their customers' opinions and evaluations of the offered services, and try to improve the quality of those services before complaints are directed to their customer service departments. This strategy actively tries to improve the service to make existing customers happier, with the hope of retaining loyal customers and perhaps placing the transit service in a better position to attract and retain new customers. Unfortunately, it is very difficult to evaluate the effect of a proactive customer service program upon an agency's ability to attract new patrons, which made these programs less suitable for further study.

Local Public Policy Changes

We identified a few examples of local public policy initiatives that appear to have an indirect positive impact on transit ridership. For example, trip reduction ordinances are typically designed to encourage drive-alone commuters to switch to HOVs, often through employer-based actions. King County Metro, for example, capitalized on the fact that many employers were not in compliance with trip reduction ordinances to market an innovative transit pass directly to employers.

CHOICE OF CASES FOR FURTHER STUDY

In sifting through the evidence collected in our telephone interviews, our goal was to identify those types of strategies

and examples that most warranted more detailed and thorough attention. The eight criteria used in making this selection are presented in Table 19.

Ideally, those examples considered for further study should have caused a significant, measurable increase in transit ridership or mode share in an area. However, strictly requiring that an initiative demonstrate a positive impact on ridership presupposes that sufficient data collection and analysis accompanied the implementation of the initiative. In practice, there are several reasons why this may not be the case. Ridership gains per se may not have been the primary rationale for undertaking the project, or the main criterion by which the initiative was to be judged. Indeed, no formal "evaluation" of the change may have been planned; transit agencies often don't have the budget necessary or the motivation to conduct an evaluation study that properly tracks all of the necessary variables.

We allowed some leeway for examples of strategies that appeared to have a strong impact on ridership, even if the basis for this opinion was primarily preliminary evaluation of data or trends of unanalyzed data. Programs that lacked good data collection efforts were given secondary importance, even if the initiative seemed to be promising on paper or from anecdotal evidence.

Given the diversity of the strategies, and the nature and variability of the information generated in the interviews, we did not use a formal quantitative rating procedure to help identify the most promising initiatives. Rather, we asked the following set of questions:

- *How relevant is this **strategy** to the purposes of our study?*
  - Does it appear to have a good potential for increasing or retaining transit ridership, given what we know about the factors influencing mode choice?
  - Given the preliminary information from the telephone survey, how does the strategy appear to rate on the other evaluation criteria from Table 19?
  - Is it a strategy that has some other type of interest, such as current popularity within the industry, or novelty with regard to specific aspects of its implementation?
- *How good for our study purposes is this **specific example** of the strategy?*
  - What is the quality of local evaluations and/or relevant data?
  - How typical is this example likely to be of other settings or operating environments?
  - How successful does this example appear to be in influencing ridership?
  - Are there other features of this particular example that make it of wider interest?

Table 20 summarizes the application of these considerations to each of the strategies and examples for which for we found adequate information to warrant an extended telephone interview, and presents our determination of the best candidates for further analysis.

The project panel discussed these recommendations at a mid-project meeting, and selected eight case studies for further investigation:

- *Metro–North Hudson rail link*. This innovative feeder bus service was designed, implemented, and operated by the railroad itself, in order to improve access to (and therefore ridership from) two poorly accessible stations within New York City. Of particular interest was that the service produce a small profit for the agency, and it has apparently attracted private vehicle users to public transit. A good deal of research and evaluation of the program had also been carried out by the agency.
- *Toronto's GO Transit fare and service coordination*. This program involves the effort on the part of GO Transit, the commuter rail operator for the Toronto area, to coordinate both services and fares with the many local agencies whose transit systems provide access to commuter rail stations. The growth in commuter rail service in recent years, as well as the changing nature of commuting patterns, make this strategy particularly topical to the U.S. industry. The large number of local transit agencies in the Greater Toronto Area and the many years of experience with the program make this an especially good example for further analysis.

TABLE 19 Evaluation criteria for selecting case studies

1.	Effectiveness of the strategy in enhancing or retaining mode share
2.	Time frame over which benefits begin to accrue
3.	Political acceptability
4.	Equity (or distributional) considerations
5.	Implementation flexibility
6.	Legal and liability considerations
7.	Jurisdictional issues
8.	Costs

TABLE 20 Summary of preliminary evaluation and selection of case studies

Agency/Location	Program	Relevance of this Strategy	Suitability of this Specific Example	Candidate for Case Study?
GO Transit	Service/fare coordination	High	Good	Yes
San Francisco Bay Area	Fare integration	Moderate	Fair	Maybe
GTA transit federation	Weekly pass	Moderate	Fair	Maybe
Ann Arbor TA	Smart fare card system	High	Poor	No
Los Angeles	Metrolink commuter rail	High	Poor	No
Metro Toronto	Rapid transit expansion	Moderate	Poor	No
Tidewater Regional Transit	Timed transfer system	High	Excellent	Yes
Beaver County TA	Quality of Service Measures	Moderate	Poor	No
Metro–North Railroad	Reverse commute service	Low	Excellent	No
Southern California	Regional HOV lane experience	Moderate	Fair	No
Houston	HOV and park and ride experience	High	Poor	No
Metro Toronto	HOV lanes	Moderate	Fair	No
Los Angeles	Circulator services	Moderate	Fair	No
Potomac-Rappahannock TA	Feeder service to VRE	High	Fair	No
Metro–North Railroad	*Hudson Rail Link* feeder service	High	Good	Yes
Denver RTD	Privatization experience	Moderate	Poor	No
MTA (New York)	"A" line service improvements	Moderate	Fair	No
Minneapolis-St. Paul	Travel Link project	Moderate	Poor	No
Minneapolis-St. Paul	*Team Transit* improvements	High	Moderate	Yes
Potomac-Rappahannock TA	Real-time flex route system	High	Poor	Maybe
Bellevue	Real-time info. demonstration	Low	Poor	No
Winston-Salem, NC	Service coordination	Moderate	Fair	Maybe
Winston-Salem, NC	Mobility Manager	Low	Poor	No
Rogue Valley	Mobility manager demonstration	Low	Poor	No
King County Metro	Student/employer pass programs	High	Excellent	Yes
Portland Tri-Met	*Fareless Square*	High	Good	Yes
VIA, San Antonio, TX	Rider Programs Division	Moderate	Fair	Maybe
GO Transit	Customer Oriented Program	Moderate	Poor	Maybe
Minneapolis-St. Paul	Frequent Rider Program	Moderate	Poor	No
GTA transit federation	Integrated service map	Low	Poor	No
Metro Toronto	Land Use	High	Excellent	Yes
California	California Rule 1501 (Reg. 15)	Moderate	Fair	No
San Diego	Congestion pricing demonstration	High	Poor	No

- *Minneapolis Team Transit improvements*. This program has implemented several low-cost improvements to the transit system, making use of the existing highway infrastructure. The program has several very attractive elements of wider interest to the industry. Specifically, the centerpiece of the initiative is a unique interagency panel comprising representatives from both the transit- and highway-related agencies and designed specifically to reduce institutional barriers to implementation. In addition, the improvements implemented by *Team Transit* are oriented toward increasing the door-to-door competitiveness of transit versus the private vehicle.
- *Tidewater Transit timed transfer system*. Although interest in this concept may have peaked somewhat in the late 1970s or early 1980s, its recent application in Southeastern Virginia has renewed its relevance for today's transit industry. Tidewater Regional Transit, an agency known for innovations in service provision, has used this strategy (a complete redesign of its entire service network around a series of transfer centers) to improve service to its low density, mostly suburban- and rural-oriented service territory. To the extent that commuting patterns are increasingly focused toward these areas, this is a particularly interesting example in light of the new competitive reality faced by many agencies.
- *Seattle U-PASS and Flexpass programs*. These two programs are excellent examples of some of the new pass programs that have arisen as means of influencing transit market share. The *U-PASS* program, a cooperative effort with the University of Washington involving

unlimited transit passes for students, has documented significant ridership gains. The *Flexpass* program involves employer-based passes offering unlimited transit use for all employees for one price, and has resulted in the significant mode shifts among employees at member firms. There was good data collection for both programs for a number of years.

- *Portland Fareless Square*. This program is a fare-free zone for transit in downtown Portland, Oregon. While the concept of fare-free transit is hardly new, this is a particularly interesting example because of its context: Portland has a history as being one of the more transit-oriented cities in the United States, and the *Fareless Square* is one of several specific initiatives aimed at shifting travelers away from private vehicles.
- *Metro Toronto land use policies*. While the interconnections between transit and land use are far too complicated to address completely in the scope of this study, land use policies are potentially very important determinants of mode share. It was felt that this study would be incomplete without including at least one case relevant to this issue. Since Toronto has long been regarded as a model of a pro-transit city in North America, and further that this orientation was in large part due to land use policies, this city seemed an appropriate case to examine.
- *A synthesis of relevant road pricing experience*. Similarly, members of the project panel felt strongly that the study should incorporate some recognition of the potential of road pricing programs to affect modal choice, particularly given the renewed level of interest in the topic in recent years. Rather than attempt to document any one of the few extant examples of congestion-sensitive road pricing implementations (mostly outside North America), it was decided that one of the cases should synthesize aspects of road pricing proposals and policies that are particularly germane to transit.

This set of eight cases deliberately spans a wide range of different policy actions, from the very local through to very major policy initiatives that can only be implemented by very strong political will. The first two cases are concerned with *facilitating access and egress to line-haul transit services*, to expand their geographical scope in a manner that minimizes the time penalty of needing to transfer between vehicles. In both these cases, issues of *interagency and interjurisdictional cooperation* arise, and these same issues are addressed directly in the third case study, where highway interests are also added to the mix.

The fourth case addresses rationalization of bus services *to reduce the customer's transfer burden*, while the fifth and sixth cases are both examples of *fare-based initiatives* to encourage ridership of various sorts. Finally, attention shifts to two macropolicies requiring (at the minimum) a regional approach and policy actions that typically face significant opposition: stronger, more normative *land use control* to favor "transit-friendly" development, and *increased prices on certain uses of private vehicles*.

The eight detailed case studies are presented in Appendices G through P. The next chapter synthesizes the cross-cutting findings from the individual case studies.

CHAPTER **6**

SUMMARY OF FINDINGS

INTRODUCTION

This chapter summarizes our findings and presents our study conclusions. We first provide some general impressions and observations, which represent the principal themes that emerged from the case study research. We then present a summary of the results of the case studies, as well as more detailed conclusions about the individual cases. Finally, the chapter provides some insights into the issue of the transferability of each of these strategies to other locations or contexts, as well as recommendations for further research, both in terms of the individual strategies examined as well as transit market share and mode choice more generally.

SOME CROSS-CUTTING IMPRESSIONS AND OBSERVATIONS

In the introductory chapter, we opined that the primary value of our detailed case studies had proved to be as *individual* examples of specific types of strategy. In many cases, even for policies that may have been implemented at a number of places around the country, the lack of good data describing changes and outcomes severely limits the ability to draw *robust, general conclusions* about the results of the policies, or the factors influencing the results.

Nevertheless, even absent the ability to undertake quantitative analysis of plausible hypotheses, it is feasible and valuable to make a number of cross-cutting general observations, albeit somewhat impressionistic ones.

■ Ridership growth is not necessarily a high priority for transit agencies.

In our initial telephone interviews, we noted a general tenor of skepticism among our interviewees about the potential for *any* strategy, absent very major infusions of further public investment, to have really significant impacts on transit's market share of the sort described in the language of the TCRP project statement. We certainly observed a widespread perception that, within the constraints of the current funding and public opinion environment, there is no way to divert *large numbers* of private vehicle users onto transit.

Secondly, given the diverse set of objectives that public transit systems need to pursue, building market share often has to be given lower priority than more urgent considerations such as maintaining existing services, holding together existing local sources of funding, or coping with the safety problems of decaying infrastructure. Just maintaining the *status quo* from day to day is in itself often a major accomplishment.

Relatedly, there may be a significant measure of achievement in hanging onto the current level of ridership or market share, or reducing or halting losses, when peer transit agencies are experiencing more marked declines. But keeping current patrons happy and loyal may well imply a somewhat different agenda from trying to find and attract new ones.

Several of our case studies, on examination, proved to have been less successful at spurring ridership *growth* than our initial investigations had suggested, although they may still be considered successful for moderating a prior decline.

We noticed several commonalities in this regard across the case study agencies:

- *A focus on* ***existing*** *customers, for the most part.* Most of the service-oriented strategies shared this characteristic in one form or another. Most notably, the manager at Tidewater Regional Transit (TRT) had used market research to assess the concerns of current patrons, and the timed-transfer system was ultimately implemented to address those concerns. Despite the promotional message of the *Team Transit* initiatives as making transit more competitive with the private vehicle, a few ad hoc conversations with bus drivers revealed that the changes were more often used to improve schedule adherence than actually to reduce total travel time, and bus schedules were not changed to reflect the improvements. Further study of even the GO Transit fare and service integration strategy showed that it was ultimately designed to improve transit *access* to the commuter rail system (it was started as a way to avoid building more parking spaces at stations) rather than to boost ridership on the commuter rail service itself. By contrast, the *Hudson Rail Link* initiative *was* motivated by a wish to attract a high potential market niche onto the system—passengers for whom station access had previously been too difficult.
- *Operational concerns receive more attention*. While certainly the Seattle pass programs were initiated with

the intention of increasing ridership, several of the other strategies seemed to come about, at least in part, because of a desire within the agency *to improve the operation of the system* rather than to serve the explicit goal of increasing patronage.

- *Limited local interest in identifying ridership impacts*. Generally we observed that agencies had performed very little analysis to try to isolate the ridership impacts of the programs they had implemented. In many cases the ridership impacts were hard to identify because of the presence of many simultaneous changes occurring during the period of implementation, but nevertheless managers had rarely attempted an assessment of the program in light of ridership trends. Even in the case of the MNR *Hudson Rail Link*, which has increased ridership on the commuter rail line itself, the focus appeared to be more on the positive financial contribution of the feeder service than on its ridership impact.

■ Transit operational strategies *alone* are not enough for a large modal shift.

While it was beyond the scope of this study to examine a broad range of traffic limitation policies (such as parking management and other TDM strategies), even the current case studies reveal that large improvements in transit market share will require *both* a "carrot" and a "stick." Those strategies that resulted in unambiguous ridership gains, the MNR *Hudson Rail Link* and the Seattle pass programs, both had circumstances that were particularly unfavorable to private vehicle use. Specifically, at the stations served by the *Rail Link* parking was extremely limited, and in the Seattle case a very large increase in campus parking fees was instituted at the same time as the *U-Pass* program. The strategies that focused *solely* on improving the level or quality of transit service (through operational initiatives, as distinct from major capital investments) were generally unsuccessful at achieving a marked mode shift to transit.

While one may be tempted to conclude that this is only logical as the combined strategies "do more" to make transit more attractive, the situation is not quite so simple. If it were, we might infer that if the transit-side strategies only had been implemented, but with "larger" improvements in the transit service, the effect might have been the same. Our examination of the factors influencing mode choice (in Chapter 4) reveals why this is unlikely to be the case. Specifically, we know that

- *The private vehicle's quality of service attributes are valued very highly*. The wealth of literature on mode choice behavior, as well as our own experience, tells us that automobile users place a large premium on the privacy, safety, and comfort of the automobile, as well as its infinite departure flexibility. Absent level of service changes in the private vehicle mode, therefore, transit improvements would need to be valued highly enough to overcome this large advantage.
- *And the range of transit service improvements is quite limited*. In practice, there probably is not a realistic transit operational improvement large enough to overcome the advantage of the private vehicle by itself. Fares are already very low (in absolute terms), and the literature (and our Portland case study) indicates that even *free* transit would not divert large numbers of auto users. In the Minneapolis case, transit *line-haul* travel times (that is, vehicle speeds) are shown to be competitive with private vehicles, but clearly this is not enough, since the waiting and access times associated with transit are a more important hindrance to the relative attractiveness of transit. Further, we know that these out-of-vehicle times are perceived to be particularly onerous by travelers (studies show that they are valued at up to two and a half times the in-vehicle time).
- *The auto* ***ownership*** *decision dominates the mode choice hierarchy*. Because the decision to own (or lease) a vehicle is so central to the entire choice process, and because this process is ultimately driven by lifestyle choices that are increasingly making the private vehicle ownership decision a "given" for many people, automobile users need more than an incentive to use transit. Put simply, they need a strong incentive not to drive.

In summary, therefore, all of the evidence about mode choice suggests that the scope for improvement in transit, at a reasonable cost, is not the same as the potential impacts from worsening travel by private vehicle. Since the mode choice decision is strongly influenced by vehicle ownership, and because the private vehicle is overwhelmingly preferred by many travelers who have the choice, strategies which target the transit service *alone* will have little chance of being very effective.

This discussion is focused on those situations where transit is in direct competition with private vehicles at comparable costs and speeds. It is not to deny that there are many corridors, particularly in the core areas of densely developed cities, where transit already has a strong competitive advantage by virtue of high traffic congestion levels, low private vehicle ownership, limited parking opportunities, or high parking prices.

■ Land use and related factors are very important.

If we believe that the attractiveness of the private vehicle is itself the big determinant of transit's ability to capture any significant market share, then it follows that external factors which may also influence the ownership and use of the private vehicle must also figure in the equation. The Metro Toronto land use case study showed that, although not necessarily the result of a systematic, conscious transit-oriented

planning effort in that city, the higher transit shares we observe may result from the fact that development has not been as favorable to the private vehicle as in many U.S. cities.

By contrast, the TRT case study is an example of the paradoxical problem facing many U.S. transit agencies. The timed transfer system implemented by TRT was designed to better serve the more geographically dispersed market in which the agency operates. However, it is precisely this market which is *most* conducive to the private vehicle, namely the suburb to suburb and/or rural flow. To the extent that trends in development patterns have been increasing these types of commuting flows in most metropolitan areas, it has become that much harder for transit systems to maintain their market share. While the land use connection is known to be quite complex, for the purposes of this study we can observe three simple factors:

- *Urban expressway capacity*. Somewhat surprisingly, the Toronto case revealed the lack of a single organized, comprehensive plan to develop the city in a decidedly pro-transit fashion. Rather, political pressures quite simply halted the growth of urban freeway within the city. As a result, fast and congestion-free access to the urban core was not as available to most private vehicle users, and became even less so as the city grew over time. At the same time, transit lines were being extended into the suburbs, favoring transit as a commuting mode.
- *Urban core density*. The discussion in Chapter 2 touched on the issues of commuting flow orientation and central city density as determinants of transit market share. The Toronto case shows how these factors can be affected proactively, in that zoning policies allowed or encouraged development at very high densities around the core, and specifically, near transit stations. Although not explicitly examined as part of the Portland case study, the city's *Urban Growth Boundary* has allowed Portland to increase the density of its urban core, which is a probable cause of the relative success of transit in that city.
- *Downtown parking availability*. A very important and related factor is the availability of parking in the central city. While increasing its urban core density through zoning changes, Portland also imposed a moratorium on new parking spaces and in fact undertook a major redevelopment project on the site of what was then a large parking lot. As the city grew rapidly in population but remained constant in size, and no new parking was available, private vehicle use became less attractive.

These factors are important because they *directly* affect the level of service experienced by private vehicle users, both in absolute terms and relative to public transit. Less highway capacity means more congestion, which in turn means both *longer* travel times and *more uncertainty* about travel times. A more dispersed central city will make the private car almost a necessity for many commuters, and will make driving and parking in the city easier. Parking is perhaps the most important factor in that if unavailable, it can totally preclude trips by private vehicle. If scarce, it has the potential to increase drastically the perceived out-of-pocket costs of driving. By creating large changes in the level of service of private vehicle travel, these factors are also much more likely to influence mode share than transit-side improvements.

■ Institutional cooperation is often essential.

An important focus of the case study research was the examination of the *implementation process* involved with each strategy, in order to understand the factors that allowed the initiative to go forward within the organization, and most importantly, to assess the applicability or transferability of the strategy to other agencies or localities.

The *Team Transit* case study examined a specific set of improvements to the express bus service in the Twin Cities area, but it is clear that these improvements would not have been possible without the interagency cooperation created by the *Team Transit* program. While this case may be exceptional for its creation of an *organization* specifically for the purpose of overcoming institutional barriers to project implementation, this aspect was found to be essential to almost all of the case studies in one way or another.

Most obviously, the fare and service coordination undertaken by GO Transit requires the cooperation of the many local transit agencies involved. The transit-oriented land use patterns in metro Toronto are in part due to concerted efforts in this direction on the part of the local, metropolitan, and provincial governments, and the local transit agencies. The Portland *Fareless Square* initiative is also ultimately the result of a cooperative transportation planning process in the city which involves zoning and development interests, local businesses, and of course Tri-Met, the local transit agency. Similarly, the pass programs implemented in Seattle represent agreements between the transit agency and the local university or employers.

The exceptions to this conclusion are the TRT timed transfer system and Metro–North's *Hudson Rail Link*. Each of the other cases involves a "big picture," metropolitan areawide emphasis on focusing a city's transportation system more towards transit (*Team Transit* involved working with the highway department to find intermodal solutions, and the Portland case is part of a reorientation of downtown around the transit system). The TRT and Metro–North cases differ in that, in large part, they involved *only* autonomous changes to the operation of the transit system itself. As such, the institutional issues involved were almost totally internal to the transit agency. In the TRT case, the organization is small enough that the Service Development Manager was essentially free to redesign the system. At the other extreme, the *Hudson Rail Link* represents such a relatively small change

in the vast Metro–North system, and in fact did not affect the commuter rail service itself, that there were few institutional issues involved.

MORE DETAILED CONCLUSIONS FROM THE CASE STUDIES

It was our original hope to use the eight evaluation criteria listed in Table 19 to appraise each of the selected strategies in light of the information gathered in the case studies. While the case study research did not generally yield data adequate for a more rigorous *quantitative* analysis, nevertheless the criteria were used to assess and compare at least the *qualitative* differences among the cases, and to provide additional support to our impressions and opinions about the overall efficacy of these types of initiatives.

Effectiveness in Enhancing or Retaining Mode Share

Table 21 summarizes the effectiveness of each strategy in influencing transit ridership and mode share. The table shows clearly that those strategies that deal only with the transit side of the mode choice decision are unable to affect ridership or mode share in any significant fashion. While we have observed that initiatives such as the *Team Transit* program may have stemmed further declines in ridership, it is only those strategies that employ incentives or disincentives targeted at private vehicle use that produced any noticeable shift in mode share. On the evidence of foreign experience, congestion-sensitive road pricing has by far the highest mode shift *potential*.

Time Frame to Achieve Benefits

The second criterion relates to the time frame over which any benefits of the strategy begin to be realized. There are, in fact, *several* important dimensions to the timing aspect that need to be considered when comparing the case studies. First, there is inevitably some time required to study or plan the details of how the strategy will work and how it will be implemented. This phase may include, very importantly, the work necessary to build a consensus and obtain any approvals necessary from interested parties. Secondly, there is the actual implementation itself—can the strategy be implemented "overnight," or must it be phased in or put in place over perhaps even an indefinite period of time? Finally, how much time is required after the strategy is implemented before benefits begin to accrue? Comparing only the *total time* required for the strategy may mask some important differences in these three elements, each of which may have important implications for the overall prospects of the strategy.

In order to clarify these different elements of elapsed time, we found it useful to group the case studies into three categories:

- One-time initiatives that permanently change the service provided in some fundamental way (the Portland *Fareless Square*, the TRT timed transfer system, the Seattle pass programs, and the MNR *Hudson Rail Link*);
- Programs involving various incremental changes to service over a longer period of time (*Team Transit* and GO Transit Fare and Service Coordination); and
- Large policy initiatives through which various programs are implemented pursuant to the strategic goals on a more-or-less ongoing basis (Toronto's land use coordination).

TABLE 21 Summary of effectiveness in influencing transit share

Case study	Effectiveness of mode split
Hudson Rail Link	Ridership gain/mode shift for users of affected stations, but negligible effect on entire system given the total overall ridership.
GO Transit FISC	Limited to transit access to commuter rail stations; negligible for commuter rail itself.
Team Transit	May have stemmed declines, but in practice changes in overall service level were too small to produce more than very limited mode shift. May have encouraged additional ridership growth on new express routes, but this is a tiny fraction of total system ridership.
Tidewater timed transfers	Probably very limited because overall service level did not increase; improvements were ultimately quality-related in nature and focused on existing customers.
U-PASS/ Flexpass	*U-PASS* created notable mode shift when combined with increase in parking charges; *Flexpass* created large increases in transit trips per employee.
Fareless Square	Very limited impact on mode share after initial implementation.
Toronto land use	Transit shares notably higher than other North American cities.
Road pricing	Potentially extremely effective based on evidence obtained to date.

Road pricing initiatives are, of course, somewhat different from the other cases, but they map most closely onto the first category.

Table 22 compares the timing aspects of the various case studies. For the initiatives in the first category, the largest component of the required time is usually for the initial planning and study phase. For strategies in the second category, by contrast, the actual implementation takes up more of the total time. For strategies in the third category, by far the dominant aspect of the time frame is the time required after implementation in order for benefits to accrue.

Broadly speaking, the *overall* time frame of the strategies is likely to increase with two factors: the *magnitude* of the change (and/or of the likely behavioral response), and the *nature* of the change, as one moves from the first to the third type characterized above. Most of the relatively small one-time initiatives took less than 3 years; the incremental changes took perhaps 3 to 5 years (more like 10 years in the case of GO Transit FISC); and Toronto's land use coordination efforts spanned well over 10 years. The relatively longer planning time required for the one-time initiatives, as well as the time required for information dissemination after implementation, is more than offset by the very large amount of time needed for the Toronto land use policies to begin to accrue benefits. Because initiatives using phased incremental changes will also usually require a planning and study phase, they are likely to take longer than the strategies using one-time structural changes.

The case of road pricing may be an important exception to the above conclusions. The time needed for "planning and study" could be greatly extended by the political issues surrounding this strategy, an aspect that we next address.

Political Acceptability

The political issues involved with road pricing make it by far the most difficult of the case study strategies to implement. By its very nature, congestion pricing has the potential to benefit one constituency dramatically at the expense of another. Depending again on the magnitude of the change, this characteristic may well be shared by other types of policy: for instance, fare and service coordination could implicitly require the cross-subsidization of patrons across the integrated transit systems, and the application of a significant, widespread reorientation of land use policies clearly could pit suburban residents against central city dwellers.

However, the other specific cases that we examined had, by and large, a high degree of political acceptability. This was because no group of travelers was made significantly worse off by the changes. In fact, two cases, the MNR *Hudson Rail Link* and the Portland *Fareless Square*, could be argued to be "good politics" (rather than just politically neu-

TABLE 22 Summary of the time required to achieve benefits

Case study	Time frame to achieve benefits
Hudson Rail Link	Study phase took about two years; planning and implementation about 2½ years. Additional time was required for dissemination of service and fare information, but initial ramp-up of ridership took only a few months.
GO Transit FISC	Integration with individual properties was achieved relatively quickly, but maximum benefit required full integration of all adjoining systems. Program begun in 1979 and agencies still being added today. Also required dissemination of new service and fare information.
Team Transit	Individual improvements were implemented quickly (in some cases within a few weeks), but entire program was over a period of three years (and will continue if funded). Additional time was required to establish interjurisdictional team and begin planning process.
Tidewater timed transfers	Extensive route and schedule changes required program to be implemented in phases, and requires dissemination of this information for riders to fully benefit from new system. Including planning, program took about three years to be completed.
U-PASS/ Flexpass	Planning and marketing of *U-PASS* took place during two academic years, implementation began with the next academic year. Benefits were achieved immediately with implementation, but participation has also increased since then. *Flexpass* took two years to plan and implement. Maximum benefit requires highest possible participation, and this may take several years given the need to market the program, etc. (number of companies doubled after first year).
Fareless Square	Planning to implementation took three years, including marketing of new policy; large ridership gain achieved within two years of start of service.
Toronto land use	Benefits from these policies may have taken decades to manifest themselves.
Road pricing	Planning and approval process could take *many* years, given political and legal issues. A large component of the behavioral response will be experienced relatively quickly after implementation, but further adjustments are likely to continue over an extended period.

TABLE 23 Summary of political acceptability

Case study	Political acceptability
Hudson Rail Link	Very acceptable; no travelers were made worse off.
GO Transit FISC	Definite political issues with respect to subsidization of operating expenses between agencies (absent a stable dedicated source of operating subsidy).
Team Transit	Neutral; not a big issue since no one was made worse off, but some motorists perceived an unfair advantage to transit agency.
Tidewater timed transfers	Neutral; not a big issue since is completely within agency and most customers will have better service.
U-PASS/ Flexpass	No significant political issues; both programs are voluntary.
Fareless Square	Very acceptable; no one made worse off and program financed with existing revenues.
Toronto land use	Application of similar policies in major US cities today would require massive changes, and as such would likely be very unpopular politically.
Road pricing	Significant political problems, including strong perceptions of unfairness, unwarranted increased taxation, and excessive government control, etc.

tral) since the level of service to the affected community was increased at no additional cost. (See Table 23.)

Equity and Distributional Considerations

The issue of differentially-affected constituencies is an issue of politics because it is ultimately an issue of equity. Equity issues may also arise *within* the population of transit patrons, however, since even those strategies that are not overtly political in nature may nonetheless have distributional impacts. The comparison in Table 24 summarizes the extent of equity-related issues across the case studies.

The table shows that nearly all the cases had differential distributional effects associated with them. However, since those people who benefited less (or not at all) from the strategy were not actually made *worse off* in most cases, the equity issues were not significant influences in the approval of the change or on the outcome. Not surprisingly, the policies with the biggest political problems—road pricing, land use coordination, and interagency fare and service coordination—are the ones generating the most notable equity concerns.

Implementation Flexibility

Table 25 summarizes our appraisal of the case studies in terms of their implementation flexibility. The table shows that the cases exhibit a wide range on this criterion. By its nature, comparison of this criterion across diverse cases is somewhat problematic. Therefore, our evaluation focused on two areas:

TABLE 24 Summary of equity issues

Case study	Equity
Hudson Rail Link	Benefits only the users of the affected stations, but there are no "losers" and accessibility of these stations was not made superior to other stations in the system.
GO Transit FISC	Revenue sharing will inevitably favor one agency over another, and coordination favors feeder service over strictly local services.
Team Transit	Tends to favor patrons living outside the city, but not at the expense of other customers.
Tidewater timed transfers	Large majority of customers benefit; service not much worse for those who don't.
U-PASS/ Flexpass	*Flexpass* is more expensive for suburban than for downtown companies.
Fareless Square	Obviously benefits users of "Square" area disproportionally, but doesn't compromise service for other patrons so equity not a big problem.
Toronto land use	Clearly favors central city residents at expense of outer city/suburbs.
Road pricing	Potentially serious equity issues, even if toll revenues are redistributed.

TABLE 25 Summary of implementation flexibility

Case study	Implementation flexibility
Hudson Rail Link	Agency was free to design the routes, schedules, fares, and vehicles to meet the specific needs of the patrons using the system, and they can all be modified fairly easily as need arises.
GO Transit FISC	Other issues (politics, equity, funding) place a practical limit on the options available, but can be partially implemented, expanded, or reduced fairly easily.
Team Transit	Program was designed specifically for fast and flexible implementation and this was achieved.
Tidewater timed transfers	Limited flexibility in designing and operating timed-transfer system, but can be phased in or only partially implemented.
U-PASS/ Flexpass	Together the university and agency controlled all parameters relating to transportation and were therefore free to design the most appropriate program for *U-PASS*. *Flexpass* was designed for the specific local conditions and to meet the specific needs of the customers.
Fareless Square	Area covered by program can be and has been changed, but otherwise there is really only one way to do this type of program.
Toronto land use	Other issues (politics, equity, funding) place a practical limit on the options available, and once in place, potentially hard to reverse.
Road pricing	Technology allows great flexibility, but other political and other issues may limit range of viable options.

the importance of external factors (those outside the direct control of the implementing agency), and the ability of the agency to modify different aspects of the strategy to ease implementation or to "fine tune" the strategy once it is in place.

The most flexible strategies were generally designed specifically to be so, including the *Team Transit* initiatives and the Seattle *Flexpass* program. The MNR *Hudson Rail Link* and Seattle *U-PASS* programs also offer a good deal of flexibility, but most notably because they were completely within the control of the agency. Other strategies such as the GO Transit FISC and Tidewater timed transfer system are limited by external issues (political/equity concerns, and somewhat rigid design parameters, respectively), but such policies can be implemented partially, phased in, or refined later.

Similarly, political and related concerns may place practical limits on the flexibility of road pricing, but the technology involved does allow for many options. The small number of parameters involved with the Portland *Fareless Square* case probably makes it one of the least flexible of the cases. Finally, the external issues and long timeframe make implementation of the land use policies of the Toronto case by far the least flexible of the eight.

Legal and Liability Considerations

A summary of the legal or liability issues involved with each case is provided in Table 26. Several of the cases have

TABLE 26 Summary of legal/liability considerations

Case study	Legal/liability issues
Hudson Rail Link	Plan was examined by agency attorneys who identified no significant legal issues because of common jurisdiction. If applied elsewhere, jurisdictional conflict could result in legal issues.
GO Transit FISC	No significant legal or liability issues.
Team Transit	Adaptive reuse of infrastructure may create some additional liability issues for agency; no other significant legal issues.
Tidewater timed transfers	No significant legal issues since program is completely within agency. No legal challenges arose from proposed changes in service.
U-PASS/ Flexpass	No significant legal or liability issues.
Fareless Square	No significant legal or liability issues.
Toronto land use	No significant liability issues but implementation subject to legal challenges.
Road pricing	Implementation could involve a variety of legal concerns (depending on the specific proposals), and be vulnerable to numerous legal challenges.

TABLE 27 Summary of jurisdictional issues

Case study	Jurisdictional issues
Hudson Rail Link	Not an issue in this case since stations affected were within the jurisdiction of the agency (New York City); potential jurisdictional conflict if applied outside of the city.
GO Transit FISC	Program requires a high degree of interjurisdictional cooperation.
Team Transit	Program depends completely on interjurisdictional cooperation, a remarkably high level of which was achieved in this case.
Tidewater timed transfers	Not an issue since program is within the agency.
U-PASS/ Flexpass	*U-PASS* required the cooperation of the agency and the university, but both programs are administered entirely within the jurisdiction of the agency.
Fareless Square	Not an issue since program is within the agency.
Toronto land use	The nature of these policies requires extensive interjurisdictional cooperation, as was the case with the more successful aspects of the Toronto example.
Road pricing	Probably involves multiple jurisdictions, but depends on where the policy is applied.

no significant legal- or liability-related issues that we could identify. In the *Team Transit* case, the agency has adapted existing freeway shoulders or portions of downtown streets as bus-only lanes and installed ramp meter bypass lanes at freeway entrances. To the extent that accidents with other vehicles may occur in the operation of these facilities (since they are not barrier-separated, for instance), the agency is open to potential liability issues.

The other potential legal issues that we have identified arise from two sources: interjurisdictional conflicts, and the equity and political concerns described above. While the *Hudson Rail Link* is operated within the service territory of the Metropolitan Transportation Authority, the application of a similar service by another commuter rail agency might result in a jurisdictional conflict with the local bus company. The land use policies of the Toronto case and the implementation of road pricing are almost certain to bring legal challenges from some of the affected constituencies, given the potential of these policies to favor one group at the expense of another and to make some travelers worse off.

Not surprisingly, the legal issues involved in the pricing of roads are quite involved. They have been addressed in some detail in the road pricing literature.[1]

Jurisdictional Issues

Table 27 summarizes our findings with respect to jurisdictional issues, and shows that several of the cases required jurisdictional cooperation in order to be successfully implemented. Most notably, the *Team Transit* program is based *entirely* on an interjurisdictional partnership whereby improvements are made to the city transit system using the highway infrastructure of several adjoining municipalities. Although not to the same extent, this feature is also very important in the case of the GO Transit fare and service coordination. This strategy requires the agency and other local transit operators, often serving other jurisdictions, to agree on a common fare policy and schedule, and even more importantly, a revenue-sharing agreement.

Interjurisdictional cooperation was also a big factor in the Toronto land use case study. The successes we have observed in this case are surely the result of the cooperative (or at least consistent) efforts among the governments of the Toronto region to limit the expansion of freeway access between their various jurisdictions (between the central city and outer city/suburbs, for example).

For some of the other cases, the importance of jurisdictional issues will depend on the geographic context in which the strategy is applied. While the operation of the *Hudson Rail Link* bus service is within New York City, and hence the area within which the MTA had bus operating rights, this might not be the case for feeder services implemented in other cities or even elsewhere in Metro–North's system (the majority of the stations on the system are outside the city limits).

Road pricing may or may not have jurisdictional issues associated with it, again depending on where it is implemented. Certainly with privately-financed facilities there may not be any conflicts. With public urban roadways, however, there are potentially many jurisdictions involved—the federal government has limited the ability of states to enact new tolls on interstates, states control most of the rest of urban highways rather than the local governments, and where local governments do control some facilities (such as tunnels and bridges), the authority may be spread across multiple agencies (as is the case in New York City, for example).

Finally, for two of the cases, TRT and Portland, there were no jurisdictional issues, nor is there likely to be any were the

[1] See, for example,
Coit, R.J., "Legal Issues Surrounding Roadway Pricing on City Streets and Bridges." *Transportation Research Record 494* (1974) pp. 1–10.
Bosley, J.J. & M.B. Schaller, "Legal Considerations in Urban Transportation Pricing." *TRB Special Report 181* (1978) pp. 57–61.
Olson, D.J., "Pricing Urban Roadways: Administrative and Institutional Issues." *TRB Special Report 242* (vol. 2) (1994) pp. 216–249.

strategies applied elsewhere, since these programs affected only existing services that were completely within the purview of the respective agencies.

Costs

Any discussion of the costs of these case study strategies requires a few caveats. First, there are several different measures of "cost" that are of interest—there may be an up-front cost for planning or studying the strategy, there may a direct capital cost associated with the implementation of the strategy, and there may be ongoing capital and operating costs created by the application of the strategy. Second, any one of these three types of costs may or may not be borne directly by the sponsoring agency. Third, there are differences in the sizes and budgets of the case study agencies that may mask how relatively expensive a strategy is.

And finally, any comparison of costs across policies and agencies is usually a demanding and hazardous exercise. There are countless opportunities for erroneous conclusions because of varying accounting procedures, cost-sharing arrangements, and other minutiae that can often be brought to light only by very painstaking examination of the data and detailed questioning of agency officials.

Such a detailed examination of costs was not expected (or warranted) as part of this study, given the uncertainties on the benefits side of the analysis. Rather than focus rigorously on the question "*How much did it cost?,*" we directed our attention to the question "*Were costs a big issue in this case study, and if so, why?*" Table 28 summarizes our conclusions for each case study.

In fact, cost was not a big factor in any of the cases. This is hardly surprising, since we had deliberately avoided cases requiring large capital investments (such as the addition of a new commuter rail service), and in general, budgetary pressures are an ever-present fixture at today's transit agencies. Table 28 shows that the *Hudson Rail Link* is actually judged to make a small *profit* for the agency, so cost was not an issue there. However, were the concept applied elsewhere, local conditions might not provide such a result. Likewise, the Portland *Fareless Square* program required no *additional* funding but benefits from a local payroll tax that is dedicated to transit. The *Team Transit* program was designed to be very low cost, but many of the improvements (such as ramp meter bypasses) rely on existing infrastructure.

On the other hand, the Seattle pass programs were designed to be revenue-neutral to the transit agency, and although part of the funding for the *U-PASS* comes from the university, the university certainly benefits from the service. Any potential road pricing programs could also easily be designed to be revenue-neutral to a toll authority, or to pay for any costs incurred in implementing them.

The biggest cost issues of the cases examined have to do with additional, ongoing expenses that may result in service changes enacted subsequent to implementation of the strategy. Implementation of the GO Transit FISC has created a situation whereby *some* agency will require additional subsidy. In the case of TRT, service changes required to implement time transfer could lead to a worsening in the cost performance of the system.

For the more far-reaching initiatives like land use coordination and road pricing, the impacts of which are likely to be felt by a wide range of different interest groups, the cost issues are of course not limited solely to the implementation costs borne by the agencies making the change. For such pervasive policies to be approved, they should—in an analytically-oriented world—require a showing that the total social benefits exceed the total social costs, both construed

TABLE 28 Summary of cost issues

Case study	Costs
Hudson Rail Link	No net cost to agency (service provided by a contractor, and agency actually makes a small profit with increased commuter rail revenue).
GO Transit FISC	Implicitly involves an ongoing subsidy across agencies that may be significant.
Team Transit	Mostly low-cost improvements, but many of them rely on the existence of potentially expensive infrastructure.
Tidewater timed transfers	Small cost for planning and design of system; little cost for implementation, and ongoing costs depend on resulting revenue changes (additional subsidies may be required).
U-PASS/ Flexpass	*U-PASS* funded completely from user fees, increased campus parking charges, and assistance from the university; *Flexpass* designed to be revenue-neutral to the transit agency.
Fareless Square	Funding completely out of existing agency revenues, but made possible by a dedicated local payroll tax for transit.
Toronto land use	Cost is not a factor *directly*, but could be important in effects of policy on infrastructure spending.
Road pricing	Could be designed to pay for itself, both in terms of capital (where applicable) and operating costs.

TABLE 29 A summary appraisal of the case studies

Case study	Effective-ness of mode shift	Time frame	Political acceptabil-ity	Equity	Implemen-tation flexibility	Legal/ liability issues	Costs	Jurisdic-tional issues
Hudson Rail Link	🚌🚌	🕒🕒	☺	⚖⚖⚖⚖⚖⚖	+++	🚲🚲	$	++
U-PASS/ Flexpass	🚌🚌🚌	🕒	😐	⚖⚖⚖⚖⚖	++++	🚲	$$	+
Team Transit	🚌	🕒🕒	😐	⚖⚖⚖⚖⚖	++++	🚲🚲	$$$	+++++
Tidewater timed transfers	🚌	🕒🕒🕒	😐	⚖⚖⚖⚖⚖⚖	++	🚲	$$$	+
Fareless Square	🚌	🕒🕒	☺☺	⚖⚖⚖⚖⚖	++	🚲	$$$	+
GO Transit FISC	🚌	🕒🕒🕒🕒	☹☹	⚖⚖⚖	++	🚲	$$$$	++++
Toronto land use	🚌🚌🚌🚌	🕒🕒🕒🕒 🕒🕒	☹☹☹	⚖	+	🚲🚲🚲	$$	++++
Road pricing	🚌🚌🚌🚌🚌 🚌	🕒🕒🕒🕒 🕒🕒	☹☹☹☹☹	⚖	++	🚲🚲🚲🚲	$	++

broadly. These social costs and benefits will include, importantly, consideration of net travel time effects, and the impacts of the proposed policies on various components of the regional economy. Of course, the real world is not always an "analytically-oriented world," and the acceptance and rejection of such potentially powerful policies hinges on far wider (and often more emotive) considerations than the dry calculations of applied welfare economists.

Evaluation Summary

Table 29 provides an overall summary of the application of the various evaluation criteria, incorporating more succinctly the above observations and allowing the reader to compare the relative strengths and weaknesses of each of the cases. Each column in the table presents a graphical depiction of the case-by-case summaries for each evaluation criterion shown in Tables 21 through 28. Reading across in the table, each row compares the eight evaluation criteria for a given case study.

Because of the qualitative nature of these evaluations, however, this table is intended more as a summary-level reference rather than as a tool for "ranking" the strategies. Comparisons can be made both within a criterion across the cases, as well as within a case across the evaluation criteria. The graphical representations of the ratings are intended to summarize the more detailed qualitative conclusions highlighted in the preceding tables. They should ***not*** be used, however, to impute quantitative values for any of the criteria.*

* For example, although road pricing receives a rating of "six buses" for the mode shift criteria, this does ***not*** mean that road pricing is six times as effective as FISC; it only means that it is "a lot" more effective.

While the table provides a highly summarized view of the results of our research, there are a few conclusions that can be drawn from such a broad overview. For example, this table makes clear that there are certainly strengths and weaknesses to be traded off in considering each strategy. It also appears that, perhaps not unexpectedly, those strategies that appear most promising in terms of their effect on mode share also have the most formidable barriers to implementation. In general, we really found no strategies that provide "ideal solutions" to the problems motivating this study.

APPLICATION OF RESULTS TO PRACTICE

Transferability of Results

In order to assess the potential transferability of case study strategies to different settings, both geographic and institutional, we used four criteria:

- *Ridership impact*. Are there important ridership impacts of this strategy that could possibly be duplicated elsewhere?
- *Special conditions*. Are there unique or unusual conditions for the case study example that limit the strategy's applicability in other settings, or does the nature of the strategy itself make it relevant only to a narrow range of applications?
- *Other positive factors*. Are there other specific elements of the case that are themselves particularly interesting and may provide a motivation for adoption elsewhere, independent of its ridership impact?

- *Need for further study*. Are there aspects of the case examined about which the results are inconclusive, or would the strategy's prospects for success in other settings be improved by additional research?

Table 30 summarizes the application of the above criteria. The table shows that most of the selected strategies would benefit from additional research, either because (as we have discussed in the preceding chapters) the data available to make a rigorous quantitative evaluation were lacking, or because the general concept shows promise but there is only limited practical experience with its application. The latter certainly is the case with road pricing, which has been studied extensively in the academic literature of the last 40 years, and has been evaluated in its few actual applications in other parts of the world. It is also true, however, of the Seattle pass programs and the Toronto land use case.

Several of the case studies incorporate and illustrate interesting aspects that are themselves worthy of consideration for application elsewhere. For example, the level of deliberate multi-agency cooperation that made the *Team Transit* program possible is a model for the intermodal planning

TABLE 30 Summary of transferability evaluation

Case study	Ridership impact	Special conditions	Other positive factors	Need for further study
Hudson Rail Link	Marked increase in station boardings; negligible effect on total system	Atypical situation of topographical constraint of station		
GO Transit FISC	Poor	Very few large metro area commuter rail networks; requires cooperation among agencies		
Team Transit	Probably very limited; may have stemmed further declines	Several special conditions (ramp meters, forward thinking, etc., congestion relatively low) reduce transferability	Multi-agency cooperation Innovative use of existing infrastructure	Need more data to evaluate true ridership potential
Tidewater timed transfers	Probably very limited; may have stemmed further declines	Middle of the range of many examples (see Table 49)	Method of serving low density service territory	Need more data to determine true ridership potential
U-PASS/ Flexpass	*U-PASS*: 13% increase in transit share/9% decrease in SOV; 60% increase in university ridership on METRO *Flexpass*: increases in transit trips per employee of 18%-410% at participating firms	Few existing employer-based programs, but any city can use one (little or no extra funding needed; only need companies in CBD)		These types of programs are relatively new; continued experience will provide more data with which to evaluate their promise for more widespread application
Fareless Square	Probably limited	Motivated by air quality problems (as are many cities) Portland has dedicated funding source and coordinated long term planning	Coordinated , transit-oriented planning effort by city, including parking space moratorium and transit mall, etc.	Although data for this example are limited, literature contains much study of fare-free transit implying limited ridership potential (except for occasional promotional applications)
Toronto land use	Potentially very high	In principle could be applied in any metro area, but mere fact that Toronto stands out as an example implies potentially unique circumstances	Toronto is an interesting example for many North American transportation issues	Given the importance of this example and topic, it deserves much additional research
Road pricing	Potentially very high			Evidence is very compelling already, but political nature will require even more study

efforts originally envisioned under ISTEA. Similarly, Toronto has often been cited as a leading North American example of a "successful" transit-oriented city in an automobile-oriented society.

It's also clear from Table 30 that several of the cases we examined may be somewhat atypical examples with only limited potential for application in other contexts, for somewhat different reasons. The *Hudson Rail Link* is an interesting solution to what may be an infrequent problem—the topography of the area makes both parking at and walking from the station very difficult. The *Team Transit* improvements benefited from some uncommon local infrastructure in the nearly complete coverage of metered freeway entrances, a situation that is currently duplicated in only a small number of other cities.

Perhaps the best prospects for transferability lie with the Seattle pass programs, particularly the *Flexpass* program. These types of programs could in theory be applied in any metropolitan area, and are sufficiently flexible to be adapted to local conditions. The experience in Denver with a similar program shows that other cities have an interest in this strategy, and applications elsewhere should prove to be an important source of further research about these initiatives.

Recommendations for Further Research

We have stressed throughout this report that robust, rigorous, quantitative conclusions are not feasible with the level of data typically collected by the implementing transit agency. This in itself may be a motivation for improved monitoring and analysis of outcomes and causes, and additional research into the types of strategies examined in the case studies, whether it be further study of the specific examples we have discussed here, or other applications of the concept.

We have also observed, however, that the implementing agency itself often has only limited motivation (and resources) to evaluate the "success" or "failure" of its own initiatives. The institutional and political environment of public sector enterprises certainly inhibits such efforts, and there's no strong reason for the implementing transit system to be concerned about whether the policy would work *elsewhere*.

Historically, the communal, *industrywide* interest in understanding the determinants of "success" has been seen as a strong rationale for federal funding and involvement in research and development concerning transit operations. In the past, the FTA has spent considerable efforts on experimental demonstrations of innovative services and methods, with *independent* monitoring and evaluation. These types of activities have now been replaced by cross-cutting research and analysis funded significantly through the TCRP program. However, this study has clearly identified a *gap* in the new transit R&D arrangements: there really is now a much curtailed ability to identify, *in advance of* their local implementation, promising operational innovations that justify a careful, preferably independent monitoring and appraisal effort to permit strong statements about both the local outcomes and the transferability to other settings.

Despite the *qualitative* nature of this study's conclusions, it is clear that the most thorough understanding of the urban mode choice decision does not come from examination of transit user behavior alone. In Chapter 3, we set out an understanding of the process that results in the mode choice decision, and we also summarized the empirical evidence of the determinants of mode choice from past research and from CRA's own travel demand modeling experience. Decisions about the ownership and use of private vehicles are a central factor in the mode choice decision. Travelers buy or lease private vehicles because their lifestyle and aspirations motivate them to do so, largely independent of the availability or attractiveness of other modes. With the availability of the private vehicle(s) then a given, travelers greatly prefer to use their own vehicles rather than a common carrier, because of the additional convenience, comfort, privacy, and (importantly) schedule and routing flexibility that a personal vehicle provides. The circumstances in which transit can provide a comparable service/price package—and hence, a relatively attractive marketplace offering—are somewhat limited: dense travel corridors, congested highways with travel time advantages for transit, low private vehicle ownership levels, and high private vehicle usage costs (particularly parking charges and tolls). Happily for transit, however, these conditions do exist for large volumes of trips made in peak period commuting to the core areas of the nation's most densely developed cities.

Outside the situations covered by these conditions, travelers are likely to prefer to use a private vehicle *even with large improvements in transit service*. Thus the ability to affect significantly the market share of the public transit mode lies not in the characteristics of the transit mode itself, but more in the conditions affecting private vehicle ownership and use.

If we accept that transit-side strategies by themselves are unlikely to influence mode choice in a substantial way, and if we concede that transit operators are not primarily interested in these types of strategies anyway, then it is logical that the focus of additional research ought to be mostly on those strategies that influence directly the attributes of private vehicle travel. Although beyond the scope of this study, we know (even from the Seattle *U-PASS* evaluation) that parking pricing is a significant determinant of mode share. The contemporaneous TCRP Project H-3, *Policy Options to Attract Auto Users to Public Transportation*, ought to provide a good foundation for the continuing investigation of this subject.

The impact of land use on transit market share also ultimately boils down to its effects on the attractiveness of private vehicle ownership and use. We know from the Toronto case that the limitation of urban freeway capacity can be a big factor in the success of these policies. While the subject of

the transit/land use connection has also been the subject of much research, both within the TCRP program and elsewhere, it is important for the transit community to continue to investigate the implications of innovative initiatives: for example, significant bold attempts in a few places to create greater "mixed use" development projects, with balanced housing/employment uses, and transit-friendly provisions for both internal and external access.

Finally, there is compelling evidence of the relatively strong potential of congestion-sensitive road pricing to affect urban mode choices. While there has already been a great deal of research on the topic, the highly political nature of the subject will no doubt require even more understanding and greater experimentation before any widespread implementation of the strategy will become a practical reality.

APPENDIX A

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
APTA	American Public Transit Association
AVL	Automotive Vehicle Location
CAAA	Clean Air Act Amendments of 1990
CAFE	Corporate Average Fuel Economy
CBD	Central Business District
CMAQ	Congestion Management and Air Quality
CMSA	Consolidated Metropolitan Statistical Area
CUTA	Canadian Urban Transit Association
EPA	Environmental Protection Agency
ETC	Electronic Toll Collection
FHWA	USDOT Federal Highway Administration
FISC	Fare Integration and Service Coordination
FTA	USDOT Federal Transit Administration
GO	Government of Ontario
GTA	Greater Toronto Area
HC	Hydrocarbons
HOV	High-Occupancy Vehicle
HRL	Hudson Rail Link
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
LEV	Low-Emission Vehicle
MC	Metropolitan Council
MCTO	Metropolitan Council Transit Operations
MnDOT	Minnesota Department of Transportation
MNR	MTA Metro-North Railroad
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
MT	Mississauga Transit
MTA	Metropolitan Transportation Authority (New York)
MTC	Metropolitan Transit Commission (Twin Cities)
MTO	Ministry of Transportation of Ontario
NAAQS	National Ambient Air Quality Standards
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NPTS	Nationwide Personal Transportation Survey
NRC	National Research Council
PAYE	“Pay as you enter”
PAYL	“Pay as you leave”
PM	Particulate Matter
PMSA	Primary Metropolitan Statistical Area
R&D	Research and Development
RFP	Request for Proposal
RVSH	Revenue Vehicle Service Hour
SIP	State Improvement Plan
SOV	Single-Occupant Vehicle
STP	Surface Transportation Program
TCM	Transportation Control Measure
TCRP	Transit Cooperative Research Program
TDM	Transportation Demand Management
TIP	Transportation Improvement Plan
TMP	Transportation Management Program
TRB	Transportation Research Board
TRRL	Transport and Road Research Laboratory (UK)
TRT	Tidewater Regional Transit
TTC	Toronto Transit Commission
TTDC	Tidewater Transportation District Commission
ULEV	Ultra Low-Emission Vehicle
UMTA	USDOT Urban Mass Transportation Administration (now the FTA)
USDOT	U.S. Department of Transportation
UTP	Urban Transportation Planning
ZEV	Zero Emission Vehicle

APPENDIX B

DETAILS OF THE CAAA AND ISTEA LEGISLATION[1]

THE CLEAN AIR ACT AMENDMENTS OF 1990

Title I and parts of Title II of the CAAA focus on the transportation sector's contribution to national and regional air quality. Title I establishes criteria for attaining and maintaining the National Ambient Air Quality Standards (NAAQS) that set allowable concentrations and exposure limits for various pollutants. Under the NAAQS, certain pollutants should not exceed specified levels more than *once per year*. Areas with levels that violate the standard, either in frequency or in the high concentration of pollutants, are designated as "non-attainment areas" for the associated pollutants and must reduce the emissions from any sources causing this pollution. Emissions from mobile sources include carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x), and particulate matter (PM), all of which are known to degrade air quality. Moreover, CO and NO_x may react in the presence of sunlight, creating ozone (O_3) which also reduces urban air quality.

Title I stipulates certain actions that must be taken by state and regional agencies to comply with the NAAQS. Each state must create a state improvement plan (SIP) that addresses how the state will attain and maintain conformity with the NAAQS. The state is responsible for ensuring that each non-attainment area within the state will meet the NAAQS in a timely manner. Regions may be classified as non-attainment areas for ozone, CO, and PM; for each pollutant, the regions are also classified by the *degree* of the problem (from "marginal" to "extreme non-attainment").

Requirements for the SIP are outlined in the CAAA, and depend heavily on the degree of non-attainment of a region. At marginal non-attainment, only minimal changes in the transportation system may be suggested or required. However, with moderate non-attainment, the state must specify transportation control measures (TCMs) that will result in the required reductions in mobile source emissions. More restrictive measures are required for areas with serious or severe non-attainment, including the use of cleaner and reformulated fuels, employee trip reduction programs, and strict limitations on vehicle miles of travel. Under extreme non-attainment, control measures include vehicle use restrictions during peak hours.

More to the point, the metropolitan planning organization (MPO) of each non-attainment region must submit a transportation improvement plan (TIP) that specifies how the region intends to address problems with mobile source emissions. To this end, the CAAA require that the transportation plans, programs, or projects resulting from the TIP must not

- Create new NAAQS violations;
- Increase the frequency or severity of NAAQS violations; *or*
- Delay the regional attainment of NAAQS.

In addition, the CAAA also require that the TIP be in conformity with the SIP. Additional guidance from the federal government suggests that a TIP should contribute to annual ozone and/or CO reductions in non-attainment areas, and that it should provide for "expeditious" implementation of TCMs as required in the SIP. Continued violation of the air quality targets from the SIP will result in sanctions, including, most importantly, the loss of federal highway funds.

A part of Title II of the CAAA identifies actions to be taken for reducing emissions from mobile sources. By and large, the transportation-related sections consist of guidelines and regulations for reducing tailpipe emissions on new vehicles. The emissions standards are specified in the CAAA for incorporation in cars and light-duty trucks in the 1994 models, and in heavy-duty trucks by the 1998 model year. For transit buses, Title II establishes a stringent particulate emissions standard, scheduled to take effect in 1994. The net result of these more stringent vehicle emissions standards, namely the reduction of pollutants from new (and some existing) vehicles, will be achieved at a higher price for vehicle emissions equipment and cleaner fuels.

Implications for mode choice

The CAAA have potentially broad implications for mode choice. For ozone or CO non-attainment areas, the SIP and TIP requirements bring vehicle emissions into the foreground of transportation planning, with a substantial disincentive (loss of federal highway funds) for violation of the NAAQS. The statewide SIP and the local TIP, then, must consider voluntary (or in some cases mandatory) transportation-related measures to improve air quality. Perhaps most obviously, these measures involve reduction in vehicle miles of travel through employer-based "trip reduction programs," and enhancement of alternative modes to the single-occupant automobile. Specific measures mentioned in the CAAA include

- Improvements to public transit service;
- Restriction of lanes to exclusive high-occupancy vehicle (HOV) or bus use;
- Employer-based transportation management plans, including incentive programs;
- Trip reduction ordinances;
- Traffic flow improvements resulting in reduced emissions;
- Park-and-ride facilities for transit and ridesharing;
- Restrictions on use of vehicles in downtown areas at peak times;

[1] The information presented here is based (in part) on a review of the following documents:

US Department of Transportation, Federal Highway Administration, "Air Quality Programs and Provisions of the Intermodal Surface Transportation Efficiency Act of 1991: A Summary." Washington, DC, US Department of Transportation (1992).

US Department of Transportation, Federal Highway Administration, "Transportation Programs and Provisions of the Clean Air Act Amendments of 1990." Washington, DC, US Department of Transportation (1992).

US Department of Transportation, Federal Transit Administration, "The Intermodal Surface Transportation Efficiency Act of 1991: Flexible Funding Opportunities for Transit." Washington, DC, US Department of Transportation (1992).

US Department of Transportation, Federal Transit Administration, "The Intermodal Surface Transportation Efficiency Act of 1991: Flexible Funding Opportunities for Transit, FY 94." Washington, DC, US Department of Transportation (1993).

US Department of Transportation, "The Intermodal Surface Transportation Efficiency Act of 1991: A Summary." Washington, DC, US Department of Transportation (1992).

- Improvements to HOV and ridesharing services;
- Measures that reduce vehicle idling times;
- Measures that reduce cold starts;
- Flexible work schedules;
- Programs to discourage single-occupant vehicle (SOV) use to major activity centers;
- Conversion of facilities to bicycle and pedestrian use;
- New bicycle and pedestrian facilities; and
- Voluntary removal of pre-1980 automobiles and light trucks.

These measures suggest a heavy emphasis on improving alternatives to the single-occupant vehicle, including transit and other high-occupancy vehicles. The requirements of the CAAA for non-attainment areas are obviously intended to require state and local governments to consider ways of enhancing public transit and other modes, as well as to discourage single-occupant automobile use. Voluntary and mandatory mode shifts, achieved through these sorts of TCMs, may be necessary to achieve the NAAQS targets specified in Title I.

Title II will have significant implications for the cost of using automobiles and public transit. Because many of the vehicle emissions and clean fuel standards have not yet taken full effect, the cost implications for private vehicle and public transit travel are not easily quantified. However, it is clear that the mandatory emission standards will require more expensive emissions control equipment on all vehicles, resulting in higher costs to purchase and maintain these vehicles. Mandatory use of cleaner fuels will also increase the costs of operating a vehicle, again resulting in somewhat higher travel costs for the users of both transit and private vehicles.

THE INTERMODAL SURFACE TRANSPORTATION EFFICIENCY ACT OF 1991

In the broadest view, the ISTEA of 1991 was intended to authorize federal funding for the nationwide transportation system through the federal fiscal year 1997. As such, the legislation covers a broad spectrum of surface transportation activities. For the more narrowly-focused purposes of this project, however, there is much in the ISTEA legislation with the potential to influence the flow of federal money for transportation investment, and thereby to influence local travel mode choice.

Within the scope of our study, two sections of the ISTEA are most relevant: Title I, dealing with surface transportation; and Title III, dealing with the Federal Transit Act amendments. Within Title I, several new programs were introduced, including the Surface Transportation Program (STP), the National Highway System (NHS), and the Congestion Management and Air Quality (CMAQ) Improvement Program. Significant funding is authorized for both the STP and CMAQ programs ($23.9 billion and $6 billion, respectively).

One of the more noticeable features of the STP and CMAQ funding is that it may be used directly at the discretion of local transportation decisionmakers. A fixed 50% of STP funds are allocated to the regions in a state *by population*, and an additional 30% of funds may be allocated to regions *at the state's discretion*. However, the MPO within each region has the final discretion on which specific projects receive these funds. This flexibility allows these funds to be used for a broad range of transit and non-SOV projects within each region, including transit capital purchase and/or rehabilitation; TCM development and implementation; system planning; research and development; carpool and vanpool projects; and pedestrian and bicycle facilities. The federal share of funding for projects under the STP may be as high as 80%.

CMAQ funding is distributed to ozone and CO non-attainment areas throughout the country, based on a formula that weights the population of each qualifying area by the severity of its pollution levels. Thus, areas facing high congestion and considerable air quality problems receive substantial funding, which may be used at the MPO's discretion in selecting projects. Projects funded by the MPO through the CMAQ program must meet the goals of the CAAA as specified in the SIP. Projects meeting these criteria are directed toward reducing SOV travel and improving transit and other ridesharing modes. Generally, the federal share of funding for CMAQ projects can be up to 80%. However, for CAAA-mandated transit programs (that is, the installation and purchase of emissions equipment for transit buses), that share may increase to 90%.

Other funding from Title I may also be used to develop alternative modes. Funds set aside for the NHS and Interstate highway programs, totaling $21 billion and $7.2 billion respectively, can be used under certain conditions to develop transit and HOV facilities in these same highway corridors (at up to 90% federal share of project costs for Interstate highway programs). In addition, at the discretion of the states, a portion of funds may be transferred from other programs to the STP, including 50% from the NHS, 20% from the Interstate Maintenance program, and 40% from the Bridge Replacement and Rehabilitation program. This implies that significant funding may be made available to local MPOs through the STP program, and this funding may be used largely at the locality's discretion for meeting air quality and other congestion management objectives.

In addition, the ISTEA includes authorization of funds for up to five *congestion pricing demonstration projects*, with total annual funding of up to $25 million. This provision suggests that market-oriented road pricing options—once considered politically and technically infeasible in specific local contexts—may be considered by the federal government as providing appropriate ways to manage travel demand.

While the legislation requires substantial conformity between a non-attainment area's air quality and long-range transportation plans, it isn't entirely clear at this stage how decisionmakers will adjudicate that conformity. In November 1993, the US Environmental Protection Agency published highly technical and complex regulations. Aligning the objectives and details of the area's TIP, the state's SIP, and the plans required under federal transportation programs is a challenging problem both politically and technically, not least because NO_x emissions are likely to increase with any increased vehicle speeds made possible by strategies designed to reduce existing traffic congestion. Since substantial portions of a metropolitan area's federal transportation funding can be held hostage to an acceptable degree of "conformity," it seems likely that cities will have incentives to give higher priority to air quality considerations over long-term mobility improvements on the highways.

Title III of the ISTEA authorizes funding for the federal transit programs in the forms in which they broadly existed prior to ISTEA. These programs include the Section 9 formula grants (for capital and operating assistance), Section 3 capital grants, and Section 16 assistance for transit services for the elderly and disabled. However, the ISTEA introduced some new features of funds provided through these channels, involving increased federal shares of project funds.

In particular, to match similar mechanisms for highways, the federal government's share for Section 3 grants was increased from 75% to 80%, and incremental costs associated with compliance with the CAAA and the Americans with Disabilities Act (ADA) are covered at 90% (previously 80%). These changes suggest a greater federal role in providing public transit capital and operating assistance, and thus a higher importance of transit in the scope of this legislation.

Implications for mode choice

There are several broad implications of the ISTEA legislation for mode choice. *First*, it is important to note that the legislation in ISTEA will not *directly* affect travelers' mode decisions in the same way that the CAAA may result in restrictive TCMs in non-attainment areas and/or higher vehicle costs through emissions control equipment. However, the funding allocations of ISTEA imply changing priorities for the federal government's transportation investment and pricing policies, thus indirectly enhancing certain travel modes.

In terms of investment priorities, the federal legislation leaves much to the discretion of local MPOs. Most notably, through the STP and CMAQ programs, significant funding is made available to local agencies to use at their discretion. Since they must be in conformity with the local TIP and the statewide SIP mandated by the CAAA, projects funded under the STP and CMAQ are likely to emphasize modes of travel besides the single-occupant automobile. In addition, HOV and transit improvements are also eligible for some funding under other programs, including the NHS and Interstate programs.

Secondly, the process of transportation and air quality planning has the potential to be improved. The statewide SIP and the local TIP are likely to be developed either jointly or through more extensive collaboration of state and local officials, thus potentially yielding transportation plans and programs that are in the larger public interest. The requirements of the CAAA may result in more federal funding for cleaner and congestion-reducing travel modes such as transit. Furthermore, there is greater discretion at the state and local levels to use funds for transportation planning, research, and development. In particular, there are no restrictions on the amount of NHS and STP funds that may be used for these purposes.

Finally, in the realm of pricing, the federal government has authorized funding for congestion pricing demonstration projects. This endorsement creates a possible incentive for innovation, and suggests that congestion-sensitive pricing of single-occupant and other automobile travel may be more feasible in the future.

APPENDIX C

THE DEBATE ABOUT THE GRADIENT OF THE URBAN TRANSPORTATION PLAYING FIELD

In the struggle between interested parties to influence federal, state, and local government priorities regarding urban transportation, it has become commonplace to hear that existing public policies are not "fair"—that is, they explicitly encourage one sectional interest rather than another. Transit industry representatives, in particular, often claim that past and current policies create significant advantages to the ownership and use of private vehicles, and further, that this imbalance should be corrected either through increasing the costs of automobile* ownership and use or through greatly increased public support for high-occupancy public transportation services.

Such arguments often start with the marked discrepancy between the amount of public funds flowing to transit and the amount flowing to highway construction, maintenance, and repair. However, there is a big difference between the *sources* of these two rivers of funds. The governmental expenditures on highways are derived in substantial part from highway user fees (primarily fuel taxes and tolls), whereas those for transit are typically pure subsidies from general revenues or from dedicated taxes. At this point, the debate usually shifts to questions of just how much of the *total social costs* of highway provision and use are borne by the users, and how much by society at large. Are there "hidden costs" that are equal to or greater than the sums that governments provide to support transit services?

The scope for Transit Cooperative Research Program Project H-4A required us, in part, to examine these issues, and this Appendix has been written in response to that requirement. However, it is our contention that there is no theodolite that can be used to measure the gradient of the public policy playing field in a completely objective and universally acceptable manner. Rather, quantitative appraisal of the "fairness" or neutrality of the relevant governmental policies must inevitably involve questionable data and assumptions, as well as very significant value judgments.

COSTS IN THE HIERARCHY OF TRAVEL CHOICES

Because transportation involves the consumption of resources (labor, fuel, infrastructure, and travelers' time, for example), there is clearly a set of *costs* associated with travel decisions. Particularly as we examine local travel by public transportation and private vehicles, the costs of these travel alternatives and their resulting impacts on tripmaking decisions are important. The studies we review later in this appendix show there is, at least, some agreement on the types of costs that should be included in any rigorous accounting of automobile and transit travel.

Table 31 summarizes the various types of costs incurred in local transportation. The table identifies the major categories of costs incurred or borne by four entities:

- The *travelers* themselves;
- The agencies that own and/or operate transportation facilities and services (*"transportation facility operators"*);†
- Federal, state, or local *governments*, acting in roles other than as transportation facility operators; and
- *Society* at large.

It isn't necessary for the purpose of this discussion to expound at length on the nature, theory, and analysis of transportation costs.[1] To interpret Table 31 correctly, however, several of its key features should be understood. First, the primary intent of the table is to be *comprehensive* regarding the costs incurred by each of the entities. The categories of costs presented are not mutually exclusive; they overlap in several different ways. Most importantly, the lists comprise both true *resource costs*—representing an economic valuation of the scarce resources actually consumed—and *transfer payments* made between the different entities. The transfer payments do not themselves represent the consumption of resources; rather, they represent a financing, rationing, or reimbursement policy.

So, for example, when transit services are provided, the land, capital, and labor actually used are resource costs incurred (for the most part) by the "transportation facility operator." The fares paid by transit riders and the capital and operating assistance provided by governments are transfer payments made in return for benefits received from the transit services. Similarly, a motorist's expenditures on fuel (and previously, tires) include taxes dedicated to reimbursing governments for the resource costs involved in providing and managing the public infrastructure. If we were to try to quantify costs under each of the categories in Table 31, and then to add them all up, we would be overstating significantly the resources consumed in providing local transportation services; that is, we would be double-counting to the extent of the total transfer payments listed in the table.

Secondly, an important component of the costs incurred by the travelers themselves is the investment of *time* for traveling. This is a real resource. It has a clear (albeit sometimes difficult-to-determine) value because it has definite opportunity costs, and traveler behavior (that is, choices observed in the marketplace) can only be understood and explained adequately when travel times are considered alongside out-of-pocket money costs. People are definitely prepared to trade time savings in their travel for increased money costs.

* In line with popular usage, we have used the term "automobile" loosely throughout this appendix to characterize all types of household-owned private motor vehicles used on the highway, including cars, vans, and sport utility vehicles.

† These range from purely private companies (such as taxicab firms) through quasi-private (but publicly owned) corporations (turnpike authorities, transit properties, etc.), to government agencies (state highway or transportation departments, for example).

[1] The reader interested in following up at greater length on some of the issues summarized in the discussion of Table 31 is referred to the following texts:

Wohl, M. and Hendrickson, C., *Transportation Investment and Pricing Principles: An Introduction for Engineers, Planners, and Economists.* New York, NY, John Wiley & Sons, (1984) Chapters 1 and 2.

McGillivray, R. G., Kemp, M. A., and Beesley, M. E., "Urban Bus Transit Costing." *Urban Institute Research Paper 1200-72-1*, Washington, DC, The Urban Institute (1980).

Keeler, T. E., Merewitz, L. A., and Fisher, P., *The Full Costs of Urban Transport.* Berkeley, CA, University of California Institute of Urban and Regional Development (1974–1975).

TABLE 31 Categories of costs associated with local travel

User-incurred costs (costs borne directly by travelers): • vehicle (and related equipment) acquisition costs (purchase, lease, or rent) • vehicle maintenance and repairs • fuel, oil, and tires • vehicle registration, licensing, and ownership-related taxes • vehicle insurance • vehicle parking at home • paid parking away from home • tolls for facility usage • private expenses of accidents, regulatory infractions • private expenses of driver education and licensing • public transportation fees • travel time
Transportation facility operator costs: • land or right-of-way acquisition • capital costs (infrastructure construction, vehicles, structures, etc.) • operations and maintenance costs (labor, fuel, etc.) • taxes
Costs borne by governments: • support for research, development, and planning • support for facility capital and operating costs (including public parking subsidies) • police, courts, fire, and other emergency services • administration of vehicle, driver, and carrier regulatory policies • "tax expenditures" related to local travel • national energy security policies • other publicly borne costs related to accidents and pollution
Costs borne by other entities, or by society at large: • private costs associated with public infrastructure construction • private infrastructure costs (e.g., repair of vibration damage) • pollution costs (health care, productivity loss, environmental damage, etc.) • accident costs (productivity loss, pain and suffering, etc.) • noise • unpriced parking provision • changes in property values • aesthetics • indirect land use impacts • congestion delays incurred by parties other than the travelers themselves

Source: Charles River Associates Incorporated, following Apogee Research (1994) and others.

As one moves away from those costs clearly identified as the incremental resources consumed directly by users and providers through to more amorphous (albeit very real!) costs imposed on wider communities, the difficulties of analysis multiply. These difficulties are both conceptual and empirical. In technical terms, they include

- The need to *allocate fixed and/or common costs* to different functions or objectives, in defensible but essentially arbitrary ways;‡
- The problems of *quantifying* impacts, when that involves inferring causality in complex systems influenced by many factors; *and*
- The problems of *valuing* impacts, when marketplace-based evidence is lacking, skimpy, or provides different values in different contexts.

But these technical generalizations are probably less instructive than a few specific examples of the types of theoretical and practical questions that can typically arise. Consider the following for instance

- The court system serves far wider purposes than simply adjudicating travel-related infractions or disputes. Similarly, the national strategic petroleum reserve not only serves as a fuel supply insurance for petroleum-using local transportation modes; it presumably is an instrument of foreign policy and a soother of the national psyche, among other things. In cases like these, how much of the costs of these systems is it fair to allocate to local transportation modes? On what basis?

‡ There is no such thing as a comprehensive costing model, immediately and uniformly applicable to all kinds of decisions. Rather, the costs that are relevant, and the appropriate methods for measuring them, vary with the nature of the decision under consideration. Some decisions require the "fair" allocation of common costs, a procedure that rests less on economic theory than it does on achieving consensus about what is "fair."

- Gasoline- and diesel-powered vehicles generate noxious emissions. How far these emissions impair the quality of the local air depends not only on the amount of the emissions but on climate, urban design, and other factors. How far poor local air quality results from transportation emissions, as distinct from other local or regional sources of air pollution, is similarly the result of many factors. To what extent poor air quality results in an increase in health problems is similarly complex. All of these are very complicated systems, for which our ability to understand and to model the effects quantitatively is still very limited. What level of (say) increased respiratory problems should be fairly imputed to a city's commuters by private vehicle or by bus?
- While economists have developed ingenious ways of finding and analyzing consumer choices that provide an indication of the public's willingness-to-pay for (say) improved safety or less noise, and survey researchers have also developed "stated-preference" methods of measuring these types of values, there is a great deal of variability in the results.§ So there remains a lot of uncertainty, not only in (say) how much reduced auto or bus emissions affect the quality of the air, but also in how much monetary *value* should be ascribed to an air quality improvement.

These caveats help us to understand the intent and limitations of the type of list illustrated by Table 31. We will have reason to return to such a list later, but for our present purposes we draw four conclusions from the table. *First*, the costs that are incurred by the end user, the local traveler—whether by transit or by private vehicle—represent only a fraction of the total costs associated with that travel. In particular, many of the various types of resource costs or deleterious impacts of the travel are borne by the facility operators, or by governments, by specific "third parties," or by society at large. For example, the costs of private vehicle travel not *directly* borne by travelers include such things as infrastructure provision, unpriced parking, congestion delays to others, and contributions to air pollution. Whether travelers as a whole, or travelers by certain modes, are "paying their way" depends on whether their total use-related charges are at least equal to the total economic costs associated with their travel.

Secondly, the costs borne by the end user are incurred at different levels of the choice hierarchy. Some of the costs in Table 31 occur as the direct result of the use of a vehicle for a specific trip: fuel costs, tolls, parking fees, and transit fares. However, other costs borne by the user are associated with the choice of where to live (parking at home) and with vehicle ownership decisions (purchase, registration, insurance, maintenance, accident expenses, and so on).

Thirdly, as we consider the mode choice decision *per se*, the *incremental* costs to the traveler associated with choosing one of several feasible modes will typically represent only a small fraction of the total user costs. For example, the costs of using the automobile *on a trip-by-trip basis*—including parking expenses, tolls, and fuel—are significantly lower than the user's total cost of automobile use. There is evidence, too, that while mode choice decisions for habitual travel may affect a broader set of costs,** the perceived costs associated with a decision to use a private vehicle are still restricted to only those that vary on an individual trip basis. Likewise, the traveler's cost for a transit alternative, if paid with a single-ride fare, is borne directly by the user for each specific trip, but unlimited ride passes can reduce the incremental cost of a transit ride to zero.

If decisions about mode choice are based (in part) on the perceived incremental costs of the alternatives, travelers' choices are likely to be distorted to the extent that these costs deviate from the marginal social costs†† ascribed to the alternatives. If, for some reason, one mode is a relative bargain, in the sense that the perceived price of using it is significantly below the marginal costs to society created by its use, then resources will be misallocated.

Finally, we should observe that our observations about the difficulties of measuring and valuing several types of costs imply that ultimately there is likely to be no single, unambiguous, completely objective answer to the issue of whether public policies benefit one mode more than another. If the difficult-to-appraise cost items—those involving the "fair" allocation of common costs or the valuation of analytically tenuous impacts, for instance — form a significant component of the total costs, then the analysis must inevitably rest on some value judgments that may be capable of tipping the scales. In these circumstances, analysis can help to clarify the issues, pinpoint the areas of possible contention, and explore the sensitivity of the findings to the value judgments, but it may not be feasible to produce a clear, authoritative answer that all parties to the debate will accept by dint of its analytical purity.

WHAT HAS ANALYSIS OF COSTS AND PAYMENTS BY MODE REVEALED?

We next turn to summarizing the current state of research into the relative costs of local transportation modes, and the impact of governmental policies on those costs. The existing body of research on such matters comprises two different types of studies: those that attempt a strict "accounting" of costs with the aim of identifying the relative total resource costs associated with the use of each mode, and those that address cost allocation or externality differentials in the context of the public policy debate. While by no means comprehensive, the studies reviewed here are meant to provide a representative sample of the current level of understanding, and the range of differing points of view.

We first review three major recent studies addressing the issue. A summary of the content and focus of each is provided, and we detail the main conclusions and their wider implications. We then summarize some other supporting research that has advanced the understanding of the subject. Finally, we discuss how the conclusions and implications of this research relate to the consumer decisionmaking process and the factors that affect the mode choices made in the marketplace.

§ Some of the variation can be rationalized, either in terms of the strengths and weaknesses of the analytical methods used, or in terms of the underlying values that the methods seek to measure. When risks of harm are both relatively small and difficult to comprehend, for example, it isn't surprising that the same person may be making essentially inconsistent valuations when he or she chooses a risky occupation, smokes a cigarette, decides not to wear an automobile seatbelt, or decides which car to buy. It is from behavioral situations like these that econometricians have inferred widely varying values of a "statistical life" saved.

** For example, a decision to use a private vehicle regularly to commute to work may affect one's insurance premiums, and if the household's vehicle stock is influenced significantly by a wish to drive to work, some vehicle ownership costs could also be imputed to that mode choice decision.

†† By "social costs" we mean the full resource costs and deleterious impacts associated with the alternatives, including those borne by private parties, by governments, and by society at large.

Some major recent studies

We begin our review with three studies that all attempt to assess the relative costs associated with the use of public transit and the automobile for local transportation, and more importantly, who pays these costs. They were supported by three very different constituencies: an environmental interest group, a public transit trade association, and a group concerned with promoting the interests of highway-related industries.

It is noteworthy that all three of these studies were commissioned by organizations with a strong viewpoint to promote. There have been relevant studies funded by, or carried out by, more "objective" parties, but these are not among the ones published most recently. Not surprisingly, parties with strong vested interests are more likely to commission work of this sort, on a highly contentious issue in which value judgments are ultimately inevitable. However, by choosing a spectrum of different viewpoints, all contributing to the debate within a relatively short span of time, we are more likely to capture the full range of issues involved. These three studies provide recent original research as well as syntheses of previous work.

Conservation Law Foundation Study

The Costs of Transportation is the 1994 report of a study prepared for the Conservation Law Foundation by Apogee Research, Inc.[2] It provides a comprehensive assessment of the costs of the various transportation modes used in urban transportation, focusing particularly on commuting travel. The purpose of the work was to assess the total relative costs of all of the available modes in an urban area, and detail each of the various components of these costs. The study combines a literature review on all identified cost factors with original research using case studies of two dissimilar metropolitan areas.

To assess various types of costs and their sources, the authors first develop an analysis framework, identifying both the full range of costs and also the relevant "submodes" of travel for which the costs are derived and compared. Costs are identified as falling into one of three categories:

- User costs, paid directly by travelers,
- Net governmental costs, paid with public-sector funds, *and*
- Societal costs, external to both users and government.

For each mode and cost category, the authors attempt to identify all of the costs, and quantify most of them with range estimates drawing on values developed from the literature. In each of the two case study cities—Boston (Massachusetts) and Portland (Maine)—estimates of each of the costs are derived and compared across modes, cost categories, times of day, and urban areas.

The principal findings and conclusions of the Apogee study can be summarized as follows:

- The costs of travel by transit vary substantially, depending primarily on the passenger load. In some circumstances—particularly in peak periods in the central city, when loads tend to be high—transit's costs are relatively low per passenger mile. But under other circumstances—particularly in off-peak periods and low-density areas—transit costs can far exceed those of other modes. This means that it is very important to specify *the context* when comparing average costs.
- On an average cost per passenger-mile basis, single-occupancy private vehicle use (SOV) is by far the most expensive mode *for morning peak period commuting in a dense city* (such as Boston).
- In that same context, high-occupancy private vehicle use (HOV),‡‡ is in total, approximately as expensive per passenger-mile as transit services, but with a different division of costs among users, governments, and society at large.
- For peak period travel in a dense environment, SOV has the highest external costs to society, both in the aggregate and as a percentage of the total, while transit has the lowest.
- However, the total costs not borne by the travelers themselves (that is, the net governmental cost plus the costs borne by society at large) are roughly the same for SOV and transit, albeit much higher as a percentage of the total for transit.

While recognizing that examining costs alone, without also examining travel benefits, provides a limited basis for policy prescription, the authors do suggest a number of policy implications of their analyses, including the following:

- The "most obvious" ways of reducing the overall costs of transportation are to promote reduced trip lengths—for example, by encouraging cluster development—or to reduce the inconvenience of such lower-cost modes as walking or bicycling.
- The promotion of increased vehicle occupancy—both in private vehicles and on transit—will also reduce the total travel costs per person-trip.
- Pricing mechanisms that increase the cost of SOV travel to the drivers—at least in peak periods—could help adjust their travel choices to reflect the relatively high external costs of those trips.

The primary virtues of the Apogee study are its recency and relative comprehensiveness, both in terms of characterizing the *main strands* of the relevant literature and in attempting, heroically, to quantify many of the more nebulous external costs. Without reviewing in detail the value judgments used to make the more arbitrary assessments, we would take issue with only one conceptual matter in the Apogee report. The authors regard free or subsidized parking provided by employers, retailers, or other nonusers as an external social cost. However, if the notion of cost is to be applied consistently, we would ascribe the cost of providing this benefit as falling on the providers of the parking directly, and indirectly on those firms' general base of customers or employees.

In the case of parking spaces constructed and owned by employers or retailers, the owners or lessees of this land clearly bear the opportunity costs of providing the spaces. Where employers or retailers only rent or lease spaces, they still must pay these costs. Although the employer or retailer is neither a user nor a government actor, this does not mean that the costs are *external* to the private vehicle users. Free or subsidized parking, like any other employ-

[2] Apogee Research, Inc., *The Costs of Transportation: Final Report*. Washington, DC, Conservation Law Foundation (1994).

‡‡ The authors state that their HOV mode was "defined as 2.5 passengers per vehicle." This implies that the category includes vehicles carrying two or more passengers, including (presumably) such services as private or commercial vanpools.

ment benefit, is part of an employee's total compensation package, and therefore, in a competitive market for labor, is implicitly given in lieu of additional direct compensation.[3] Similarly, a retailer will recoup the cost of providing parking spaces through higher prices, since the shopper implicitly makes a purchase decision based on all of the costs of the transaction (the direct cost of the item, time, convenience, and so on). That is, the retailer implicitly provides free parking in lieu of lower prices.

When viewed in this way, free or subsidized parking is not an external cost in the true sense, since the notion of externality implies the use of a resource without paying for it. To the extent that employees accept lower salary or fewer other benefits, and where shoppers forego lower prices for free parking, such privately provided parking can be considered a user cost paid *indirectly* by travelers.

Canadian Urban Transit Association

The CUTA report[4] was written by a graduate student in civil engineering at the University of Toronto, under the direction of Canadian Urban Transit Association staff. This project attempted to document, from existing sources, all of the costs of automobile travel in the urban setting during the peak period. It did not look at other transportation modes.

The study analyzed costs—in the Canadian context—in three categories in a similar manner to that used in the Conservation Law Foundation study. However, instead of making the explicit distinction between costs paid by the user and costs paid by governments or other nonusers (external costs), this report groups costs as "direct costs," "indirect costs," and "hidden costs." Direct costs were defined as actual out-of-pocket expenses paid by users, while indirect costs included government expenditures and costs absorbed by commercial organizations for the public. Finally, hidden costs were defined as those costs not directly paid by private vehicle users or associated with government expenditures on the transportation system, generally comprising accident, land-use-related, and environmental pollution costs.

Each of the cost components was identified and values were derived from the literature. Average values were computed to derive estimates of the total cost of automobile travel, and the share of this total constituted by each of the components and cost categories. Statistical measures were also used to indicate the reliability and the level of consensus among the available data sources. The report concludes that:

- Sixty-one percent of the estimated total cost is paid directly by the user,
- Twenty-four percent of the total is indirect cost,
- Fifteen percent is hidden cost, *and*
- Accidents, not pollution, constitute the largest share (43%) of the total hidden costs.

Our observations about this report again center on the cost accounting used to derive the estimates. We believe that the estimates are critically dependent on a number of conceptual errors. Specifically, we would argue that the apparent finding that only 61% of total costs are paid by the user is misleading for several reasons. First, nearly all of the indirect costs can arguably be attributed to users or to those who directly receive the benefits of those expenditures. The indirect costs identified in the calculations included free or subsidized parking, road construction and maintenance, road land value, and police, court, fire, and ambulance costs.

In line with our earlier discussion, free or subsidized parking could be considered to be paid indirectly by users. In the United States at least, the road construction and maintenance costs are paid by users through gasoline and other taxes, and at the local level "nonusers" also benefit from these expenditures since police, fire, and medical services, as well as commercial vehicles, school buses, and public transit all make use of the roadway infrastructure. The opportunity cost of the foregone value of the land consumed by roads is also paid by users and other beneficiaries in similar fashion. While it could be argued that the costs allocated to policing the roadways and administering the traffic court system are paid in part by nonusers, the costs used in the report do not subtract out the revenues collected from associated fines, and Au's estimate of the gross costs accounts for less than 10% of total indirect costs.

In addition, the report attributes 18% of total indirect costs to interest on the provincial debt resulting from purported large net subsidies to automobile manufacturers that are not made up by corporate tax revenues. These subsidies do not exist in the United States, but the report also does not recognize that the subsidies are presumably intended, at least in significant part, for societal purposes other than to reduce the user cost of automobile travel, and that the nonusers who bear these costs presumably also receive whatever other social benefits accrue from the subsidies (higher employment, for example).

If one accepts that most of these indirect costs are indeed paid by users or beneficiaries, therefore, the potentially uncompensated costs of the automobile would generally fall into the area of "hidden costs," which comprise only 15% of the total according to the study. However, the derivation of the 15% number itself deserves some consideration. *First*, the largest component of hidden cost is accidents, and only 20% of accident costs appear to be truly external. When the other 80% of accident costs are attributed to users, hidden cost drops to only 10%.

Secondly, nearly one-fourth of the hidden cost figure consists of an amount imputed to "urban sprawl." The assessment of the effects of urban sprawl has several problems. It partly comprises transportation costs associated with longer driving times, and these costs are already included in direct user costs or counted separately as pollution costs. And while, on an *individual* or *household* basis, there are many cross-subsidies in the provision of public services, at a *jurisdictional* level the additional costs associated with lower density land-use patterns are probably borne in large part by the people living in those communities.

In addition, studies that attempt to measure the cost of urban sprawl typically assume that it is by definition undesirable (an economic "bad") to live in a low-density area. The fact that roughly 65% of US residents live in places with populations under 50,000[5]

[3] The value of employee fringe benefits is not insignificant. Current government estimates place the average value of all employee benefits at nearly 29% of total compensation, or over 40% of total base pay. See U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1995*. Washington, DC, U.S. Government Printing Office (1995) Table 683.

[4] Au, J., *The Economic and Social Costs of Private Urban Transportation by Automobile*. Toronto, ON, Canadian Urban Transit Association (1994).

[5] U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States, 1993*, Washington, DC, U.S. Government Printing Office (1993) Table 36.

makes this assertion highly questionable. If the costs ascribed to urban sprawl are removed from hidden cost (since it is not unambiguously clear that it is an external cost at all), the hidden cost becomes 7%, and this still assumes that *all* pollution costs are external.

Finally, the largest component of the remaining external accident costs is "costs of human value," which is basically an estimate of pain and suffering costs. The methods for deriving such estimates are often highly suspect, and it is difficult to judge how much credence to place in the figures presented here.

In summary, by comparison with the more careful Conservation Law Foundation study, the CUTA report appears to have significantly less credibility to a US audience: the data are based on Canadian policies and experience; there appears to be a significant level of double counting; and we have serious problems with the conceptual basis for major components of the author's indirect and hidden cost categories.

Highway Users Federation

The report funded by the Highway Users Federation[6] was prepared by a former USDOT economist, primarily in response to two articles by Professor John Pucher (Rutgers University) on the external social and environmental costs of driving that appeared in the APTA weekly newspaper, *Passenger Transport*. While the rebuttal nature of this report may emphasize the fact that—like the two previously reviewed studies—it is clearly a piece motivated by the interests of the sponsoring organization, we have chosen to review it because the central issue with which it is concerned is the identification of the true external costs of private vehicle travel, and in particular, their relationship to public policy. In this regard, the discussion it provides is especially pertinent to the aims of this review.

In assessing the various types of costs at issue, the author of the HUF study chooses cost categories similar to the two studies described previously, but draws a distinction between costs created primarily by private vehicle use and those that largely result from other factors. The categories are as follows:

- Costs that are not external,
- External costs where automobiles or auto use are *not* central issues, *and*
- External costs where automobiles or auto use *are* central issues.

In order to respond directly to the Pucher articles in *Passenger Transport*, the author does not independently identify the full spectrum of costs associated with the automobile/highway system. Rather, he examines each of the costs identified by Pucher, grouping them into one of the above categories. The discussion centers, first, on providing theoretical justification for the categorization, and secondly on how the policy instruments advocated by Pucher would affect not only the costs in question, but also the *benefits* consumers receive from private vehicle travel. Beshers arrives at several general conclusions:

- Users and other direct beneficiaries pay for at least 99% of costs for construction, maintenance, and operation of roads in direct, use-related charges.
- Free parking in private lots is *not* a subsidy.
- There *are* external costs directly related to private vehicle use, but they are limited to air pollution, congestion, and developmental sprawl.
- The best policy responses to external costs are those that target the undesirable effects accurately (for example, place taxes on emissions, not fuel, to reduce emissions, and so on).

The conclusion that 99% of direct costs for highway infrastructure are paid directly by users is at odds with the figure of 60% that has gained some currency in recent media discussions on the subject. However, the two estimates are actually based on the same source, namely Table HF-10 in the annual FHWA *Highway Statistics* publication.[7] The Highway Users Federation report argues that there are revenues in the table that, although not clearly labeled as such, are actually paid directly by users. These include the portions of the federal gasoline tax used for deficit reduction, taxes designated for construction and maintenance of specific roads levied on the owners of the property served by those roads, and impact fees charged to developers and dedicated to pay for specific or general road improvements. Beshers also argues that only current resource costs for highways should be used in the calculation, and therefore subtracts out bond retirements and interest payments from the expenditures and excludes bond proceeds and interest receipts from total revenues.

While we are unable to confirm the exact nature of each of the cost figures described in the *Highway Statistics* table, we find Beshers persuasive with regard to the percentage of highway-related monetary costs recouped through user payments being much closer to 99% than it is to 60%. The gasoline taxes earmarked for deficit reduction are clearly paid only by users, and property taxes collected for specific roads are certainly paid by users and/or those who receive the benefits of private vehicle travel. Although it may not be as low as the report claims, the percentage of uncompensated direct costs of the automobile/highway system is probably small enough not to constitute a large "hidden subsidy."

The conclusion that free or employer- or retailer-provided parking is not a subsidy in the conventional sense follows the argument advanced earlier in this appendix, namely that employers and/or retailers bear this cost as a normal part of doing business (like any other cost) and are also able to pass it on (indirectly) to users. Moreover, it is argued, there is no evidence that this private parking is not being valued at market prices, precluding the notion of a true subsidy. The report makes the point that *publicly provided* parking may be a different story; where prices are set by local governments instead of by market forces, serious underpricing may occur.§§

While the report does point out that that there are significant external costs resulting from auto travel, it contends that Professor Pucher's policy prescriptions are inappropriate for reducing or eliminating many of these costs, and may even result in net reductions in social welfare. Specifically, Pucher advocates higher fuel taxes, parking charges, and congestion pricing. Beshers concedes that congestion pricing is indeed an appropriate means to internalize the external costs of congestion, but he points out fuel taxes and increased parking charges *indirectly* target private vehicle use, not

[6] Beshers, E., *External Costs of Automobile Travel and Appropriate Policy Responses*. Washington, DC, Highway Users Federation (1994).

[7] U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 1994*. Washington, DC, U.S. Government Printing Office (1995) Table HF-10.

§§ In Boston, for example, where residents are allowed to park for free in on-street spaces in very dense areas with high land values, and privately provided parking is tightly limited and expensive, in some neighborhoods demand is said to be two or three times higher than the number of available spaces.

the *direct* causes of external costs such as air pollution. In this way, such charges reduce the benefits of travel for those who do not necessarily contribute to the externalities, such as motorists in rural or high attainment areas or those who drive vehicles with lower emissions.

Aspen Institute/American Academy of Arts and Sciences

Beyond these three polar studies representing different stakeholder interests, there are a number of other relatively recent contributions to the debate about governmental policy as it impacts different transportation modes. One such report, written by a former Director and Executive Vice President of General Motors, presents the results of a project to study the need for a new approach to public policy in urban transportation.[8] Participants in the project included many prominent academics and scholars in relevant areas, with a panel of advisors drawn from government, industry, and special interest groups. The report reviews the conditions that have led to the current set of perceived problems with regard to private vehicle use, and proposes policies to mitigate those problems.

Unlike the other studies reviewed above, the purpose of this project was not to identify the totality of costs associated with driving, or to provide a precise accounting of the extent of each of these costs. The project sought rather to inform the debate about public policymaking by exploring the nature of externalities and inequities generated by the proliferation of the automobile over the century, and how best to approach these problems through public policy. For this reason, the results of the project are highly relevant to our current research, despite the lack of a rigorous accounting of costs or additional original research.

The main conclusions of the study combine general findings about sources of the problems associated with increased driving, and specific recommendations for policies that would best address these issues. The results represent a consensus of the diverse interests, expertise, and experience of panel participants and advisors as well as of the author:

- Strategies must be devised that signal the true social costs of driving.
  - Only 60 percent of the costs of auto travel are paid by the user.
  - Users receive additional subsidies for parking.
  - Users don't pay the external costs of accidents, air pollution, congestion, or dependence on foreign oil.
  - Funding of other functions such as police, courts, and emergency medical services is independent of use.
- Effective pricing policies must focus on existing vehicles (all vehicles), not just new ones:
  - Congestion pricing,
  - Equal tax treatment of commute modes,
  - Roadside detection of emissions to directly penalize high-polluting vehicles through registration fees, and
  - Federal energy policies, including an increase in fuel taxes.

The findings on the nature and extent of external or hidden costs of private vehicle travel are consistent with many of the widely held views mentioned previously, including the findings of some of the other studies reviewed here. This is to be expected, however, since the author relied on existing sources for this material. We would therefore make the same assessment of these findings, as discussed earlier, namely that the fraction of the direct costs paid by users is probably well above 60% (although it may well be less than 100%), the assertion that parking represents a hidden subsidy may be unfounded, but that air pollution impacts and congestion delays *do* represent significant costs of automobile travel that are not paid for entirely by the users.

The policy recommendations advocated in the report are generally consistent with the principle advocated by Beshers. Specifically, Johnson implicitly argues for policies that focus *directly* on the undesired costs or effects associated with private vehicle use, such as directly taxing the emissions generated by all vehicles as they are used, rather than simply increasing the standards for new vehicles, for example. However, the author also advocates measures that are meant to discourage private vehicle use generally, such as much higher fuel taxes. These measures may not be at odds with the targeting principle to the extent that the author views a *general reduction* in private vehicle travel as a desirable goal of public policy. This position is nevertheless motivated by concerns about the supply of natural resources and about environmental phenomena that are more matters of debate than universally accepted fact.

Transportation Research Board

The report, *Curbing Gridlock*,[9] is the result of a special TRB study on the need for, effects of, and feasibility of implementing road pricing in the United States. The project was conducted by a committee of experts appointed by the National Research Council and drawn from several relevant fields, including economics, political science, and transportation planning.

The report comprises two volumes, the first describes the current theory and experience with road pricing, as well as the technical and political issues associated with the design and implementation of such techniques and the methods for evaluating their success. The second volume is a compilation of the technical papers commissioned by the project committee. These papers cover a variety of topics—case studies, discussions of political and technological factors, and the ancillary effects of congestion pricing (such as emissions reductions and land-use patterns), for example—and they are meant to provide a broad, objective perspective on the subject from both academic and industry experts.

The report is not a study of the relative costs of the transportation modes *per se*, since it has the single focus on road pricing. However, to the extent that the road pricing and similar related techniques addressed by the committee are intended to remedy perceived inequities in the relative pricing of automobile travel, and to the extent that the research concentrates on the peak period commuting situation in metropolitan areas, the study is relevant to our current work. Specifically, it is thought that road pricing could be a key strategic tool in reducing the external and social costs of the automobile, while at the same time making more efficient use of the transportation infrastructure. The report identifies the following external costs of automobile travel:

[8] Johnson, E. W., *Avoiding the Collision of Cities and Cars: Urban Transportation Policy for the Twentyfirst Century*. Chicago, IL, American Academy of Arts & Sciences (1993).

[9] National Research Council, Transportation Research Board, "Curbing Gridlock: Peak Period Fees to Relieve Traffic Congestion." *TRB Special Report 242* (two volumes), Washington, DC, National Academy Press (1993).

- Air pollution,
- Noise,
- Accidents, and
- Congestion delays.

In addition, the committee asserts that there are "hidden subsidies" associated with the pricing of private vehicle travel. These "subsidies" are not external costs, but rather are factors that contribute to the underpricing of auto travel. This underpricing, it is argued, is the main cause of congestion. This argument is a straightforward extension of the basic economic principles of supply and demand—where the price is artificially lowered below the market price (at which supply and demand are in equilibrium), demand exceeds available supply (capacity), and congestion occurs.

Specifically, the hidden subsidies are said to be the result of the following conditions:

- User taxes purportedly account for only 80% of total direct costs at the federal level, and even less at the state and local levels.***
- Free or below-market parking provided by employers, retailers, and local governments is not paid for directly by users.

These propositions are by now familiar ones, similar to those we have already reviewed in the findings of the other studies. The proposition that the direct monetary costs of the highway system are not totally borne by the user is taken from other existing sources, including some of those described above. Also, it is important again to make the distinction between publicly and privately provided parking with regard to the magnitude of the parking "subsidy." That is, while it is clear that public parking spaces may well be priced significantly below market value in many metropolitan areas, the argument that private parking provided either by employers or retailers is priced at below market rates is much harder to sustain.

The report uses best available estimates to try to predict the possible effects of implementing congestion pricing in the United States. The committee finds that a modest charge for the use of the major roadways in the greater Los Angeles area would result in nontrivial reductions in total private vehicle travel and in trips made during the peak period, as well as tangible benefits to travelers in these corridors, such as reductions in travel time. The program would also result in emissions reductions, which although modest, would be greater than those achieved with many other methods.

Although these estimates cannot predict whether an optimal level of private vehicle travel could be achieved (no congestion), they do signal the direction of the change that would occur. That is, by making motorists pay more of the full costs of driving under congested conditions, traffic patterns would begin to move toward efficient levels.

The most important implication of the road pricing research, however, is that it confirms the assertion (made in the body of our report) that the most effective ways to modify travel behavior are those that target most directly the perceived costs users face (or perceive) when making their specific travel-related choices. Approaching the problem from the viewpoint of consumer choice and recognizing the relationship of costs to the decisions travelers make are the keys to achieving effective results. Decentralizing the incentives for travel choices allows individual preferences to bring about an efficient solution.

*** We found no detailed justification for this estimate in the report.

Other relevant source material

In its review of other relevant studies, the Conservation Law Foundation report provides a useful categorization:

- *User cost studies*, which estimate the direct costs associated with owning and operating a private vehicle or with using public transit;
- Highway *cost allocation studies*, which analyze government expenditures for highways, and who pays these costs;
- *Externality studies*, which provide evidence that can lead to estimates of the external costs of transportation; and
- *Total cost studies*, which attempt to provide an accounting of the total costs associated with transportation.

Estimates of user costs on a nationwide basis can be found in the USDOT publication, *Transportation Statistics*, and the *Transportation Energy Data Book*, a publication of the Oak Ridge National Laboratory. The American Automobile Manufacturers Association's annual *Facts and Figures* and the FHWA's *The Costs of Owning and Operating Automobiles, Vans, and Light Trucks* are both publications that provide estimates on a per-mile basis.

Cost allocation studies have been performed by the FHWA and by state governments. The FHWA's most comprehensive study, released in 1982, dealt with federal expenditures for road construction and maintenance, administration and planning, and related sales and excise tax revenues, as well as heavy truck sales and use.[10] Recent state studies have been completed by Pennsylvania, Indiana, and Maine, and a review of state practices for performing and updating the studies can be found in the AASHTO publication, *Highway Cost Allocation Study Report, 3rd Edition*, released in 1991.

Externality studies cover a wide range of topics, from accidents to noise pollution and land-use impacts. Detailed studies are therefore usually restricted to one of these topic areas. Accident costs have been examined for the FHWA by The Urban Institute,[11] and by the National Highway Traffic Safety Administration.[12] The most thorough studies of the extent and external costs of highway congestion have been conducted for the FHWA by Hanks and Lomax.[13]

Although the subject of free or discount-rate parking has been a matter of debate throughout this review, there are a number of studies that have helped identify the nature and extent of the underpriced parking problem. Perhaps the most definitive exposition of the subject can be found in Shoup and Pickrell's 1980 USDOT report *Free Parking as a Transportation Problem*. A more recent study of parking economics and policy has been prepared by Willson.[14]

What is not a matter of debate in the literature or in this document is that pollution represents a significant external cost of automobile travel. However, the subject of the costs of pollution is very complex, both because there are many different pollutants with

[10] U.S. Department of Transportation, Federal Highway Administration, *Final Report on the Federal Highway Cost Allocation Study.* Washington, DC, U.S. Government Printing Office (1982).

[11] The Urban Institute, *The Costs of Highway Crashes.* Washington, DC, U.S. Department of Transportation, Federal Highway Administration (1991).

[12] U.S. Department of Transportation, National Highway Traffic Safety Administration, *The Economic Cost of Motor Vehicle Crashes 1990.* Washington, DC, U.S. Government Printing Office (1992).

[13] Hanks, J. W. and Lomax, T. J., *Roadway Congestion in Major Urban Areas, 1982-1988.* College Station, TX, Texas Transportation Institute (1990).

Hanks, J. W. and Lomax, T. J., *1989 Roadway Congestion Estimates and Trends.* College Station, TX, Texas Transportation Institute (1991).

[14] Willson, R. W., *Suburban Parking Economics and Policy: Case Studies of Office Worksites in Southern California.* Monograph prepared for the Federal Transit Administration (1992).

many different effects (both human and environmental), and also because many of the costs associated with air pollution are notoriously hard to quantify and to allocate. For this reason, we refer the interested reader to the review of this literature developed in the Conservation Law Foundation report. This review includes studies that seek to appraise the effects of ground-level air pollution, global warming, acid rain, and reduced visibility, as well as noise and water pollution.

Finally, there is only limited relevant analysis of the potential external costs associated with land-use effects. There are a couple of studies that attempt to measure the opportunity cost of land used for roadway infrastructure, such as the recent work by Hanson.[15] In addition, a review of the limited number of studies on the effects of alternative development patterns has been compiled by the Urban Land Institute,[16] drawing particularly on the Real Estate Research Corporation's 20-year-old study of the costs of urban sprawl[17] that is currently being updated in TCRP project H-10.

Total cost studies have been much more numerous, although the most authoritative work is probably still the University of California at Berkeley study carried out in the mid-1970s.[18] A more recent review has been made by Hanson.[19]

SOME CONCLUSIONS, BOTH OBJECTIVE AND SUBJECTIVE

Attempts to quantify modal costs

In our attempt to derive some general conclusions about the gradient of the urban transportation playing field, we will start first from where we will subsequently argue is the *wrong* place—at the various attempts to quantify the total social costs associated with each mode, described in the preceding section of the appendix.

It is impossible to avoid value judgments

According to Bismarck, the making of sausages and legislation are two manufacturing processes that one should not witness firsthand. In a similar vein, one should not grapple with the minutiae of modal cost studies until fully disabused of any expectation that it is technically possible to carry them out in a fully objective manner.

For here there are common costs that need to be allocated. Economic theory can inform that process, but it has relatively little to say when it comes to making judgments about which of several possible approaches is the "most fair." Here again there is causality to be ascribed, when scientific evidence and econometric analysis provide only very limited insights into (for example) how incremental exhaust emissions in Miami affect the health of the residents there. And here too there are hypothetical base cases to be devised, representing hypotheses about what sort of costs might be avoided or incurred under different circumstances. It is no wonder that there are almost as many quantitative estimates of the social costs of private vehicle use as there are analysts who have looked at the issue.

The costs appear to be very sensitive to the travel context

Of the several studies we have reviewed here, we found the one undertaken by Apogee Research for the Conservation Law Foundation to be the most informative and persuasive, for several reasons.††† Importantly, the analysis was not limited to only global aggregate data, but sought to exemplify a few specific types of trips in a couple of different environments. It showed that the variations in per-passenger-mile costs ascribable to trip *context* are at least as great as the variations between *modes*. For a prototypical high-density suburb-to-downtown trip in the morning peak, the drive-alone option has clearly much greater social costs than any transit alternatives. But for low-density off-peak travel, the total costs of the transit modes, *at typical current load factors*, were found to be at least twice as large as those of drive-alone. These findings should raise questions about the meaningfulness and value of some of the more global estimates of these costs.

Are there direct net government costs of the highway system?

In other words, do governments *subsidize* highways (as distinct from acting as treasurer and disburser of user revenues)? The answer appears to be "yes," but the payments related to the highway system that exceed the revenues from users are probably fairly small by comparison with the total monetary costs of the system. The variations in findings on this point appear mostly to hinge on conceptual issues and value judgments about several potentially troublesome components of the revenues and costs to be counted. Should we count sales tax revenues if they are imposed generally over all goods? How about debt service? What allocations should be made of expenditures that may have a broader base of beneficiaries than just highway users?

The Conservation Law Foundation study found net governmental expenditures on highways that were most pronounced for peak-period drive-alone travelers on non-expressway facilities. They were judged to be much lower for off-peak travel in low-density areas. For a prototypical suburb-to-CBD commute, the appraised net governmental cost was estimated to be roughly 5 to 10 percent of the total monetary costs. On this basis, we doubt the less-well-substantiated claims that highway users pay only 60 percent to 80 percent of the direct costs of providing the system.

Are there external costs associated with the highway system that are borne by society at large?

All parties appear to agree that there are, and that the environmental and accident-related costs (at least) may be quite significant. Estimating their magnitude provides plenty of opportunities for

[15] Hanson, M. E., "Automobile Subsidies and Land Use: Estimates and Policy Responses." *Journal of the American Planning Association*, Vol. 58 (1992) pp. 60–71.

[16] Frank, J. E., *The Costs of Alternative Development Patterns: A Review of the Literature.* Washington, DC, Urban Land Institute (1989).

[17] Real Estate Research Corporation, *The Costs of Urban Sprawl: Environmental and Economic Costs of Alternative Development Patterns at the Urban Fringe.* Washington, DC, U.S. Government Printing Office (1974).

[18] Keeler, T. E., et al., *The Full Costs of Urban Transport, Part III: Automobile Costs and Final Intermodal Comparisons.* Berkeley, CA, University of California, Institute for Urban and Regional Development (1975).

[19] Hanson, M. E., *Results of Literature Survey and Summary of Findings: The Nature and Magnitude of Social Costs of Urban Roadway Use.* Monograph prepared for the Federal Highway Administration (1992).

††† Not least among them is the authors' frequent caveats about the limitations of their prototypical examples, their data, and their methods.

arbitrary judgment, however, and hence plenty of scope for disagreement. There is also ample disagreement over the relevance and magnitude of other possible social costs, the most contentious being those ascribed to land-use impacts, the depletion of natural resources, and private parking that is not priced directly. We ourselves are persuaded that to count unpriced private parking is not valid *given the purposes of these types of studies* (although as we shall subsequently aver, unpriced parking is very relevant to mode choice decisions).

Do the nonuser costs of private vehicle travel exceed those of transit?

Possibly, but it isn't clear that they do. The Apogee report suggests that, in the peak-period suburb-to-CBD case, the nonuser costs per passenger-mile are lowest for private HOV use, and roughly equal between drive-alone and transit. While the net governmental subsidy to SOV is much smaller than the subsidy to the transit rider, the increased external cost redresses the balance.

In the less-dense off-peak example, however, the nonuser costs of a transit mile greatly exceed those of the highway-based submodes.

Do these cost studies have any relevance to the public policy debate?

Probably not much, in our opinion—or at least they *shouldn't* be given much weight. First the amount of consensus is small, and isn't likely to increase significantly with further information and analysis. It is intrinsic to the nature of the decisions that have to be made in these studies, and to the vested interests of the parties funding them. Secondly, differentials in the *total* (or *average*) social costs of modes are relevant to only one type of broad judgment. In *aggregate*, is society's relative investment in the modes in line with the country's objectives concerning efficiency and equity? While the motive may be a good one—that is, after all, a reasonable question to ask—the cost accounting-type studies provide a very blunt instrument with which to form any sensible policy judgments. They consider costs without considering benefits, they are only marginally relevant to how many people want to travel, and (as we have seen) there's a lot of noise in their message. Counting the dollars ascribable to the nation's highway system appears to be very similar, in both challenge and value, to counting the angels on the head of a pin.

Mode choice decisions and public policy

It seems much more sensible, in our opinion, to refocus attention on *the mode choice decision*, and on how public policies may directly or indirectly influence that.‡‡‡ When a person is deciding how to make a desired trip, she is not considering average social costs, or even average user costs. Oversimplifying, she is considering the *marginal perceived* costs, where travel *time* considerations usually play an important role in the costs that are perceived. That cost may well be influenced by other decisions in the choice hierarchy, as we describe in Chapter 3, but to make any difference to which modes people choose to use, the most direct instrument that governments have available is the ability to manipulate the short-run marginal perceived costs.

In this context, unpriced parking (whether privately or publicly owned) definitely *is* relevant. More generally, to the extent that the perceived social costs of private vehicle use in specific contexts provides a basis for governments that wish to influence market share, there is much greater leverage from increasing automobile prices (or travel times) than there is in decreasing transit prices (or travel times). Thus, we concur with the policy prescriptions of the majority of analysts:

- The most powerful lever to influence mode choice, in the travel contexts where governments have a justifiable reason to do so, is to raise the price of private vehicle use.
- The nature of the price increase should be targeted as specifically as possible on the reason for the intervention. Thus, congestion can be managed through congestion-sensitive prices, air pollution through emissions taxes, and so on.
- Current income taxation policies may continue to create an incentive to automobile use, to the extent that employers are gearing commute subsidy policies to the amounts that are tax-free to employees. This is the most obvious example of a government policy that affects short-run perceived marginal costs in a way that is inconsistent with the tenor of the ISTEA/CAAA legislation.

‡‡‡ Of course, such a marketplace-based approach would be rejected as unhelpful by those who believe that there has been a market failure in urban transportation, only addressable by bold government regulatory or financial actions beyond those indicated by any signals coming from the marketplace.

APPENDIX D

WHAT HAS RESEARCH INTO CONSUMER TRAVEL DECISIONS SHOWN?

EVIDENCE FROM EARLY ATTITUDINAL SURVEYS

While most of the quantitative relationships developed to help forecast travel behavior and to plan transportation investment and operating policies are derived from the analysis of existing behavior, a richer insight into underlying traveler motivations can be gained from attitudinal research. In particular, much attitudinal work was done in the latter half of the 1960s, largely as an outgrowth of the federal government's then fascination with potential major investments in technologically new systems of urban public transportation.

Some key studies were carried out by a team of researchers at the University of Maryland,[1] by John Lansing and his co-workers at the University of Michigan,[2] by Chilton Research and National Analysts in a national NCHRP-sponsored survey,[3] by Russell Ackoff at the University of Pennsylvania,[4] and by Abt Associates.[5] Most of these studies were concerned primarily with local (urban) travel.

Synthesizers of this work observed many general similarities among the findings.[6] First, people frequently say that *travel time*-related factors are very important to them in making their travel decisions. Significantly, this includes not only the *amount* of travel time (or the average travel speed) but also the *reliability* of the time. Reliability considerations consistently figured highly whenever questions were asked about this aspect.

Safety aspects are also always rated highly when they are explicitly included in attitudinal surveys. However, people often do not perceive much difference between their available travel options with regard to safety—typically all of the choices meet the threshold level beneath which safety might be a significant concern—so that the expressed strong interest in safety doesn't have much practical effect in influencing the marginal travel decisions.

Personal comfort and convenience aspects also receive strong endorsement. Different researchers have used these terms to include somewhat different concepts, but it is clear that people rate highly such considerations as not needing to transfer between vehicles, having control over departure times, and having adequate personal space and privacy.

Typically, despite often vocal opposition to increases in highway tolls and transit fares, the *out-of-pocket costs* associated with travel decisions usually appear well down the rankings of factors. Here the opinion survey evidence is consistent with the behavioral evidence. As we observe in Chapter 4, transportation price elasticities are low, and the trends are often towards options that imply higher travel costs.

The University of Maryland studies, carried out among Baltimore and Philadelphia residents, are particularly interesting because they used 33 different attitudinal statements to characterize various choice attributes. The authors observe that, while they found absolute differences among their importance ratings by trip purpose, the relative **ranking** of factors was similar for all trip purposes:

1. "Reliability of destination achievement (probably reflecting both safety and time consideration);
2. Convenience and comfort (with emphasis on flexibility and ease of departure);
3. Travel time (but considerable difference depending on trip purpose);
4. Cost;
5. Independence of control (reflecting individual autonomy in determining speed, routes, diversions, etc., during the trip);
6. Traffic and congestion (probably reflecting annoyance and perhaps safety);
7. Social (reflecting concern about who is being, or capable of being, traveled with);
8. Age of vehicle (perhaps indicative of a status dimension); and
9. Diversions (with some understatement of the importance of the scenery attribute)."

As one might expect, the more qualitative or abstract the attitudinal concept, the more sensitive are the findings to the particular context and wording of the survey. Examples include such considerations as "status," "self-esteem," and "social contact." These concepts were felt to play some potentially important role in (for example) commuting mode choice—at least in the 1960s, when racial distinctions and tensions were much in the public consciousness in the major cities—but attitude survey responses suggested that such aspects were well down the list in the importance rankings of major influencing factors.

The NCHRP national survey of the travel attitudes and behavior of approximately 5,000 people produced rankings of attitudinal factors that were very similar to those found in the earlier University of Maryland surveys. Here are the seven highest attitudinal measures, when ranked by the proportions of respondents rating them "of great importance" in connection with any trip purpose:

- Feel confident the vehicle will get you to destination without accident 48%
- Feel confident vehicle would not need to be stopped for repairs 45%
- To feel independent of anyone else for your transportation 41%
- To not have to change vehicles 38%

[1] Brunner, G. A., Hille, S. J., Nash, A. N. and Paine, F. T., *Consumer Conceived Attributes of Transportation: An Attitude Study*. College Park, MD, University of Maryland Department of Business Administration (1966).

Paine, F.T., Nash, A. N., Hille, S. J. and Brunner, G. A., *User Determined Attributes of Ideal Transportation Systems*. College Park, MD, University of Maryland Department of Business Administration (1967).

[2] Lansing, J. B., and Barth, N., *Residential Location and Urban Mobility*. Ann Arbor, MI, University of Michigan Institute for Social Research (1964).

[3] McMillan, R. K. and Assael, H., *National Survey of Transportation Attitudes and Behavior*, National Cooperative Highway Research Program reports 49 & 82. Washington, DC, National Research Council Highway Research Board (1968, 1969).

[4] Ackoff, R., *Individual Preferences for Various Means of Transportation*, prepared in connection with NCHRP project 8-3. Philadelphia, PA, University of Pennsylvania Management Science Center, Wharton School of Finance & Commerce (1965).

[5] Abt Associates, Inc., *Qualitative Aspects of Urban Personal Travel Demand, a Report of the US Department of Housing & Urban Development's Study in New Systems of Urban Transportation*. Cambridge, MA, Abt Associates, Inc. (1968).

[6] Hartgen, D. T. and Tanner, G. H., "Individual Attitudes and Family Activities: A Behavioral Model of Mode Choice." *High Speed Ground Transportation Journal*, Vol. 4, No. 2 (1970).

Hartgen, D. T. and Tanner, G. H., *Mode Choice and Attitudes: A Literature Review*, Preliminary Research Report 21. Albany, NY, New York State Department of Transportation (1970).

• To be protected from weather while waiting for a ride	37%
• To travel in an uncrowded vehicle	32%
• To have a comfortable vehicle	31%

The one surprise in the NCHRP survey results was that the statement "To make the trip as fast as possible" was thought to be "of great importance" by only 17% of the sample, thereby ranking travel time considerations significantly lower than found in other attitude surveys. This was thought to be due, at least in part, to a higher proportion of private vehicle users in the sample than for other surveys, and these people's speed expectations may have been satisfied for many of their trips.

This last finding highlights a problem with many of the attitudinal studies. The findings on the importance of influencing factors on travel are inversely related to the current level of satisfaction with that attribute.

The analysts of the 1960s attitudinal surveys also examined which characteristics of the travelers and of their trips were associated with the most important variations in the expressed attitudes. The *purpose* of the trip was an obvious candidate, because it reflects the varying values that people are likely to derive from their activities at the destination. Nevertheless, at least as far as the relative *rankings* of choice attributes were concerned, trip purpose didn't seem to have much effect.

The most important differences noted were that travelers making work-related trips expressed a slightly greater interest in travel time and speed, whereas for non-work trips "comfort" and "convenience" considerations increase somewhat in importance.

The University of Pennsylvania study, concerned (like many of the other studies) primarily with **modal** choice decisions, provides the most marked example of this tendency:

". . . it was found that, for work and school trips, 33% of the sample felt they were primarily sensitive to time, 23% felt they were primarily sensitive to comfort, 15% to cost, and 15% to convenience. For other trips, 37% felt they were primarily sensitive to comfort, 23% to convenience, 11% to cost, and only 12% to time."

The only other trip descriptor that appeared to have some influence on attitudes is trip *length*. Not surprisingly, the longer the trip, the more people are interested in comfort and convenience aspects, particularly if they are traveling by common carrier.

As for variations in attitudes by the demographic and socioeconomic characteristics of travelers, the most important personal characteristics appear to be the obviously associated factors of *income level* and *education*. In most (but not all) studies, the *cost* associated with travel options increased in importance as income and education declined. But there were some more subtle effects, too, as the University of Maryland work found:

"(Reliability) is most important to respondents on the 'to work' trip. . . . Its importance increases to those (a) with lower incomes, (b) with full-time jobs, (c) who are non-whites, (d) who are employed and middle-aged, and (e) who are non-owners of homes and automobiles."

EVIDENCE FROM REVEALED PREFERENCE STUDIES

The main features of the attitudinal survey findings are supported by *behavioral* evidence at several different levels, ranging from superficial observation through to painstaking statistical analyses—both time series and cross-sectional—of detailed information about travel patterns.

A good example is the low importance of out-of-pocket costs as an influence on travel choices, relative to travel time and reliability considerations. At the anecdotal level, one has only to observe the high level of taxicab ridership and revenues nationally, relative to those of rail transit, or the relative growth of private vehicle commuting in dense metropolitan areas. In 1990, over 70% of all US workers living in urbanized areas drove *alone* to work each day by private vehicle. Many have a transit alternative that would be considerably cheaper for them if money cost were their major consideration. Most people are clearly telling us by their behavior that, at least under present economic conditions, they are prepared to pay for *quality* transportation service.[7]

Time series analysis of local travel purchases by consumers—be they of gasoline, turnpike tolls, or transit rides—generally shows that the aggregate demand is quite inelastic with respect to prices. There are sometimes specific market segments that reveal a higher-than-average price sensitivity—even, in a few rare cases, sufficiently elastic that revenues can be increased by *lowering* prices—but for the overriding majority of travelers and trips, price increases have only a limited impact on their travel behavior. And this finding is not restricted to the price levels typical of current North American experience. In other developed countries, where fuel taxation policies usually make travel significantly more expensive relative to income levels and other prices, behavior is equally price-inelastic.

Many of the same analyses of time series data have shown a greater sensitivity of demand to changes in average travel times and other service quality variations. However, at the aggregate level, and over time, these differences may be relatively rare and difficult to measure. A much richer vein of quantitative analysis is derived from investigating the effects of *cross-sectional* variations in travel conditions. For example, analysts have studied how people's choices of mode, route, or parking facility vary with the prices and the perceived service characteristics of the various alternatives open to them.

One convenient way to summarize key findings from analyses of this type is to express the travelers' values for marginal adjustments in various service attributes in terms of the magnitude of the price change that would have an equivalent effect. For instance, analysts often infer an average monetary value for travel time savings. Comparable valuations can be made for other service attributes—reliability, comfort, convenience, and so on—insofar as these attributes can be quantified and their individual influence on travel choices can be identified.

EVIDENCE FROM MORE SOPHISTICATED STATED PREFERENCE TECHNIQUES

Survey research techniques have progressed significantly since the early attitudinal studies carried out in the late 1960s. In particular, the 1970s saw the development of so-called *tradeoff survey* methods, in which respondents are asked to indicate their preferences among a set of hypothetical alternative choices, each one described in terms of several of its key attributes.* A tradeoff survey basically simulates a marketplace choice. It essentially says to the respondent, "*If, under certain specified conditions, you were*

[7] Kemp, M. A. and Cheslow, M. D., "Transportation." Gorham, W. and Glazer, N. (eds.), *The Urban Predicament*, Washington, DC, The Urban Institute (1976).

* The original and best-known tradeoff method is called *conjoint measurement*, which uses a variant of the analysis of variance to estimate each respondent's utility function. Since the late 1970s, tradeoff survey data have also been analyzed using similar *discrete choice models* to those originally developed to analyze observed (revealed preference) travel choices.

presented with each of these different alternatives, which combination of attributes would you most prefer? Which next?" If the choices have been designed carefully to maximize the learning potential, multivariate analysis methods can then be used to infer the respondents' underlying preference structure.

Such methods are likely to be less vulnerable to the response biases that make stated preference methods more suspect than revealed preference evidence. The "art" lies in designing questionnaires that provide a realistic simulation of a real life decision, while not overtaxing the typical respondent's interest, patience, or information-handling capabilities.

Tradeoff methods are most useful when they can extend understanding into areas that cannot be addressed by behavioral evidence, while anchoring the analysis by reference to behavioral aspects that are already well understood. In a travel choice context, travel times and costs are such strong influences that they must be included in any realistic tradeoff exercise. The fact that the expressed preferences with regard to these "traditional" attributes typically conform to the well-established "rules of thumb" (about, say, elasticities or the valuation of travel time savings) helps to validate the tradeoff method. But one can also include attributes (or attribute values) that are *not* found in the marketplace today, or attributes that may not be well quantified in behavioral datasets, or attributes that in real life are so highly correlated that their individual influence cannot be clearly identified.

For example, in previous stated preference tradeoff surveys, Charles River Associates has included such variables as

- Schedule reliability (or the probability of arriving at the destination within *x* minutes of the target arrival time);
- Amenity aspects of existing travel choices (such as traveling in a new or refurbished car on the New York subway, or using a renovated station);
- Personal security considerations;
- Technologically advanced modes (for example, high speed rail or maglev peoplemover); and
- Amenity aspects for intercity common carrier modes (such as seating density, carry-on luggage arrangements, and cabin arrangements tailored to business travelers).

Some of these CRA studies are summarized in the table in Appendix E.

The relative importance of many of these variables has proved (not surprisingly) to be quite sensitive to the context, and to vary with the nature of both the trip and the traveler in ways that conform to common-sense expectations. For example, in our studies conducted to date, the highest values for marginal improvements in *reliability* have been observed among people making ground access trips to New York area airports, who are very concerned that they catch their flights (that is, the cost of missing their flights is very high). In other studies, reliability is a relatively important consideration for both intercity travelers and New York subway users, with (in both cases) a greater value for work-related trips than for personal trips.

APPENDIX E

REVIEW OF QUALITY OF SERVICE STUDIES

This appendix summarizes several studies that we have examined for evidence about the effects of changes in *quality of service* variables on public transit ridership. The following pages tabulate the studies we have reviewed. The table lists first the category of the factor studied, then the source of the study, and finally any elasticity information available in the paper along with a brief synopsis of why the paper is relevant.

Factor affecting mode choice	Source	Elasticity information
Level and quality of service	Charles River Associates, *Comprehensive Line Improvement Study*. Final Report prepared for the Metropolitan Transportation Authority, New York (1994).	This report describes the results of an analysis performed by CRA of the New York City Transit Authority's Comprehensive Line Improvement Project for the "A" subway line, carried out in 1992. This project involved a series of service improvements to the "A" subway line in the areas of reliability, station and subway car amenities, customer information, employee recognition, and personal security, and was accompanied by a marketing campaign. The study evaluated whether subway services improvements have a positive effect on travelers' perceptions, identified links between service performance measures and customer perceptions, and assessed the potential impacts of services improvements on subway ridership by quantifying the relative importance riders attach to improvements. The results show that changes in riders' perceptions do properly reflect changes in the subway level of service. However, there were discrepancies between travelers' perceptions of subway service quality and the NYCTA's measures. It was thought that changes in the definition of the quality of service attributes and the data collection and measurement techniques used by the NYCTA would significantly improve the usefulness of these data. Models were developed to estimate traveler valuations of service improvements. These results showed that the most effective ways of increasing ridership are to reduce the number of homeless people in stations or cars by 30 percent, rehabilitate existing subway stations, increase police presence by 30 percent, and improve subway on-time reliability. However, even the highest potential improvements were shown to only provide estimated ridership increases of less than 1 percent. The model results including estimated coefficients and willingness-to-pay values for each of the improvements are provided.
Reliability of transit service	Charles River Associates, *Projected Ridership on an Automated Guideway Transit (AGT) System Linking John F. Kennedy International and LaGuardia Airports to the New York Regional Transportation Network*. Final Report prepared for the Port Authority of New York and New Jersey (1995).	This report provides ridership projections for a peoplemover system linking the New York airports with Manhattan. Although this is not a study of the effects of quality of service factors, *per se*, service reliability is one of the key factors used in the ridership analysis (due to the high level of variability in airport access travel times in the New York City region). Models were estimated for a number of market segments using tradeoff analysis methods, and estimates of the implied value of service reliability were developed. Several specifications of variables to measure service reliability were tested. The estimates of the value of reliability are generally very high -- delay time is valued at about ten times linehaul time on average, the ratio ranging from a high of about 23 to 1 for travelers currently using taxi or being driven by car and dropped off at the airport, to a low of 3 to 1 for those currently using transit to access the airport. Estimated coefficients and values of service reliability for each access mode and trip purpose for both departing passengers and airport employees are also provided.

Factor affecting mode choice	Source	Elasticity information
Improved services and amenities	Charles River Associates, *Setting a Ridership Goal for New York City's Subways.* Final Report prepared for the Metropolitan Transportation Authority, New York (1987).	This report evaluates the ridership impact of major capital improvements in the New York City subway system. Survey research using tradeoff analysis techniques is used to estimate ridership increases based on the main elements or results of the improvements, namely an increase in the number of trips using new or substantially overhauled cars from 32% to 100%, the modernization of a number of subway stations (such that the number of trips beginning or ending in a modernized station would increase from 3% to about 27%), and the resulting reduction in delays and travel times brought about by the use of newer and more reliable equipment. Ridership gains attributable only to the service and amenity improvements are estimated to be in the range of 5% to 7.5%. Elasticities are not provided, but estimates of willingness-to-pay for each improvement are provided for peak period riders, off-peak riders, and non-riders. Willingness-to-pay is highest for the new or refurbished subway cars, followed by reductions in car crowding, modernized stations, and reductions in delays. A series of sensitivity analyses is also provided.
Crime	Plano, S. L. , "Transit-Generated Crime: Perception Versus Reality—A Sociogeographic Study of Neighborhoods Adjacent to Section B of Baltimore Metro." *Transportation Research Record,* No. 1402, (1993) pp. 59–62.	Discusses potential increase in crime at suburban metro stops. Paper compares the perceptions of crime and dangerous areas within ridership groups (urban vs. suburban), and compares the perceptions against the actual crime levels as reported by the police. Results are inconclusive, and no elasticity estimates are given.
Fear of crime	Ingalls, G. L., Hartgen, D. T., and Owens, T. W., "Public Fear of Crime and Its Role in Bus Transit Use." *Transportation Research Record,* No. 1433 (1994) pp. 201–211.	Discusses the differences in the perception of crime between transit riders and the general population of Greensboro, North Carolina. The authors are part of the same study reported on in Benjamin, et al (1994). A survey of both residents and riders suggests that ridership could be improved by addressing safety issues. However, the problems associated with transit use were soft crimes such as public drunkenness, panhandling, and the use of obscene language, and were probably associated more with walking in the downtown areas that transit serves rather than with the transit system itself. Therefore, the authors suggest that basic service improvements coupled with improved information provision could dispel some of the negative safety *perceptions* associated with transit. No quantitative elasticity estimates given.
Perception of crime	Benjamin, J. M., Hartgen, D. T., Owens, T. W., and Hardiman, M. L., "Perception and Incidence of Crime on Public Transit in Small Systems in the Southeast." *Transportation Research Record,* No. 1433 (1994) pp. 195–200.	Discusses the difference between the perception of crime and the reality of crime in and around the transit system in Greensboro, North Carolina. The authors are part of the same study reported on in Ingalls, et al (1994). This paper demonstrates that crime as recorded in police reports indicates that the transit system should be perceived as safe, and yet residents, riders, and drivers reported problems, and non-users stated that they felt that the system was unsafe. The recommendations to counteract this perception (and possibly improve transit ridership), are to create transit environments that provide the *perception* of safety; to conduct a public relations campaign to educate people about the safety of transit; and to convince people to use the system and experience its safety first hand. No quantitative elasticity estimates given.

Factor affecting mode choice	Source	Elasticity information
On-Time / quality of service	Strathman, J. G. and Hopper, J. R., "Empirical Analysis of Bus Transit On-Time Performance." *Transportation Research A*, Vol. 27A, No. 2 (1993) pp. 93–100.	Discusses factors that affect bus on-time performance. Eleven of twelve hypothesized factors influencing on-time performance were found to be significant at the 0.05 level. These were: Boardings and Alightings since the previous time point; the Position of the Sampled Time Point in the sequence of time points on a route; a Weekday dummy; an AM Peak Inbound dummy; a PM Peak Outbound dummy; a Part Time Driver dummy; the Distance from the previous time point; the scheduled Headway, both linear and quadratic terms; and a dummy New indicating if the observation occurred in the first two weeks after a new schedule change. The number of Service Stops made since the previous time point was not significant, being highly correlated with distance and passenger activity variables. Not all results were intuitive, and page 98 of the paper should be consulted for the results. Unreliable service (poor on-time performance) increases transit customers' out-of-vehicle waiting time. This paper does not discuss how on-time performance influences ridership, nor do the authors recommend an appropriate level of on-time performance, pointing out that an appropriate level can be determined through an economic analysis of the costs and benefits of improving on-time performance.
Travel time / quality of service	Shalaby, A. S. and Soberman, R. M., "Effect of With-Flow Bus Lanes on Bus Travel Times." *Transportation Research Record,* No. 1433 (1994) pp. 24–30.	Discusses the impact of with-flow bus lanes on bus performance, including ridership improvements during AM, PM, and midday periods. The paper discusses the fact that although ridership improved within the corridor, the increase is not solely due to a decrease in total travel time. The authors show that although running time along the corridor generally decreases, dwell times at the stops generally increase due to increased passenger volumes. The authors suggest that the attractiveness of transit in the corridor increased due to the perception of improved service, both in the entire corridor and within previously congested segments. The authors have specific recommendations about how to maximize the actual impact of with-flow bus lanes, based on their segment-by-segment analysis. The paper quotes another study that recorded a 25% ridership increase in the corridor. This study recorded ridership increases in the direction of am and pm peak flows, and a 45% ridership increase in both directions during the midday period. These gains cannot be converted into elasticity estimates for the reasons discussed above.
Level of service	DeGraw, R., "Regional Rail: The Philadelphia Story." *Transportation Research Record,* No. 1433 (1994) pp. 107–112.	Discusses the history of Philadelphia commuter rail. Lots of anecdotal references to reasons why ridership has declined, but no hard data given. Also some discussion of plans to improve ridership, including potential conversion of some lines to light rail service, which would be cheaper to operate, which in turn would enable more frequent operation, possibly leading to more ridership.
Public policy / level of service	Lyons, W. M., Weiner, E. and Shadle, P. "Comparative Evaluation of Performance of International Light Rail Systems." *Transportation Research Record,* No. 1433 (1994) pp. 115–122.	Discusses the differences in performance characteristics for light rail systems in six different countries. Provides some insight into how local and national political goals influence light rail development and performance. Some discussion of ridership gains, in connection with policy reasons for implementation of light rail system. In San Diego, 45% of trolley users previously traveled by car. In Nantes, France, 17% of LRT riders previously traveled by car. In Grenoble, France, 12% of LRT riders were new to public transit. In Nieuwegein, the Netherlands, 8% of LRT users were former auto drivers. In Bern, Switzerland, auto traffic on the Bernstrasse has declined since 1985. Other statistics in the paper relate to comparative statistics between efficiency and effectiveness between countries.

Factor affecting mode choice	Source	Elasticity information
Public policy / level & quality of service	Boyle, D. K., "Jitney Enforcement Strategies in New York City." *Transportation Research Record,* No. 1433 (1994) pp. 177–184.	The paper discusses instances of enforcement in New York, and relates the associated ridership gains over time, and increases in services designed to compete with the jitneys. Since this is only applicable in New York and Dade County, refer to pages 180 and 181 for details. Unfortunately, this paper is pro-traditional-transit, anti-jitney. The ridership increases, etc., that are reported are for the New York bus system at the expense of jitney ridership. No numbers are given for jitney ridership. There is an interesting anecdotal observation that jitney services are prevalent in New York and Dade County, Florida—both areas with relatively large immigrant populations from the West Indies, where jitney services are common. These people seem to provide an initial customer base for jitney services, although the article states that once established, jitneys draw riders from all ethnicities. Although it is not emphasized, this article also indicates that jitneys provide an effective, competitive stimulus for cooperation between transit unions and management. The more riders jitneys siphon off, the more both transit management and unions lose, through losses in revenue.
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K., "Employer-Provided Transportation Benefits, Public Transit, and Commuter Vanpools: A Cautionary Note." *Transportation Research Record,* No. 1433 (1994) pp. 152–158.	This paper examines the impact of implementation of employer subsidies to vanpools and carpools upon public transit ridership. Using Stated Preference techniques, the authors asked employees of the Technical Center of the PANY/NJ in Hoboken, N.J., to complete 16 hypothetical choice tasks representing realistic future commute options. The results show that there is a latent demand for vanpools and carpools. Since almost 80% of those surveyed use transit often, the growth of vanpools and carpools would come at the expense of current transit users. The following table describes some marginal rates of substitution revealed by the survey.

Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between vanpool subsidy and a $1.00 transit subsidy	$0.83 vanpool / $1.00 transit
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between transit subsidy and a 1 minute commute time savings by carpool	$0.10 transit subsidy / 1 min. saved
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between transit subsidy and a 1 minute commute time savings by vanpool	$0.09 transit subsidy / 1 min. saved
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between a transfer and the transit subsidy (carpool users)	$2.02 / transfer ($ transfer penalty)
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between a transfer and the transit subsidy (vanpool users)	$0.91 / transfer ($ transfer penalty)
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between the necessity to transfer and the additional time spent on public transit (carpool users)	19.7 minutes / transfer (time transfer penalty)
Transit subsidy	Beaton, W. P., Meghdir, H., and Murty, K. (1994)	MRS between the necessity to transfer and the additional time spent on public transit (vanpool users)	10.5 minutes / transfer (time transfer penalty)

Factor affecting mode choice	Source	Elasticity information
Elasticities	Chan, Y., and Ou, F. L., "A Tabulation of Demand Elasticities for Urban Travel Forecasting." The Pennsylvania Transportation Institute, Penn State University, August 1977.	As stated in the title, this is a tabulation of elasticities literature through 1977. The report lays out elasticity estimates and the bases for those estimates, and attempts to classify the elasticities according to 4 types of cities: large vs. medium, and core-concentrated vs. multinucleated. The tables are not reproduced here.
Elasticities	Pucher and Rothenberg (no other information)	One page sheet entitled "Table 2, Summary Table of Travel Demand Elasticities from Direct Demand Models."
Elasticities	Charles River Associates, *Estimation of Energy Impacts of State Transportation Improvement Program Projects.* Prepared for the California Energy Commission (1982) pp. 30–36.	Ranges of work and non-work travel demand elasticities for urban travel compiled from sources dated 1976, 1974, 1980, and 1976; and ranges of business and non-business travel demand elasticities for rural / intercity travel compiled from sources dated 1976, 1977, 1976, and 1963.
Parking charges impact on mode choice	Surber, M., Shoup, D., and Wachs, M., "Effects of Ending Employer-Paid Parking for Solo Drivers." *Transportation Research Record,* No. 957 (1984) pp. 67–71.	Paper primarily discusses the impact of a gradual elimination of the parking subsidy for solo drivers upon the mode split for a Commuter Transportation Services company in LA (a private, non-profit firm that promotes ridesharing in the Los Angeles area). Carpools continued to receive a parking subsidy worth $57.50 per month, and transit users received a free bus pass valued at $20 per month (down from $34 per month at the start of the study). The results show a large drop in solo driving (from 42% to 8%) and a slight decline in bus ridership (from 38% to 28%). No explicit elasticity estimates (own or cross) were given.
Paratransit routing	Javid, Massoud, et al. "Application of Geographic Information Systems in Planning Transit Services for People with Disabilities." *Transportation Research Record,* No. 1429 (1994) pp. 40–48.	This paper discusses the use of a GIS system to optimally allocate resources to serve disabled people who require paratransit services in the city of Logan and Cache County, Utah. The algorithms developed are based on excluding either areas or roads (links) as inaccessible, and group together like destinations from disparate origins to minimize the number of vehicles that are needed to serve the population. No estimates of elasticities. This paper describes a strategy for improving ridership.
Attract and retain riders by direct mail advertisements to new residents	Pederson Ambruso, C. "Cost-Effectiveness of Direct Mail Marketing to New Residents." *Transportation Research Record,* No. 1402 (1993) pp. 43–50.	This paper describes a survey that examined the effectiveness of direct mail marketing to new residents. The Tri-County Metropolitan Transportation District of Oregon (Tri-Met) has been mailing promotional packets to new residents since 1989. As of 1992, Tri-Met mails out 5,000 packets per month. Each packet has a mailback card for 10 free transit tickets. The average response rate to the promotion is 32%, of which 8.6% are new riders or riders retained at the same or higher level. The survey effort followed a panel of respondents from February 1991 through December 1991 to determine the retention rate of the new riders. The survey revealed that one year after the initial mailing, 64% of the new riders continued to use transit for an average of 21 trips per month. The survey also found that the respondents generally paid via the most economical method available for their ridership level, with the exception of the poorest income categories (who traveled more than 32 times per month but did not purchase monthly passes). Given this rate of attrition and usage, the payback period for the cost of the mailing is about 2 months.

Factor affecting mode choice	Source	Elasticity information
Marketing theory applied to transit promotion	Everett, P. B. and Ozanne, L. K., "Marketing Theory and Urban Transportation Policy." *Transportation Research Record,* No. 1402 (1993) pp. 51–56.	This paper describes how three theoretical marketing perspectives might apply to urban transportation policy. The paper presents its information as applying to all TDM measures, but most of the examples are drawn from mass transit. The three marketing areas discussed are: 1. Services marketing; 2. Cultural perspectives on consumption; and 3. Reinforcement theory. The services marketing section presents transportation as a service that consumers purchase. As a service, it is intrinsically intangible, but it has tangible manifestations such as an automobile, a train seat, or a waiting area. The section discusses how to market this intangible service through promotion of the tangible aspects. The cultural perspectives section is a bit esoteric. It describes how purchased goods have cultural meaning, and how these goods satisfy both a need for the consumer to communicate intangible information about herself, and a need for the consumer to realize personal goals and ambitions. An ideal transportation mode is a Porsche or a stretch limousine, travel modes which serve transportation needs and also confer status and prestige upon the user, as well as communicate that person's financial and spatial freedom to others. In contrast, public transit use, while it satisfies the transportation need, confers upon the user the image of being poor or of lower class, and the published schedules and routes are the antithesis of freedom of movement. Finally, the reinforcement section discusses punishments and rewards that are inherent to our transportation system. This section provides a twist to the well-known economic notions of incentives and disincentives. Transportation rewards and punishments are analyzed from a psychological perspective, and the author points out that in our transportation system, the immediate rewards are primarily conferred upon auto users. Furthermore, the punishments for using the auto are delayed temporally, whereas the rewards for using other modes are delayed while their abundant punishments are immediate.

Factor affecting mode choice	Source	Elasticity information
Simultaneous supply and demand equations	Kemp, M. A., *A Simultaneous Equations Analysis of Route Demand and Supply, and Its Application to the San Diego Bus System.* Washington, DC, The Urban Institute, December 1981, 117 pages.	This report discusses the development of a simultaneous equations model describing the supply of bus service and the demand for those services in San Diego, California, based on operating data from January, 1972 through April, 1975. The simultaneous equations model describes the relationships between three types of factors: user demand (patronage), service quality (performance), and transit supply level. Three equations are used to specify the demand (patronage), two equations characterize the performance of the system, and two equations characterize the level of transit supply. Demand is represented by non-transferring passengers and transferring passengers. Service quality is represented by average bus speed. Service supply is represented by seat miles operated and average headway. The passenger elasticities implied by the estimated model are as follows: The fare elasticity of non-transferring patrons was -0.31 (p. 75) The fare elasticity of originating patrons was -0.29 (p. 75) The fare elasticity for transfer patrons was -0.22 (p. 76) The fare elasticity for the total volume of patrons was -0.27 (p. 76) The elasticity of the average headway with respect to the total ridership was -0.16 Other elasticites are presented in the paper, such as the elasticities of quality of service variables with respect to service supply variables.

APPENDIX F

SUMMARY FINDINGS OF THE INITIAL SEARCH FOR RECENT EXAMPLES OF STRATEGIES

TABLE 32 Service expansion and improvement strategies

Service Expansions and Improvements									
Agency/ location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal /liability issues	Costs	Jurisdictional issues
Metro Toronto	Service integration	Small marginal results	No mention	No mention	No mention	No mention	No mention	No mention	Coordination with other transit properties.
GO Transit	Service coordination and other improve-ments	Variable. Initiatives are evaluated and the ones that have a positive impact on ridership, efficiency are kept.	No explicit mention of time frames, except Bike on Rail introduced in 1993, with summer usage at 80 bikes per day.	No mention; expect to vary with program (disabled accessibility is mandated by Province, etc.).	Varies with programs	Varies with program. Disabled full accessibility is probably hardest to implement.	No mention; depends upon nature of the initiative.	No mention	Depends on nature of initiative. Coordination and integration with other agencies will have jurisdictional issues.
San Francisco Bay Area	Fare integration	Focus groups after introduction indicated significant interest in integrated fare media, and extreme satisfaction with the trial fare integration system.	No mention	Not an issue	Not an issue	Difficult. The more transit operators there are, the more difficult it is to settle on a uniform system that suits everybody's needs. Furthermore, there is a reluctance to select a system that is incompatible with the (old) BART fare card readers.	Unclear. Formulae for sharing fares between operators may be difficult.	No mention	MTC managed the project, and will head expansions of the program to other operators. However, by definition of the concept of fare integration, this is a definite problem area.
GTA Transit Federation	Weekly pass	No mention	Demonstration project since August 1994; review Aug. 1995. Also, common fare medium or smart card is being studied, but no action on this yet.	No mention	No mention	No mention. Seems to be difficult, due to revenue sharing, jurisdictional issues. Distribution limited to terminals to control revenue and determine revenue-sharing formula.	No mention	No mention. MTO paying for follow-up survey. MTO paying some cost subsidy.	Difficult to properly share revenue between affected agencies; determine MTO subsidy level; correct price of pass.
GO Transit	Fare integrations and other fare initiatives	Variable. Initiatives are evaluated and the ones that have a positive impact on ridership, efficiency are kept.	Variable. 6 months too short, 2 years long enough to evaluate whether a program is useful.	No mention	No fare increase in the last two years is intended to make the system more equitable. Most fare initiatives have no equity issues.	Depends on initiative. Some are simple (no fare increase), others are more difficult (integrated fare media, smart cards).	Depends on initiative. Fare coordination may have issues.	No mention; variable with initiative.	Variable with initiative. Fare integration is the area most likely to have issues.
Ann Arbor TA	Smart fare card system	No results to date. Project is still in the implementation phase.	18-month implementation period.	Strong push to have the system in place is coming from the University of Michigan, esp. the medical center. The University is the largest employer in Ann Arbor, and has a lot of clout.	Project should benefit all travelers in the Ann Arbor area, since the system will have adaptive signals, parking lots that take the smart cards, etc.	The project was awarded to a German firm, who then failed to meet the requirements of the contract, and so lost it. The AATA reevaluated the project, decided it was both feasible and desirable, and put it back out to bid.	Aside from canceling a contract, none mentioned.	The original contract was $1.9M for 18 months. The new contract is for similar terms. The funding source is an ISTEA grant.	Coordination with the Univ. of Michigan bus system, with area parking lots, and with area employers (including the U of M) is needed to make smart card useful, more economical. Coordination with traffic engineers also required.

(*continued on next page*)

TABLE 32 (*continued*)

Service Expansions and Improvements									
Agency/ location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal /liability issues	Costs	Jurisdictional issues
Los Angeles	Metrolink commuter rail	Start-up system Currently has about 18K patrons per day. About 2/3 formerly SOV.	2.5 years of operation, 75 trains on 5 lines. No mention of estimated maturity timeframe.	Due to terrible air quality and congestion, alternatives to auto are generally supported in LA. Heavy marketing after Northridge quake of 1993 highlighted need for auto alternatives.	Commuter rail serves suburban commuters traveling to downtown areas. Reverse commute not well-served, not patronized.	Program has tried to minimize capital outlay, with ROW and track leased from freight RR. Still, very difficult to implement a project of this magnitude. Not feasible elsewhere without strong support.	Negotiations with freight RRs to secure ROW difficult legal hurdle.	Total costs not specified, but very large. Funding came entirely from local sources.	Metrolink operated by Southern California Regional Rail Authority, formed through a joint powers agreement among 5 counties. SCRRA operates service, freight RRs own much of the right of way, and counties own capital equipment and right of way within their borders.
Metro Toronto	Rapid transit expansion	No sensitivity. Induced ridership.	No mention	No mention	No mention	No mention	No mention	No mention	No mention
Tidewater Regional Transit	Timed transfer system	No quantitative impact of timed transfer system on ridership. Steady ridership growth has been observed for each of the past 4 years, which is anecdotally ascribed to the timed transfer system.	Two year implementation required to develop 18 timed transfer points and reroute every bus accordingly. Ridership improvements were immediate and have continued for each of the past 4 years of operation.	Not an issue	Not an issue	Internally difficult to implement, due to incredulity, difficult scheduling job. One-time cost for AVL technology and route changes. No external barriers to implementation, since system is so logical.	Not an issue	Up-front cost for capital improvements, marketing and public awareness, but these were termed relatively minor in comparison to efficiency and time savings improvements.	None reported to date. Coordination with traffic engineers necessary if auto traffic begins to degrade transit service, impact timed transfers.
Beaver County TA	Quality of Service Measures program	11 months of steady ridership growth, exactly coinciding with the QSM program, but anecdotal causality.	Project implemented March 1994. Ridership began increasing almost immediately, and has continued to do so.	Not an issue	Not an issue	Project implemented by requiring the transit service contractor to observe criteria on safety, timeliness, and comfort, with financial penalties and rewards. Buses have AVLs attached to ensure on-time compliance.	None mentioned	There are costs for AVL system, and for initial market research to determine what factors the customers feel are important. Also some operational costs for incentives paid to encourage meeting goals.	None mentioned
Metro North Railroad	Fordham reverse commute service	Increase of 148% since late 80s in reverse commute volumes (Bronx to Westchester). Fordham is now the second busiest station, passing 125th St. station.	No mention of time frame. Service considered a success within 5 years.	Not politically sensitive	Service is beneficial to anyone taking a reverse commute from the Bronx.	There were several minor implementation barriers, including stopping outbound express in Fordham, and opening up a ticket office at the station.	None mentioned	Costs not mentioned. Overall, due to the tremendous increase in reverse commute ridership, the program is considered profitable.	Some problems coordinating feeder services with TA, but implementing the reverse commute service does not have any inherent jurisdictional problems.
Southern California	Regional HOV lane experience	General agreement that HOV lanes lead to considerable AVR increases for the facilities on which the lanes are implemented. Possible that HOV lanes and carpools are competition for parallel transit services.	HOV lanes in LA since 1974.	Not possible to trade a general-purpose lane for an HOV lane. In 1976, clashes between Caltrans and LA government, combined with public outcry, ended the only such experiment. Adding lanes is acceptable, provided funding is approved. New experiments with tolls for SOVs in HOV lanes (HOT) are unproven.	Not an issue for HOV. HOT lanes (HOV free, SOV tolled) may raise rich/poor equity issues. Possibility that carpools on HOV lanes take away potential transit patrons.	Relatively easy to restripe existing facilities to add HOV lanes, when there is space available. Political mistakes eliminated the possibility of taking away general-purpose lanes, which leaves expensive capital improvements as the only option once the existing roadway has been fully utilized.	No longer an issue for HOV. HOT lanes required authorizing legislation from state government.	No mention. However, part of the reason HOT lanes are being proposed is the expense of adding lanes as opposed to taking existing general-purpose lanes or restriping existing freeway.	Freeways are under Caltrans' jurisdiction, surface streets under local traffic department jurisdiction, which leads to conflicts when freeway volume spills onto surface streets due to construction projects, metered on-ramps, etc.

TABLE 32 (*continued*)

Service Expansions and Improvements									
Agency/ location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal /liability issues	Costs	Jurisdictional issues
Houston	HOV and park and ride experience	Metro ridership has grown at 20% to 30% over past 15 years. Transit ridership on HOV lanes up by 345% and 153%. 40% to 45% of HOV lane users previously SOV. Throughput of freeways increased from 1.8K to 2.0K persons per hour per lane to 3.5K to 4.7K persons per hour per lane.	Contra flow lanes in 1979, grade-separated HOV lanes since 1984. Lanes converted from bus/van only to all HOV due to significant underutilization of capacity. No mention of time scale of HOV use maturity.	No mention, but HOV lanes are generally acceptable. Considerable resistance to alternatives such as light rail and commuter rail.	No mention	Radial freeway system with heavy peak congestion, with employment and activities concentrated in a few areas, combine to facilitate the implementation of HOV lanes and park and ride services.	None mentioned	Not mentioned. Funding from TxDOT, Metro, FTA, FHWA.	Not mentioned
Metro Toronto	HOV lanes	Small marginal increase in ridership within range of error.	Time series measurement may be required to assess performance	No mention	No mention	No mention	No mention	No mention	No mention
Los Angeles	Downtown and community circulator services	MTA operated service at a loss with low ridership at 6-10 minute headways until 1985. LADOT operates at 20-30 minute headways with 20 to 30 boardings per hr, with cheaper operating cost than MTA.	Immediately upon transferring service to LADOT, system was able to cut overhead costs ($20 vs. $36) and improve reliability.	Not an issue	Not an issue	A similar transferring of circulator responsibility (from MTA to LADOT) may not be possible in other metro areas.	Not mentioned	LADOT keeps fare to $0.25 per ride in an effort to boost ridership. The service is supported through local transit funds. However, the service operates more efficiently than comparable MTA services ($20 to $40 per bus hour vs. $100 per bus hour).	The LADOT must operate within the jurisdiction of the MTA, and under the MTA's authorization for transit services, which is a unique position for two government agencies to be in.
Potomac-Rappa-hannock TA, Woodbridge, VA	Feeder bus system to the Virginia Railway Express	Total ridership numbers have not yet been collected. Example: feeder service carries 50 trips per day to a single VRE station, which has a full, 300-space parking lot. Service often carries more passengers in the evening than in the morning, due to informal carpools, kiss-and-ride.	Benefits to VRE are immediate, due to increased numbers of passengers who take train.	Service was requested and is funded by the VRE, which sees a benefit from the service in increasing the numbers of riders on the train service, and will continue paying for the service as long as this is true. Thus political support not necessary.	Service only serves VRE customers (commuters).	No real barriers to implementation, aside from coordinating schedules with VRE trains, and advertising service to VRE customers.	No mention	Service supported largely by a $0.25 per customer subsidy for passengers transferring for free from the VRE. Other customers pay $0.25 per ride, which covers most costs. Any other costs are covered by the PRTA, which is funded by Prince William County.	No mention
Metro North Railroad	Hudson Rail Link feeder service	Adding the bus service increased ridership at the station by 55%. Follow-up surveys on Rail Link riders showed that half were new to rail, and of these, 50% came from auto, 40% came from private express bus, and 10% came from TA. Considered an enormous success, being copied.	No mention of time frame before being considered a success. Service has been in operation for 4 years.	Politically, there are no problems.	The service focuses on the moderately affluent area of Riverdale.	The project faced skepticism within Metro North, since they were not previously in the bus business. The project was "studied to death," but since its success, similar projects within Metro North will not face the same resistance.	Not discussed	The bus service charges a very modest fee, and is essentially given away as a loss leader to get people to take the train. The train fares collected from the new patrons generated a net profit for the service.	Not discussed. There may be conflicts in other metro areas if a commuter rail wants to provide circulator service within the jurisdiction of another transit agency.

(*continued on next page*)

TABLE 32 (*continued*)

Service Expansions and Improvements									
Agency/ location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal /liability issues	Costs	Jurisdictional issues
Denver RTD	Privatization experience	No mention	1988 state bill requiring 20% of transit services to be privatized. No significant cost savings to date.	No mention	Not an issue	No mention	No mention	No cost savings have been recorded to date. RTD is working on a revised cost allocation model, which may demonstrate some cost savings.	No mention
MTA (New York)	"A" line service improve-ments	Actual benefits unknown, but modeled results show less than 1% increase in ridership.	Not known	No apparent problems since totally within agency.	Depends on which line is improved, etc. Obviously affects homeless people in stations/cars.	No real barriers to implementation except possible operational issues with improving ontime performance.	None that we are aware of.	We don't know the actual cost of this project, but cost will depend on number and extent of station/car amenity improvements and number and type of additional personnel required.	Shouldn't be any because entire program is within the agency.

TABLE 33 Strategies involving improved information to customers

Information to Customers									
Agency/ Location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal and liability issues	Costs	Jurisdictional issues
Minneapolis-St. Paul, MN	Travel Link project in the West Corridor (I–394)	New program, no results to date. Mode share impact may not be estimable, due to a simultaneous cut-back of transit service in the corridor.	The project is a pilot, and will be evaluated after December 1995. The agency is completely sold on the benefits of having an AVL system to track its bus fleet in the corridor real time, and is working on ways to outfit its entire 1000+ bus fleet.	Major technological investment required for this project. Politically, there are many partners pushing the project — highway, transit, and private interests. Some opposition along the lines of why pay $6.5M for questionable technology instead of more buses.	Project serves only those people living within the corridor. At a later stage, may be expanded to the entire city.	The project was implemented on the West Corridor because it had a new highway and therefore would require the least incremental expenditure to implement the system. Due to the huge cost, this project is not feasible w/o federal assistance.	None mentioned	The transit portion of the Travel Link project has a $6.5M price tag, funded 60% federal, 15% local, and 25% private. Until the pilot phase is complete, there is no way to make any judgment on the cost-effectiveness of the project.	The project crosses many jurisdictional boundaries. Federal, state, and local government are all involved, including both the FHWA and the FTA, as well as private sector firms. Locally there's a lot of cooperation — a necessary element in securing federal funding.
Potomac-Rappa-hannock TA, Woodbridge, VA	Real-time flex route system	Implementation scheduled for April 1995.	Unknown	Agency operates in a low-density suburban area, and therefore is almost expected to experiment with these types of service innovations to serve its community.	No mention. Service is an expansion of existing paratransit operations.	All hardware is in place, but the system has not yet been tested. Buses to be used are the 24-seat VRE feeder buses that sit idle in off-peak hours.	No mention	No mention of costs. The source of funding is Prince William County, which is spending both allocated state funds and general funds on transit services.	No mention
Bellevue, WA	Real-time information demonstra-tion	The trial project recorded one ride match between 50 participating persons in a 6-month period.	6-month, small-scale trial period. Full project still in development stage.	No mention	Participants in the program were pre-cleared to enhance security. In a full-scale program, this might become a major stumbling block.	Demonstration proved technically feasible. There were technical difficulties, such as the alpha-pagers only being able to store three potential ride matches at a time. Many problems that may be due to the small scale and scope of the project. Participants were doubtful of the ability of the system to guarantee a ride when needed (ride home).	Not discussed. One would expect thorny liability and legal problems to arise for the agency that coordinates the potential ride matches. On the other side, there is a potential for discrimination lawsuits to be raised if the coordinating agency tries to enforce its screening criteria too rigorously.	No mention of the cost. Funded as a TMA demonstration project under the ISTEA.	Not an issue for demonstration. Might be an issue for a larger implementation.
Winston-Salem, NC	Paratransit/ Rideshare/ Fixed route service coordination	Ridership not discussed. Program "pays for itself," with fares covering most of the costs of the program. 60 vans are used for vanpools and ride-matching services are provided.	Paratransit services offered since 1978. Ridesharing services are new, with regional implementation starting in Jan. 1995.	Not an issue. Strong support from Winston-Salem, area employers, and temporary help agencies.	Not an issue	Local demonstration in Winston-Salem and surrounding areas very successful, proved the concept. Expansion to the Triad (Winston-Salem, Greensboro, and High Point) just implemented, no information on regional feasibility.	None mentioned	Cost not mentioned. Vanpool program purported to pay for itself. Strong support in city government cited (aware of the need, supports program financially).	Fixed route services can only be offered within the city limits of Winston-Salem. Other services can serve outlying areas. This program links and augments fixed route services with flexible services.

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TABLE 33 (*continued*)

Information to Customers									
Agency/ Location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal and liability issues	Costs	Jurisdictional issues
Winston-Salem, NC	Mobility Manager	No results to date	Phase 1, year of technology testing. Phase 2, full implementation (1996). No maturity time scale mentioned.	No mention	No mention. Initial implementation (Phase 1) constrained to paratransit services only.	Technically very difficult, but not beyond current technology. Phase 1 is designed to test the feasibility of the project.	None mentioned	Cost not mentioned. Funding for Phase 1 (secured) is coming from FTA, North Carolina DOT, Winston-Salem.	Fixed route services can only be offered within the city limits of Winston-Salem. Other services can serve outlying areas. Mobility Manager is designed to circumvent these restrictions and provide coordinated transit service to the entire area.
Rogue Valley	Mobility manager	No estimate to date	No mention of timing. A two-phase implementation plan is being used.	Not an issue. The project conceptually should streamline the provision of transportation services through the elimination of administrative overhead, and therefore should not be politically sensitive.	The first phase focuses on services to special-needs customers. The second phase extends the program.	Challenge to keep the separate transportation providers involved in the project.	None mentioned	No information	Project organized by the Rogue Valley Council of Governments. Beyond planning and coordinating the project, the RVCOG has worked hard to keep the separate agencies involved.

TABLE 34 Marketing and promotion-related strategies

Marketing and Promotion									
Agency/ Location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal and liability issues	Costs	Jurisdictional issues
King County Metro	Employer pass program (Flexpass)	Flexpass has caused ridership shifts at firms from 38% to 350%. The similar U-Pass has increased transit ridership at the University by 40%.	Flexpass in effect since 1991.	Pass programs take advantage of political push to reduce SOV trips to work.	Flexpass and U-Pass only offered to specific groups of people.	No significant barriers. Marketing plan and other benefits of Flexpass beyond transit travel are important, need to be developed.	No mention	Cost of program not mentioned. U-Pass costs users $9 per quarter. Flexpass is purchased by employers based on number of transit users at the firm, but all employees are offered the pass.	Not an issue
Portland Tri-Met	"Fareless Square" program	Not well-documented, no clear measurement of this program's contribution to mode shift. Estimated that 4K to 5K passengers ride (free) in the Fareless Square, compared to 2K to 3K in the late 70s. Downtown area has the same number of autos entering each day as late 70s, despite doubling of downtown employment.	Fareless Square begun in 1975. Implemented along with a number of other programs such as parking restrictions (ca. 1972), dedicated downtown transit mall (ca. 1972), light rail system (1986), urban growth controls.	Strong support from downtown businesses.	Not an issue	Strong business support and general strong environment for transit in Portland have facilitated implementation.	No mention	Funded out of Tri-Met general operating funds, which are supported by a 0.61% payroll tax within the city of Portland.	Not an issue (Fareless Square within city limits).
VIA, San Antonio, TX	Rider Programs Division	No direct ridership impact measurable. Out of 150K daily passengers and 4K telephone inquiries per day, only 16 inquiries per week ask for service changes.	Rider Programs Division has been in operation for 4 years under Customer Service, with 2 years prior under Operations. There is a definite but unspecified time lag to the programs' impact.	Public outreach is not politically sensitive.	Not an issue	Somewhat difficult for a transit property to implement an effective customer outreach program. The culture at VIA is to "look good and be good" to its customers. Not every agency will have an easy time adopting this.	Not an issue	Not mentioned. Also, no direct estimate of the effectiveness of the Rider Programs Division, and so no way to determine quantitatively if the program is cost-effective. The anecdotal evidence supports the program.	Not an issue
GO Transit	Customer Oriented Program	No mention	No mention	No mention; assume there are no political problems with customer service initiatives.	No mention: assume not an issue.	True customer service orientation requires a change in internal culture. 4 programs are grouped in this Program, which may help agency change	No mention; assume none.	No mention	Not an issue
Minneapolis-St. Paul, MN	Frequent Rider Program	Demonstration project on 5 lines. Preliminary results are that the program did not entice periodic users into more frequent use.	The demonstration project took place in Autumn 1994.	This is not a politically sensitive issue. Frequent riders appreciate the recognition.	Rewards given to frequent bus users. No real equity issues.	Local vendors were solicited for rewards and sponsorship, and frequent riders were given awards. Program marketed only on the 5 demonstration lines.	None mentioned	Costs kept to a minimum through soliciting private-sector sponsorship. Advertising and administrative expenses. Program may not pay for itself, since it may not induce any new trips.	None
GTA transit federation	Integrated service map	No mention	No mention	No mention. Assume none.	No mention	Need to find a sponsor to contribute to the cost of producing, updating, distributing map.	No mention	Looking for a sponsor to help pay for map.	No mention

TABLE 35 Public policy-related strategies

Public Policy									
Agency/ Location	Program	Effectiveness of mode shift	Time frame and duration to achieve benefits	Political acceptability	Equity	Implementation feasibility	Legal and liability issues	Costs	Jurisdictional issues
Metro Toronto	Land Use	Very effective	No mention; assume far horizon for any new initiative	No mention; depends upon local history, politics	No mention	No mention; assume it depends upon local history, politics; assume quite difficult to implement at first, with decreasing difficulty.	No mention; depends on local situation.	No mention; no direct costs to transit agencies.	Strong regional or supraregional government required to properly enforce transit-oriented growth patterns.
California	Rule 1501 (formerly called Regulation 15)	Transit use rose slightly from 3.9% to 4.4% of trips. AVR increased from 1.21 to 1.26 (year 1) to 1.30 (year 2). Solo commuters dropped from 75% to 65%.	Reg. 15 was implemented on July 1, 1988. Requirements phased in gradually, so that by 1990, firms with more than 100 employees were required to comply.	Strong opposition from businesses, increasing with the phase-in of requirements.	Rule 1501 currently only impacts firms with more than 100 employees.	Program goals accepted by the public (clean air, less congestion) but program methods are difficult to implement, and of questionable effectiveness.	Not an issue	The average cost of compliance for a sample of 106 employers is $31 per employee per year. Some case studies suggest costs of $4 to $25 per day per employee diverted from SOV. Costs borne by employers, and so vary widely from firm to firm. Despite complaints about costs, 92% of employers affected by Rule 1501 still offer free parking as a benefit.	Rule 1501 affects only those firms within the South Coast Air Quality Management District, which was set up with broad powers to reduce air pollution in the LA area. Jurisdiction not an issue.
San Diego	Congestion pricing demonstra-tion	No information	In planning stages. Approximately two-year implementation plan.	Legislation authorizing the state to price selected public facilities passed into law by California state government.	Unused capacity of peak direction in the 2 HOV lanes to be used by paying SOV users, so long as the lanes remain at LOS B or better, so as not to degrade quality of facility for HOVs. Also a requirement to enhance HOV and transit service options in the corridor to get funding from FHWA.	Difficult to pass through the funding process, since the FHWA honors the sanctity of HOV lanes.	Authorizing legislation needed in California before public facilities can be priced.	Cost not specified. Planning funded by FTA since 1992. Project funding also approved by FHWA.	Not an issue. Facility lies entirely within San Diego County.

APPENDIX G

METRO-NORTH RAILROAD: THE *HUDSON RAIL LINK*

INTRODUCTION

This case study examines the feeder bus service implemented by the MTA Metro-North Railroad to serve its Riverdale and Spuyten Duyvil stations on the Hudson Line. In the context of the overall services provided by MNR, the *Hudson Rail Link* (HRL) has had a small impact on ridership and service. However, the service has improved ridership in the area, generated a net operating profit, and improved the usage of train capacity on that commuter line.

Feeder bus services are nothing new to the transit community, and this case study does not approach the *Hudson Rail Link* service as a one-of-a-kind example of a feeder service. Rather, this case study focuses on the ridership and revenue success experienced by the *Hudson Rail Link*. As a feeder bus service, it has exceeded most criteria for success. Not only does the bus service improve the ridership on the MNR commuter trains; it has also been judged to generate incremental revenues in excess of its attributed costs.

Given this success, the case study examines the implementation of the *Hudson Rail Link* service, in order to identify the factors that contributed to its admirable cash flow position and positive ridership impact for Metro-North Railroad. This chapter first describes the scope of MNR's services and describes how the *Hudson Rail Link* fits into the overall picture. The bulk of the chapter is devoted to a description of the processes involved in implementing the *Hudson Rail Link*. Finally, the chapter closes with a summary of the factors that led to the *Hudson Rail Link*'s success, and recommendations about the applicability of the HRL concept to other transit agencies.

BACKGROUND OF THE METRO-NORTH RAILROAD

The MTA Metro-North Railroad provides daily commuter service to New York City from the boroughs and suburbs north of Manhattan. New York City and northeastern New Jersey combine to form a contiguous urbanized area of over 2,900 square miles with a resident population of more than 16 million people. According to the 1993 National Transit Database, MNR's service area covers 527 square miles and contains nearly 4.5 million people, as shown in Table 36. The railroad's annual operating budget in 1993 was $431 million. It operates 696 trains in peak service, on 535 miles of railroad. The average daily ridership on all of the lines in 1993 was over 200,000 trips per day. In short, Metro-North Railroad is a very large operation in one of the world's largest urban areas.

Despite its size, Metro-North is still pursuing new riders through service innovations. This case study focuses on the *Hudson Rail Link*, a feeder bus system that serves the communities of Riverdale and Spuyten Duyvil, located in the Bronx, north of Manhattan. Figure 4 shows the location of Riverdale and Spuyten Duyvil in relation to Manhattan. Metro-North trains primarily serve daily commuters to and from Manhattan, via Grand Central Terminal, and so the feeder system mainly serves the Manhattan commuter market.

The communities of Spuyten Duyvil and Riverdale are relatively affluent, well educated, and densely populated. Table 37 depicts the population, income, and education levels of the census tracts that make up the two communities. This table was developed from 1990 Census data, using the tracts that roughly conformed to the service area for the *Hudson Rail Link* routes.

The communities of Spuyten Duyvil and Riverdale are located in a hilly area bordering the Hudson River. The Metro-North railroad tracks run along the river (as can be seen from Figures 6 and 7), and are difficult to reach by conventional bus due to the tight turns and steep climbs that are required. The steep climbs also restrict walking to and from the rail stations for all but the most able-bodied commuters. Finally, although many of the residents in this suburb may have access to a car, parking space at both stations is extremely limited, restricting park-and-ride commuters.

HRL SERVICE DESCRIPTION

The basic idea of the *Hudson Rail Link* service is provided by the description in Figure 5, excerpted from a recent service schedule. The service consists of five separate peak period routes serving two Metro-North Railroad stations. During the peak ridership periods, Routes A, B, and D serve Riverdale station, and Routes J and K serve Spuyten Duyvil station. During the off-peak, Routes A, B, and D in Riverdale are combined into a single route, Route C, and Routes J and K in Spuyten Duyvil are combined into Route L.

The *Hudson Rail Link* charges a fare of $1.50 per one-way trip during the peak periods, and $0.75 during the off-peak periods. Discounts include a weekly HRL commutation pass for $6.00 and a monthly uniticket to Manhattan, combining bus and rail travel, for $129.00. The latter compares with a rail-only monthly pass for $108.00.

The trip into Manhattan from Riverdale, via the *Hudson Rail Link*, takes about 45 minutes. The buses are scheduled to arrive at the train station five minutes before the scheduled arrival time of the train. This minimizes the transfer time between the bus and the train, which in turn reduces the end-to-end travel time.

Riverdale routes

The Riverdale service (Figure 6) begins at 5:45 AM, to meet the 6:02 AM train bound for Manhattan, and ends after dropping off the passengers from the 11:47 PM train outbound from Manhattan.

Riverdale service began in October 1992 with two routes; the third Riverdale route was added in January 1996 in response to requests of users of the service. Route A makes two stops on Riverdale Avenue, running from West 263 Street to West 254 Street. Route A makes a third stop at West 254 Street, before traveling to the Riverdale station. The scheduled time for the trip to the station is eight minutes.

Route B starts at Arlington Avenue and West 259 Street, turns down Riverdale Avenue, and makes two more stops before turning onto West 254 Street and heading into the Riverdale station. Route B is scheduled to take seven minutes.

TABLE 36 MTA Metro-North Railroad service characteristics, 1993

Service area (sq. miles)	527
Service area population	4,484,000
Annual passenger miles	1,379,836,144
Annual unlinked trips	59,119,405
Annual vehicle revenue miles	37,352,273
Annual vehicle revenue hours	1,005,752

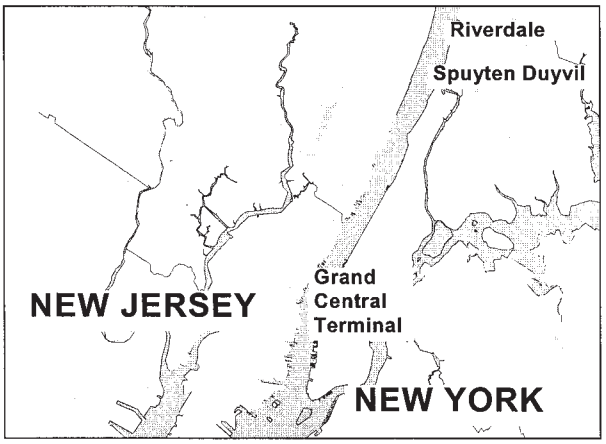

Figure 4. The communities of Riverdale and Spuyten Duyvil.

Route D starts at West 262 Street and Broadway, making two stops on Broadway and a stop at David Sheridan Plaza, then turns onto Mosholu Avenue for one more stop at Fieldston Road before continuing to West 254 Street and the Riverdale station. Route D is scheduled to take eight minutes.

Route C, the off-peak service route which combines Routes A, B, and D, makes all stops except at 263rd St. and Riverdale Avenue, and 262nd St. and Broadway. Route C is scheduled to take 13 minutes.

Spuyten Duyvil routes

The Spuyten Duyvil service (Figure 7) begins at 5:49 AM to meet the 6:05 AM train to Manhattan, and ends after dropping off the passengers from the 11:44 PM train outbound from Manhattan.

Metro-North's *Hudson Rail Link* is your seamless connection to Metro-North Railroad. It's the fastest, safest ride to and from midtown Manhattan. It alleviates your anxiety over traffic jams and diminishes your doubts about getting to work on time.

Hudson Rail Link picks you up in Riverdale and delivers you to Spuyten Duyvil or Riverdale Station, where you can connect with a Metro-North train. Look for the distinctive *Hudson Rail Link* sign at the local bus stops listed in this schedule.

From Hudson Rail Link service schedule, effective 1/15/96.

Figure 5. Description of Hudson Rail Link from service schedule.

Routes J, K, and L serve Spuyten Duyvil, with Route L serving all stops in the off-peak period. Route J begins at West 239 Street and Independence Avenue, turns from Independence to West 237 Street to the Henry Hudson Parkway, where it makes two stops on its way to Kappock Street. On Kappock Street it makes a final stop before traveling via Johnson Avenue to Spuyten Duyvil Station. Route J is scheduled to take eight minutes.

Route K starts at the Henry Hudson Parkway and West 246 Street, turns at West 239 Street onto Riverdale Avenue, where it makes two stops before connecting with Johnson Avenue and heading to the Spuyten Duyvil Station. The route is scheduled to take nine minutes. Route L makes all stops in the off-peak period, with a scheduled time of 15 minutes.

THE DEVELOPMENT OF THE *HUDSON RAIL LINK* CONCEPT AND SERVICE

The origin of the HRL concept—West Bronx Corridor Study

The idea of implementing a feeder service to the Spuyten Duyvil and Riverdale stations came from the MTA West Bronx Corridor

TABLE 37 1990 population, median household income, and education in Riverdale and Spuyten Duyvil areas

Place	Population	Median household income	Percent graduated from high school	Percent with college degree
Spuyten Duyvil	45,000	$38,500	79%	40%
Riverdale	17,000	$42,000	81%	43%

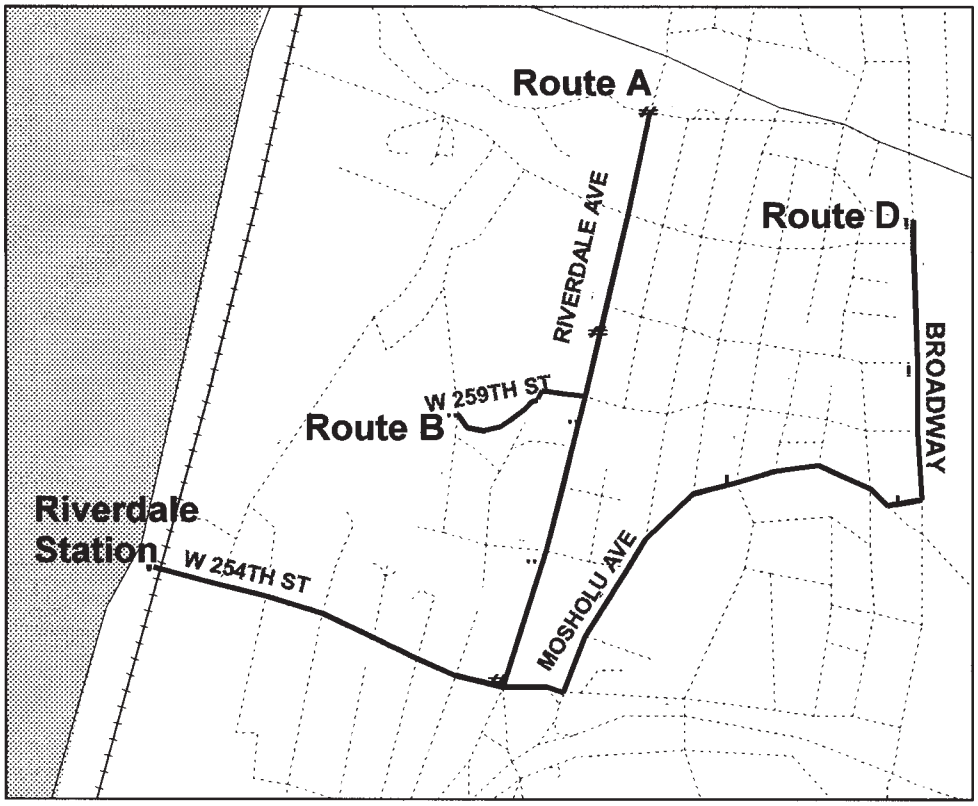

Figure 6. Riverdale routes.

Study, conducted between 1986 and 1987. The goal of the study was to examine ways to improve ridership and utilization of the MNR's commuter service in the West Bronx Corridor. The study observed that the two stations were underutilized, and that there were definite access barriers due to the severe topology of the area. Furthermore, the densely populated, affluent community fit very well with the demographics of Metro-North's existing customers. All that was needed, it seemed, was a viable way of getting potential customers to and from the stations.

After the concept was proposed and evaluated in the MTA West Bronx Corridor Study, Metro-North staff reexamined the idea. They estimated that the impact on ridership would be more modest than the 645 new passengers estimated in the MTA study, but decided that the project was worth pursuing further. Based on diversions from 1980 census journey-to-work data, the internal study estimated that a feeder bus system would attract about 349 new riders to the MNR at the two stations.[1]

The New York City Transit Authority was not interested in operating minibus feeder service to MNR trains in that area, and they couldn't operate full-sized buses. Furthermore, it wasn't clear that the benefits of a dedicated feeder bus system would be fully realized with a regularly scheduled bus service. In short, it was apparent that if the MNR wanted an effective feeder service, the railroad itself would have to provide it.

The next step of the process was to study it thoroughly. Historically, Metro-North had always been in the railroad business. The staff were reluctant to become a bus operator, and wanted to be sure that the service would be worth the potential hassle and headache of entering a new service arena. MNR hired a consultant to study the feasibility of the idea, and to propose ways to implement the project. The study took about a year to conduct, and it confirmed the previous studies that the feeder service would improve ridership on the railroad at those stations.

With several marketing reports giving the project a green light, the MNR Board decided to go ahead with the project. But the railroad still took a slow, cautious approach to developing the service. The next phase of development, which included developing an RFP, selecting an operator, and starting the service, took approximately 2½ years—from May 1989 to October 1991.

Despite their apparent *carte blanche* to implement the feeder service in any way they desired, the MNR decided to develop the HRL as an extension to the railroad. Their operating concept was to sell through tickets which combined bus and rail travel, as well as bus-only tickets. Further, the operating plan specified that the buses were to serve only trips to or from the railroad, not trips between the stops, and that the buses would arrive at the train station close to the times at which the trains were scheduled to arrive. Conceptually, the feeder bus would be equivalent to having the train tracks come much closer to the neighborhood it was trying to serve.

The service was initially contracted for five minibuses, with 25 seats per vehicle. The original service plan required four buses during the peak periods, with one spare vehicle. As the service matured and ridership grew, Metro-North added a third route in Riverdale, which increased the peak bus needs to five buses. Since the buses

[1] Internal memorandum from J. Fiegerman and D. Wong to R. C. MacLagger (February 26, 1987), "Riverdale/Spuyten Duyvil Shuttle Van Demand Estimates," p. 1.

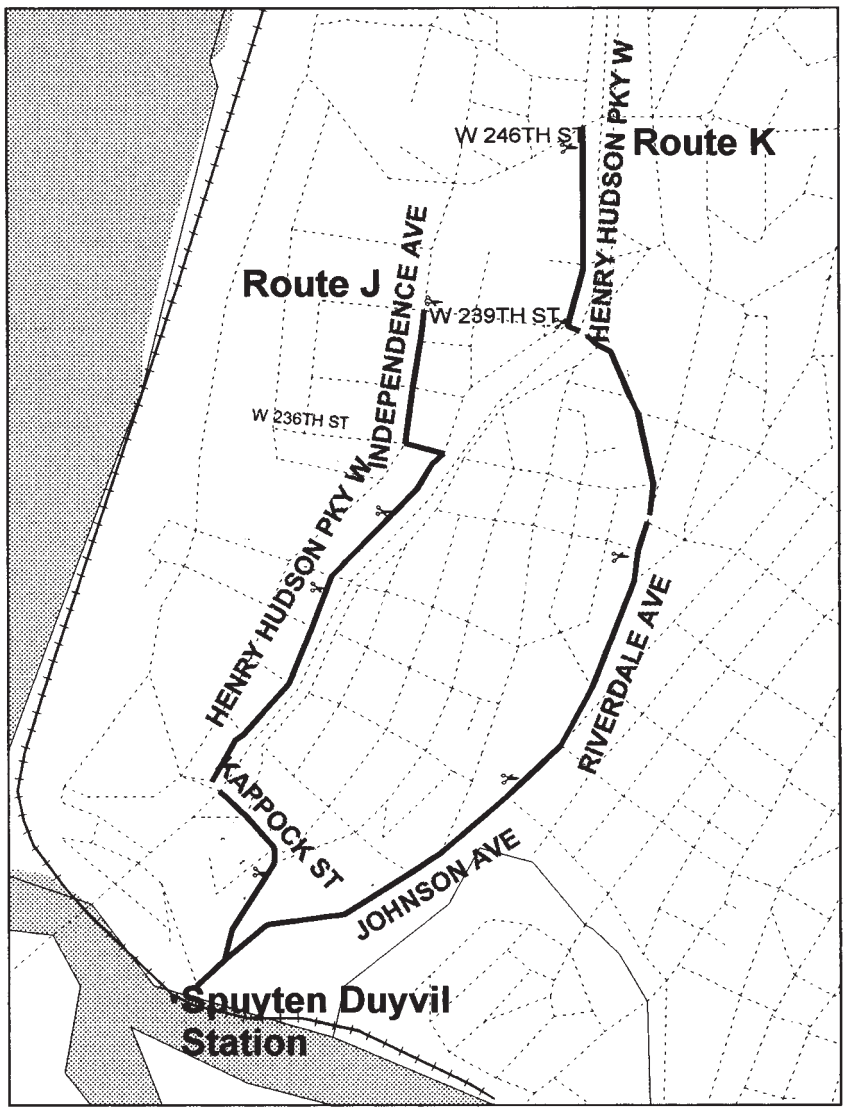

Figure 7. Spuyten Duyvil routes.

being used by the service were two years old and were carrying more than their seating capacity during peak periods, Metro-North decided to purchase larger, ADA-compliant minibuses. The bus purchase was completed and the new buses started operating in December, 1995.

Regulatory requirements

Since MNR is a railroad, staff were concerned about any regulatory requirements that might have affected their ability to operate a bus service. MNR carefully reviewed the legal and regulatory requirements surrounding the agency's entry into the bus market, and found that there were no restrictions whatsoever with respect to establishing a bus service. This is a result of the fact that Metro-North is a part of the New York MTA. As such, Metro-North has the right to operate bus service within the MTA jurisdiction. They did not need to obtain a bus franchise or an operating authority because the MTA already has the required authority.

If not for the fact that the MNR exists as an entity entirely within the operating authority of the New York MTA, the railroad would have faced some sizable legal hurdles in developing the feeder bus service. Other commuter rail operators who wish to replicate the *Hudson Rail Link* within their own service contexts may face more restrictive regulations and requirements. However, the MNR approached the planning and development of the HRL in a manner similar to the way they would have done so had they needed to obtain a franchise.

Much of the time taken in developing the service was spent gathering community input. Since the service was intended to serve the community (and to persuade residents to ride the MNR in preference to other modes), it would have been foolish for Metro-North to ignore the community when designing the service. Metro-North consulted with community boards and local leaders to establish the preferred routes and bus stop locations. They held community meetings to obtain local input into the design of the feeder service. They worked with the New York City DOT in locating and placing the

signs at the bus stops. Generally, the MNR wished to behave as a "good neighbor," since the people in the community were their potential customers.

Feeder bus service provided by a contractor

The RFP development and contractor selection process took at least six months. Since it was a new experience for Metro-North, they were careful in developing the RFP, making sure that they specified exactly what services were required. After the RFP was approved and released to the public, they allowed at least a month for responses, and then they had to select the most qualified candidate from the pool of applicants. Once the prime contender was selected, the contract negotiations began. Finally, after the contract was settled, the contractor purchased the buses required for the service, at which point the service could be provided.

MNR had to verify the fitness of the operator that was selected. There were several rumors about and accusations directed against the selected contractor. MNR had to undertake investigative work to track down the sources behind these accusations to determine if they had merit. Eventually, MNR decided that the selected contractor was competent, and capable of providing the service as contracted. Questions about the fitness of the operator could possibly come up in any location, since it was suggested that some of the accusations were leveled by a competing bus operator.

While the MNR legal staff had determined that the agency was not required to obtain any legal approvals prior to starting up its bus service, and felt that this "exemption" covered their selected operator as well, the private operator of the bus system was less sure of the legal situation. Consequently, after winning the contract, the firm insisted on applying to the state for a contract carrier rights amendment which would allow them to operate buses on the *Hudson Rail Link* routes. MNR supported their application and the rights were subsequently awarded by the state without incident.

The operator of the *Hudson Rail Link* is Atlantic Express, Inc., operating under the subsidiary name of Atlantic-Hudson, Inc. Informally, all of the people contacted at Metro-North said that they have been pleased with the service provided by Atlantic Express.

Cost of implementation

Before the implementation of the *Hudson Rail Link*, during the planning phase, the MNR estimated that the cost of the van service would be $35 per vehicle hour, or $468,650 dollars per year (in 1988 dollars). Since capacity existed on the rail line, the revenue collected from new riders could be used to offset the cost of the van service. With an estimate of 350 new peak riders and 30 new off-peak riders, this ridership growth was judged to increase MNR revenue by $412,200 per year (in 1988 dollars), and so the van service could be made profitable with a modest fare charged on the feeder bus.

Table 38 is reproduced from the December 1994 *Hudson Rail Link* Action/Work Plan. This work plan detailed the current costs of the *Hudson Rail Link*, and the projected costs of expanding the service with a third route in Riverdale. The table demonstrates that the service is profitable, based on the difference between the fares collected from new passengers and the cost of operating the service.

TABLE 38 Cost analysis of HRL

	1994-95	1995-96 no expansion	1995-96 with expansion	Amounts attributable to the expansion
Revenues	$625,000	$625,000	$674,560	$49,560
Costs	$600,844	$558,406	$622,630	$64,224
Farebox operating ratio	104%	112%	108%	77%
Variable costs				
Revenue vehicle service hours (including 11:20 train)	51.5	51.5	58.0	6.5
Average days per year	255	255	255	255
Revenue vehicle service hours per year	13,132.5	13,132.5	14,790	1,657.5
Variable costs per hour	$21.69	$22.14	$22.14	$22.14
Annual variable costs	$284,844	$290,754	$327,451	$36,697
Fixed costs				
Monthly fixed costs	$15,954	$18,074	$19,881	$1,807
Annual fixed costs	$191,448	$216,888	$238,577	$21,689
Annual fixed and variable costs	$476,292	$507,642	$566,027	$58,386
Additional bus charge per diem	$370	$0	$0	$0
Number of days in use	189	0	0	0
Total additional charges	$69,930	$0	$0	$0
Total cost (including 10% profit)	$600,844	$558,406	$622,630	$64,224

Source: MTA Metro-North Railroad.

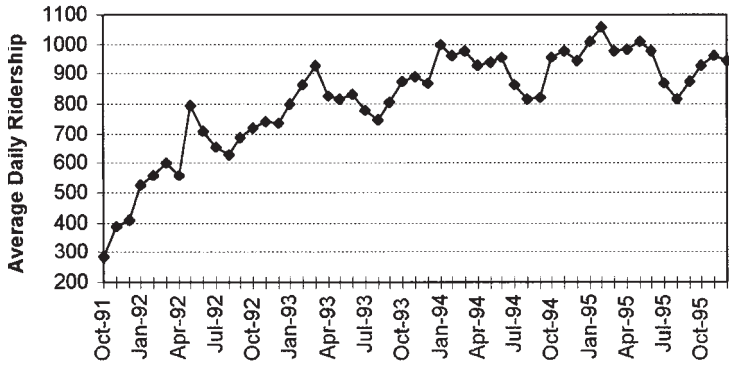

Figure 8. Average daily ridership, by month, on Hudson Rail Link.

One of the factors that makes the *Hudson Rail Link* a financial success is the fact that Metro-North has spare capacity on its commuter trains, without further expansion. Adding new riders is therefore judged to cost only as much as the cost of the feeder bus service, while the attributed revenue collected includes both the bus and the *train* fares. For example, the last column in Table 38 presents the costs and revenues from the expansion service only. The calculations were made based on an estimated 35 new riders per day. Assuming that each rider makes one round-trip per day, paying $1.50 each way, generates $105 per day, or $26,775 per year. This covers only about 40% of the full cost of operating the HRL extension. However, when the new MNR rail ticket revenue from those 35 new passengers is added in, the service expansion achieves a farebox-operating ratio of 77%.

Another way of looking at the profitability of the *Hudson Rail Link* is to determine the number of passengers necessary to generate break-even revenue. In the December 1994 *Hudson Rail Link* Action/Work Plan, Metro-North staff performed such an analysis in examining the profitability of extending HRL service to meet the 11:20 PM train outbound from Manhattan. The operating cost of the *Hudson Rail Link* per revenue vehicle service hour (RVSH) was $21.69 in 1988 dollars, or $23.86 with a 10% profit included. Extending the service by one RVSH over two routes for 21 days each month would cost $1,002 per month. Dividing this amount by $7.50 per off-peak round trip customer (the cost of a monthly Uniticket per trip) gives 134 customers per month, or 7 customers per day. A ridership survey taken at the same time as the work plan was written estimated that approximately 42 current customers could be expected to use the extended service at least once a month.

IMPACT OF THE *HUDSON RAIL LINK*

The net impact of the *Hudson Rail Link* on ridership on Metro-North is quite small, when compared to the total volume of trips that Metro-North serves each day. But the ridership impact is positive. Ticket sales for the Fare Zone 104, which includes the HRL service area, accounted for just over one percent of the total Metro-North ticket sales in December 1995. But from 1991 through 1995, ticket sales in this fare zone grew at a faster rate than for the system as a whole. The *Hudson Rail Link* buses themselves are well used by patrons of Spuyten Duyvil and Riverdale, as shown in Figure 8.

The ridership on the feeder buses displayed a sharp growth over the first few months, and then a gradual tapering off to a steady growth rate. In the first year, the system patronage grew from less than 300 riders per day to more than 700. This rate slowed, so that by the end of the fourth year of operation there was an average of between 900 and 1,000 riders per day on the system, or about 200 riders per feeder bus route.

The feeder bus ridership was paralleled by a growth in Metro-North ticket sales at the stations. Figure 9 shows the relative rates of ticket sales for Fare Zone 104 (which includes Riverdale and Spuyten Duyvil stations), and the rest of the MNR system. FZ 104 grows faster through 1992 and 1993, and then settles down to more or less the same rate as the rest of the system. The average 12-month increase in ticket sales for the fare zone is consistently equal to or greater than the system-wide sales growth. Although it is not possible to assign this ridership increase definitively to the *Hudson Rail Link* alone, all of the evidence indicates that the feeder bus service has contributed strongly to a steady growth in ticket sales at Spuyten Duyvil and Riverdale stations.

Rider opinion—March 1992 survey

Riders of the new service were surveyed in March 1992, a few months after it started. A questionnaire was distributed to inbound rail passengers boarding at Riverdale (391 forms distributed) and Spuyten Duyvil (520 forms distributed). Of the 911 distributed forms, 381 (42%) were returned. These responses were then weighted to reflect the Spring 1992 boarding counts of 986 customers at both stations.

The survey explored the impact of the *Hudson Rail Link* on ridership behavior. The highlights of the survey results pertaining to the *Hudson Rail Link* are as follows:[2]

- Thirty-seven percent of customers walk to the station, and 32% use the *Hudson Rail Link*.
- In the week, February 24-28, 1992, 85% used Metro-North to/out of Manhattan, 3% used express bus, 4% used their automobile, 4% used the TA subway or bus, and 2% used other means. Approximately 2% did not go to Manhattan.
- In the week, February 24-28, 1992, 37% used the *Hudson Rail Link* to get to the station, 34% walked, 15% drove and parked, and 10% got dropped off.

[2] Marketing Department, Service Development Group, Metro-North Railroad, "*Hudson Rail Link* Customer Survey" (May 1992), Summary points quoted from pp. 2–3.

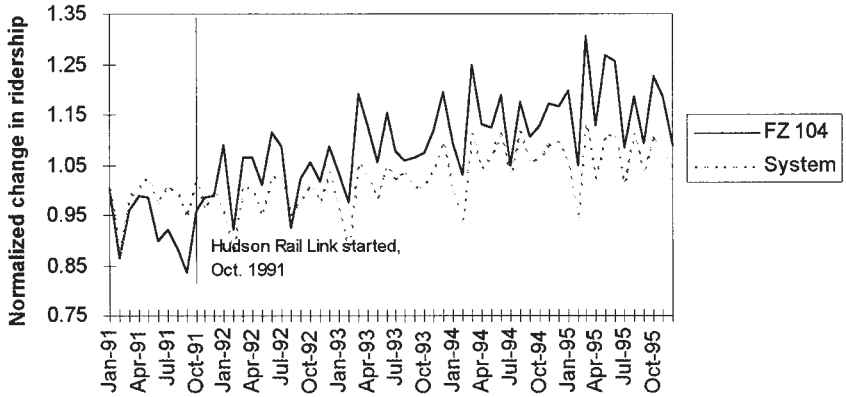

Figure 9. Normalized growth in estimated ridership (January 1991 = 1.0).

- Twenty-four percent of the existing Metro-North customers stated that they used the Railroad more often in March 1992 than they had in September 1991.
- Prior to September 1991, 51% of the MNR customers used the Riverdale station, and 46% used Spuyten Duyvil. At the time of the survey, 45% of the ridership used Riverdale, and 55% used Spuyten Duyvil.
- Of the customers who used Metro-North more often in March 1992 than in September 1991, 73% stated that the reason for the more frequent use of the Railroad was due to the convenience of the *Hudson Rail Link*.
- Within the month prior to the survey (February 1992), over 63% of the rail customers had used the *Hudson Rail Link*.
- Awareness of the *Hudson Rail Link* was attributed to advertisements and newspaper articles (39%), seeing the buses (30%), brochures (26%), and friends (5%).
- MNR customers tend to use the *Hudson Rail Link* service more during the evening, under conditions of bad weather, and after dark.
- Reasons why existing MNR customers did not use the *Hudson Rail Link* service were that the HRL stops were too far from home (36%), the cost of the HRL was too unattractive (15%), they preferred to use a private vehicle (12%), or they preferred to walk (27%).

The initial survey showed that customers had adopted the *Hudson Rail Link* as a viable alternative mode for getting to and from Metro-North. The HRL was used at the same frequency as walking, despite the fact that the service was not free. And a majority of the commuter rail patrons had taken the *Hudson Rail Link* in the past week. Thus, although used on average for only about one-third of the trips to and from the station, a majority of the passengers took advantage of the service when it was convenient for them to do so.

In addition, the respondents to the survey indicated that the HRL might be encouraging or enabling them to take Metro-North more often. Previous users of Metro-North said that they were making more use of the railroad since the start of the feeder bus services, and many of them cited the *Hudson Rail Link* as being the reason. In addition, new riders were taking Metro-North since the start up of the *Hudson Rail Link*, and the HRL was probably one of the reasons for this increase.

Rider opinion—November 1994 survey

A second survey was conducted in late 1994, three years after the introduction of the *Hudson Rail Link*. The survey was undertaken for two reasons. First, the Metro-North marketing department wanted to gauge the attitudes and opinions of their customers. Second, they wanted to test the perception that the *Hudson Rail Link* was showing signs of wear, and that the system would need new buses and revised routes in order to ease the strain that heavy patronage was putting on the system. The service had a large number of standees on some of the buses, and since new equipment and routes were actively being considered, the marketing department thought it would be prudent to solicit the opinion of the system customers before making any changes.

The second survey was distributed on board the *Hudson Rail Link* buses. The issued sample was not reported, but 157 completed questionnaires were returned prior to the cut-off date. Important results are as follows:

- Thirty-five percent of the respondents said that *advertising and promotional activities* were the motivating force behind their riding the *Hudson Rail Link*.
- Thirty-two percent of respondents said that *word-of-mouth recommendation* was the single largest motivating force for riding the HRL. *Seeing the buses* was the key motivating factor for 25% of respondents.
- *Advertising and promotional activities* were cited by 65% of respondents as raising their awareness of the HRL. Being *told by a friend* was cited by 34%, and *seeing the buses* by 42%. This question allowed for multiple responses and so the responses add to more than 100%.
- Sixty-three percent of *Hudson Rail Link* users did not use Metro-North for their trip into Manhattan prior to the introduction of the feeder service. Of those people, 63% previously used the express bus, 18% used a private vehicle, and 18% used the subway to get to Manhattan.
- Forty-five percent of Riverdale customers and 39% of Spuyten Duyvil customers began using *Hudson Rail Link* two to three years prior to the survey.
- Thirteen percent of Riverdale customers and 23% of Spuyten Duyvil customers began using *Hudson Rail Link* less than six months prior to the survey.

- Most riders were consistent users of Metro-North and the HRL. Ninety-two percent of riders reported using a monthly Uniticket for the combined bus and rail trip.
- More than 90% of HRL riders commute to work, and 85% of the survey sample commuted during the peak period.
- Customers were most satisfied with the courtesy of the bus driver (a mean rating of 4.59 out of 5) and the travel time (with a mean rating of 4.30).
- Customers were most critical of seating availability (mean satisfaction rating of 3.41 out of 5) and the reliability of the service (3.72 out of 5). Riverdale customers were most critical of these items, possibly reflecting the higher use of the Riverdale service.

The second survey reinforced many of the messages of the first survey, although because it was distributed on board the HRL buses, there is a bias towards HRL users. The feeder bus service was used by many newcomers to MNR, as well as by previous rail users. People were purchasing combination tickets to include the HRL in their daily commute. There was also some indication that people were more likely to use the HRL under poor weather conditions, or at night.

The two surveys indicate that the feeder bus did exactly what it was supposed to do—improve access and egress from the Riverdale and Spuyten Duyvil stations, and thereby improve ridership at those stations. The second survey revealed that the new riders came from express bus services more than from any other mode, and another sizable group came from the subway. In terms of improving overall public transportation ridership, these diversions are a net zero. However, 18% of the HRL customers reported previously using private vehicles for the trip into Manhattan.

The second survey also indicated that the *Hudson Rail Link* was on the verge of becoming a victim of its own success. People were using the Riverdale service at levels that exceeded the capacity of the system (two routes, using 25-seat buses, meeting each train into Manhattan). Furthermore, customers were unhappy with the service reliability gaps resulting from the aging bus fleet. As a consequence of the second survey, steps were taken to procure new, larger buses, and to examine restructuring of the Riverdale routes to improve the service reliability and capacity.

Applicability to other transit systems—factors contributing to success

The *Hudson Rail Link* demonstrates how a large, established transit agency has been able to improve its service delivery to a specific segment of its customers. In terms of MNR's annual budget, revenue, and passengers, the *Hudson Rail Link*'s impacts are quite small. However, the service is useful to current and new passengers alike, has attracted new customers, and has a positive net revenue impact. In terms of the HRL service area, therefore, the success of the system has been tremendous. Although the service might be dismissed as minor, it is a solid success and is serving as a model for other programs within Metro-North.

Several aspects of the service and the underlying operating environment contributed significantly to making the *Hudson Rail Link* a successful service, and we now explore these factors.

Small-scale service

The fact that the *Hudson Rail Link* is a small-scale service makes it highly transferable. The idea is to provide easy access to the commuter trains. In practice, the details and features can be tailored to the specific needs of the service area and potential customers. The service concept can be adopted by both large and small operators. As long as other operators have clear cases where access and egress are barriers to transit use, the details of the service can be tailored to fit the operating environment, and the transit agency can still expect that the new service will be successful.

Timeframe

The *Hudson Rail Link* delivered a boost to Metro-North ridership in a very short period of time. As has been discussed throughout this chapter, the *Hudson Rail Link* continues to attract new customers even five years after its start. However, the bulk of the Metro-North ridership jump due to the *Hudson Rail Link* was realized within the first year of operation (see Figures 8 and 9). After that year, growth in ridership on the MNR tapered off to roughly the same rate as the rest of the Metro-North system. Thus, one would expect a similar system to achieve "steady state" within its first year of operation. These quick results are important for evaluating the impact of the new system on the target market. In this case, MNR staff knew they were doing the right things as the ridership on the new buses jumped to about 600 riders per day within the first six months.

In terms of the time from conceptualization to start-up, the *Hudson Rail Link* was a very slow project, taking between four and five years to develop. Most of this was due to a cautious approach by Metro-North management. Since this was a new area of transit service for the railroad, they wanted to make sure that they were not going to make a mistake. However, the slow development also allowed Metro-North the time to conduct several studies to examine the proposed service and various options and alternatives.

High-capacity, high-quality main line service

The *Hudson Rail Link* was intended to improve ridership on Metro-North trains, not by improving the commuter service itself, but rather by improving access to the commuter trains. Metro-North already has a high-capacity, high-quality commuter train system. The HRL augments this excellent system, and would not be successful without it. It doesn't make any sense to install a feeder system when significant improvements can be made to the primary service.

One of the factors that makes the HRL a financial success is the fact that the commuter trains currently have excess capacity. Even with the boost in ridership resulting from the HRL service, the trains still are not overcrowded. If the capacity of the main line had to be upgraded as a result of the feeder bus, then the cost of that improvement would have to be deducted from the feeder bus revenue, possibly changing the financial success into a financial failure.

The high-quality train service that already existed served as its own advertisement once the feeder bus system was operational. People were willing to try Metro-North once they could get to the stations because everybody knew that MNR provided frequent, fast service between Manhattan and its northern suburban areas. The HRL marketing material promoted the fact that the train was the fastest way into Manhattan from Spuyten Duyvil and Riverdale. In a sense, the HRL extended this fast and efficient rail service from the two stations into the neighborhoods of potential customers.

Instead of having to walk for several blocks, negotiating steep streets in the process, patrons could walk just a block or two to the nearest HRL stop and enter the MNR commuter system.

Overcoming significant access and egress barriers

Metro-North is actively looking for other opportunities to replicate the HRL experience. In order to make similar services successful, it is important to make sure that enough new passengers are likely to use the new service. In the Riverdale/Spuyten Duyvil case, market research conducted before the service started, showed that people were willing to try the train *if* they could get to the station. The access/egress part of the trip was clearly the bottleneck that was limiting ridership. Putting in the feeder buses eliminated this bottleneck and generated new revenues for the rail line.

Where access and egress are *not* significant factors in limiting transit ridership on a trunk line (such as a commuter rail or an express bus), then adding a feeder bus service probably won't result in the revenue increases that the *Hudson Rail Link* generated. Where there is ample parking at the station, or quality transit service, there is little need for an extra feeder bus service. But where parking is limited, or where the local transit service is infrequent or poorly timed with the line-haul service, then there is a potential that a feeder bus service may induce new riders to switch to the transit service.

Finally, the fact that access and egress were significant barriers to MNR use in the area almost guarantees that the ridership gains realized by the *Hudson Rail Link* will continue into the future. As long as Metro-North continues to provide customers with easy, convenient access to their trains, the customers will have no reason to switch back to their previous modes.

CONCLUSION

The *Hudson Rail Link* is a the feeder bus service which Metro-North Railroad developed to serve its Riverdale and Spuyten Duyvil stations on the Hudson Line. The service has improved ridership in the area, generates a net operating profit, and has improved the usage of train capacity on that commuter line. Ridership continues to grow, five years after the system was implemented, and in January 1996 MNR expanded the service to include a third separate line in Riverdale.

The ridership and revenue success experienced by the *Hudson Rail Link* is not remarkable when viewed in the context of the service area. The existing Metro-North service offered an excellent commuting alternative to area residents working in Manhattan. However, getting to and from the stations was difficult. The two most important elements in the successful application of a feeder bus system in this case was first, MNR recognized that ridership could be improved at the two stations, and second, they designed a feeder bus system which would achieve the ridership gains for less money than would be collected from the new ticket sales.

Metro-North was cautious in their approach to developing the service. Although they faced no legal requirements to develop slowly and to solicit the input of the community, they chose to do so. This careful approach gave management plenty of room to back out of the proposed service if the anticipated ridership gains began to disappear under more careful scrutiny. In addition, the long development process allowed Metro-North to sound out the community, get their input, and identify people who were supportive of the system. All of this groundwork paid off when the system finally opened. Ridership on the buses exceeded 600 passengers per day within the first six months, and since then, *Hudson Rail Link* has been a profitable addition to the Metro-North Railroad's service.

APPENDIX H

GOVERNMENT OF ONTARIO TRANSIT FARE AND SERVICE INTEGRATION

INTRODUCTION

This case study examines the fare integration and service coordination (FISC) program implemented by Government of Ontario Transit (GO Transit). This program involves the closer coordination of services between the agency and the various local transit services that are often used for access to the GO system. In particular, this coordination entails the intregration of fare media and/or the development of fare policies aimed at the users of both systems.

The case study describes the details of the types of fare and service coordination enacted by GO Transit, the issues associated with this type of program, and the impact on service and performance measures for the agency.

BACKGROUND

GO Transit operates interregional commuter rail and bus services in the Metropolitan Toronto area. The system serves an area of over 3,000 square miles and a population of 4.5 million people with a network reaching 55 miles from the downtown area. A partial map of this service network is shown in Figure 10. The operation of commuter rail services is performed under contract by CN Rail and CP Rail on their respective rights-of-way, while the bus service is operated directly by the agency. The system carries a total of 35 million people per year, most of whom are commuters traveling to work in the core of Metro Toronto.

The agency was created in 1967 to reduce the need for construction of expressways in the region. Originally operated as part of the Ministry of Transportation of Ontario (MTO), the agency has been run by the Toronto Area Transit Operating Authority since 1974. The chairs of the regions of the Greater Toronto Area (GTA)* all serve on the board of the Operating Authority, which gives focus to interregional needs. The chairman of the board is appointed by the Province.

DETAILS OF THE STRATEGY

While over 28,000 free parking spaces are available at GO stations, they are often filled, and despite the provision of kiss-and-ride, drop-off/pick-up lanes, and bus-only loops at most stations, a greater incentive to avoid taking the car to GO was needed. As a potential solution, GO developed fare integration with local municipal transit, which was initiated in 1979 (a first in North America) with Brampton Transit, and now includes 14 of the 16 municipal transit properties within GO's service area.

Types of fare integration

There are generally two different types of fare integration in the GO Transit service area:

- *Full service integration* provides a completely free ride on local transit to and from the GO Rail station for GO passengers with a valid ticket or GO pass.
- *Partial fare integration* requires an additional purchase for the local ride, either in the form of a per ride surcharge (C$0.25 to C$0.50), or a sticker from the local agency which can be affixed to the GO pass.

GO now has fare integration agreements with almost all of the local agencies in its service area, and welcomes new partners. For example, Peel Transhelp joined in 1995, taking advantage of the introduction of the first wheelchair accessible GO stations and becoming the first paratransit agency to participate in the program. A number of other similar programs are currently interested in participating.

In addition to the individual FISC partnerships, there has been a GTA-wide fare media initiative recently, but it only marginally applies to GO as most GO service is fare-by-distance. The new GTA pass was introduced August 23, 1994 and gives unlimited transit use within the GTA on a single pass for C$30 per week without transfers or extra fares, but only GO's Bayview and Yonge C bus routes qualify. GO operates those two routes as a local service.

Fare integration with the Toronto Transit Commission (TTC), the operator of the subway system in Toronto, is via the Twin Pass medium, a combination of a GO monthly pass and a TTC Metropass monthly pass. GO has approached TTC with the possibility of expanding fare integration to other fare media to increase flexibility for those who do not use monthly passes, but so far the TTC has not been interested. TTC is not very supportive of the program, claiming that they are not getting full value for the users of the Twin Pass.

GO Transit is continuing to support the Twin Pass program despite the lack of apparent benefit for a couple of more philosophical reasons:

- Twin Pass was started by the Ministry of Transportation, and GO is a government agency mandated to support transit programs.
- The TTC provides the other end of the home-GO-work trip chain, thus completing the transit linkages across the GTA. That is, the idea that it is at least feasible to complete a trip *entirely* on transit is worth supporting.

The fact that the complete GTA transit service still requires several fare media is another issue that is being addressed through various "Smart Cards" initiatives.

In at least one instance, a small group of GO FISC partners got together and introduced a common fare medium. In February 1991,

* The Greater Toronto Area is made up of Metropolitan Toronto and the four regional municipalities of Peel, York, Durham, and Halton. More detail on the organization of the region is provided in Appendix N.

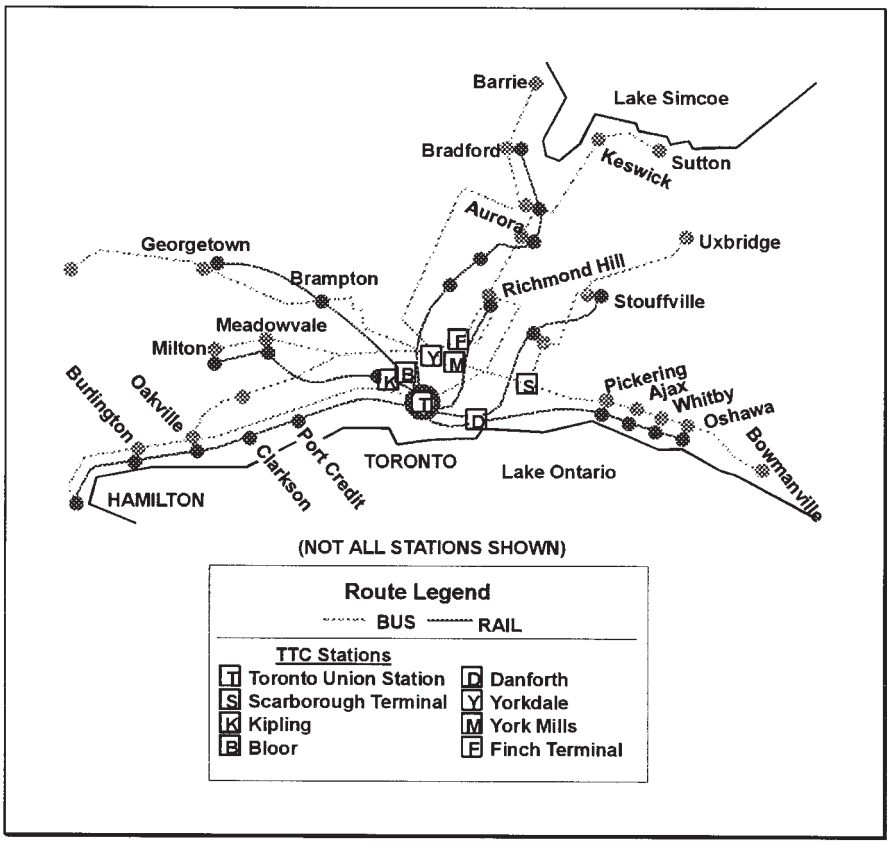

Figure 10. GO Transit service network.

GO Transit established three transit coordinating committees for west, north, and east service areas to discuss issues of common (but not GTA-wide) interest. One committee, that for the north service area (South York), introduced a common fare medium (sold as a strip of 10 tickets) in April 1994 for its four member municipalities and GO Transit.

Revenue sharing agreements

There are few, if any, difficulties in the basic sharing of revenue between GO and the local properties, as it is up to each to collect the fares that they require. GO simply pays each property an amount equal to 37.5% of the adult cash fare. This subsidy was reduced in July 1993 from 75% when FISC started, but the MTO has continued to pay the difference of 37.5% (reviewed annually since 1993), at least to the end of 1995.†

† As part of the current large provincial budget cuts, MTO will either drop the subsidy altogether or it will be combined with the general municipal transfer payment, thereby allowing each municipality to decide whether or not to continue the transit subsidy. GO officials are not very optimistic about the future of FISC in this case, although for the time being they will continue their 37.5% subsidy, but if the municipal service increases their surcharge to make up the loss, any benefit to the customers will be wiped out altogether, leaving GO back with the option of increasing parking capacity where they can.

Some local properties use a surcharge to collect the remaining 25%, but most absorb the cost. Oakville has charged C$0.25 for each GO passenger since April 1994, Ajax started a C$0.25 charge in November 1995, Mississauga has the type of monthly pass sticker scheme mentioned earlier, and in 1996 Whitby and Oshawa have started charging C$0.25 per trip, and Burlington C$0.50 per trip. GO has expressed interest in standardizing the surcharge system at a certain percentage or flat rate, to aid in promotion and to reduce customer confusion.

A difficulty in determining the amount of subsidy has arisen in recent years with the advent of “deep discount” fare structure at many local transit properties, which sets the cash fare much higher than the ticket/token/pass fares, mainly to discourage the use of cash. Unfortunately for GO, the original subsidy agreement was linked specifically to the adult cash fare. While GO wished to switch this agreement simply to the adult ticket fare, the properties protested that they had built their budgets for future years based on a cash fare subsidy. The parties have now agreed to stage the change of subsidy formula over three years, starting with 1995.

Since the start of GO/TTC fare integration, both GO and TTC have subsidized the purchase of the Twin Pass by C$10.00 each. However, while GO fares have remained relatively stable, the TTC fares have been increased by C$20.00, thereby absorbing the subsidy (although a Twin Pass is still C$20.00 cheaper than purchasing both passes separately today).

EVALUATION OF IMPACTS

This section describes the evaluation of the impacts of the fare and service integration program. The possible effects of the program on operating and other costs, as well as on ridership and modal share are assessed, to the extent that these measures can be identified.

Costs and funding

Transit operations

For GO Transit, the subsidy payment to the local transit agencies is viewed as an alternative, to an estimated C$1.00 to C$2.00 per day per space cost, for building and maintaining parking at GO stations. Hence, the agency regards the program as saving money relative to this base case. In the early days of the FISC program, the perceived savings to GO were significant, but the advantage has steadily eroded. If the local transit fares continue to rise, it may soon be in GO's interests to drop the subsidy and to go back to parking lot expansion as a less expensive alternative.

Since GO rarely has advance notice of local transit fare increases, the agency must simply anticipate a regionwide average rate increase for budget purposes. Consequently, the program often ends up with a budget surplus when the declines in ridership are greater than anticipated and fare increases are less than anticipated. GO Transit's 1994 FISC Annual Report gives the following figures:

- The 1993/94 budget was C$2.21 million. A surplus of C$106,000 was realized due to the economic downturn, which resulted in smaller fare increases and a higher-than-anticipated reduction in ridership.
- The 1994/95 budget was based on the 1993/94 expenditures. It further assumed an eight percent average fare increase, no ridership increase, a lump sum figure for studies/new properties and FISC development, and an estimate for two new properties (Peel Transhelp and Newmarket), giving a budget of C$1.96 million, or C$1.91 million based on "ticket fare" rather than "cash fare."

If GO, in the current restricted funding climate, were to decide to start charging for parking at stations to generate extra revenue, then the fare integration program would also be dropped to maintain a "level playing field." If FISC was to be maintained under this scenario, current free-parking users would take too much advantage of subsidized local transit and thereby avoid paying for parking. It appears that current funding problems are pushing GO towards this decision.

For the local transit service, FISC ridership essentially represents partial payment for a trip that would not be on the bus had the FISC program not been in place, since the local municipality must absorb 25% of the subsidy or charge the customers directly, as described above. However, in locations where local transit has tailored service to better integrate it with GO, the local cost of such additional service must be weighed against the potential revenues. The service integration in Oakville and in Ajax are viewed as being very successful, so the benefits in those two localities probably outweigh the costs.

The TTC/GO FISC situation is different. In this case, trips via TTC from a GO station‡ to a work site are against the peak direction of travel. It can be maintained, therefore, that the TTC has excess capacity to handle these trips, and each extra revenue passenger is of little or no cost to TTC. For GO, on the other hand, the GO/TTC FISC passengers are using up peak direction capacity, so they cost more for GO Transit to serve. As described above, GO and TTC each contribute C$10 per month per pass for the Twin Pass program (since February 1990).

Administration

From the inception of the TTC/GO Twin Pass in 1988 through to 1990, MTO spent C$17.3 million on FISC, primarily for service improvements, shown in Table 39.

In addition, GO charges a one percent commission on sales of TTC Metropasses as part of a Twin Pass, but believes that the agency still loses money at this rate.

Ridership and mode share

There are really three separate (but not necessarily independent) modal shares to consider: an access transit trip, the line-haul segment by GO Transit train or bus, and an egress transit trip. For the vast majority of GO users who commute from the inner or outer suburbs to work in the Toronto central business district, for instance, these trip segments are

- Local transit trips between home and the GO station;
- The line-haul trip to/from Metro Toronto; and
- The local transit (TTC) between the GO station and work.

The effect on modal share for trips between the home and the GO station is not easy to quantify with available data, but it probably varies quite markedly. The variation seems to be due to implementation differences among the various local transit properties participating with GO Transit. Some specific examples are instructive.

- Ajax Transit operates a high standard of bus service to GO stations that is well synchronized with the train schedule and claims to achieve a modal share of over 50% for trips to and from the station.
- Mississauga Transit (MT) has a rather low standard of service to the GO stations, and only offers fare integration through a C$30 monthly MT sticker affixed to the GO monthly pass (increased from a C$15 monthly cost prior to 1996). Such a price essentially limits the applicability to those who already purchase GO monthly passes and who plan to use MT for the entire month, so casual or occasional use of fare integration is unlikely. MT achieves a modal share to the GO station of just eight to ten percent.

Fare and service integration of a local service with GO Transit is quite different in character from fare integration between, say, the local services in a pair of adjoining municipalities. With the former,

‡ The vast majority of transfers occur at Union Station, which is in the center of the downtown core and directly connected to the Yonge Subway line.

TABLE 39 MTO expenditures for fare and service integration

Item	Expenditures, 1987–1990 (C$)
Service improvements to GO stations (such as new pedestrian access facilities, bus loops, etc.)	13,988,000
Twin Pass discount subsidy	2,040,000
Marketing	306,000
Twin Pass (1 piece)	53,000
Consulting fees	811,000
Total	17,198,000

Source: Ministry of Transportation of Ontario, 1991.

TABLE 40 Egress characteristics for the Lakeshore West line, PM peak

Station	Local transit	Ridership (PM peak)		Coordination		Egress mode(%)		
		On	Off	Service	Fares	Transit	Walk	Auto**
Union*	TTC	6,275	0	Yes	Part	35	65	0
Exhibition	TTC	12	6	No	Part	0	100	0
Mimico	TTC	42	233	No	Part	4	42	54
Long Branch	Mississauga	43	482	Yes	Part	11	36	53
Port Credit	Mississauga	37	978	Yes	Part	13	28	59
Clarkson	Mississauga	24	1,584	Yes	Part	14	15	71
Oakville	Oakville	3	2,123	Yes	Yes	40	3	57
Oakville West	Oakville	0	180	No	Yes	1	2	97
Appleby	Burlington	0	308	Part	Yes	11	4	85
Burlington	Burlington	0	397	Part	Yes	20	9	71
Hamilton***	Hamilton Sr	0	145	Part	Yes	5	9	86
Totals	—	6,436	6,436	—	—	14	28	57

Source: Ministry of Transportation of Ontario, Transportation Systems Planning Branch (1992), 1991 GO Rail Passenger Survey.
* Access mode statistics given for Union station.
** Includes park-and-ride, kiss-and-ride and taxi.
*** Partial GO Service.

GO would probably be the main mode for the journey whether or not another transit service was involved. In the latter case, the integration may make trips possible that would otherwise be cumbersome at best, and might be likely to be auto-captive. This means that modal shift has a number of possible manifestations.

- If GO Transit is already used, the access mode might shift from car to bus, or the egress mode in the Toronto core might shift from walking (the most common mode now) to subway, streetcar, and/or bus.
- If GO is not used now at all, it is hoped that fare and service integration might shift the entire trip chain to transit.

It is felt, however, that local transit is unlikely to be as attractive an offering to those who do not use transit at all than it is to current GO customers who drive to the stations. For this reason, any modal shift due to the integration policies is likely to be much greater for the municipal transit property than it is for GO Transit itself. For example, during the first nine months of the Oakville FISC experiment (begun in 1980), the number of passengers traveling to or from the GO Rail station via local transit increased by about 100,000, a 34% increase. When GO Rail service to Ajax was initiated in 1988, Ajax Transit achieved an over 40% transit modal share for GO station access in a very short time.

In addition, GO's large gains in the late 1980s were, at least, partly due to a modal shift from TTC services within the Metro area. This shift has been attributed partly to the higher expectations of older, more affluent commuters (an increasing segment as the baby-boomers age) and the increased speed and comfort of GO Rail over municipal transit. For this reason, it is expected that the use of municipal transit to access GO Rail may not be a big selling point to these commuters, who are more likely to use their own cars or kiss-and-ride if they continue to patronize GO. Therefore, integration policies alone seem unlikely to create increased demand for commuter rail, or to attract new riders to come if parking availability were increased.[1]

Local service coordination is crucial for transit success, as GO cannot alter the rail service schedule to meet all of the independently-scheduled local services. In addition, the availability of parking at stations has a significant impact on modal share to/from the station. Mode of access statistics for various GO Rail stations are shown in Tables 40 through 42. These tables illustrate

[1] Tranplan Associates, *GO Social Trends Study - Final Report.* Prepared for GO Transit (1991).

TABLE 41 Egress characteristics for the Lakeshore East line, PM peak

Station	Local transit	Ridership (PM peak)		Coordination		Egress mode(%)		
		On	Off	Service	Fares	Transit	Walk	Auto**
Union*	TTC	4,950	0	Yes	Part	28	70	2
Danforth	TTC	133	61	No	Part	11	69	20
Scarborough	TTC	31	313	No	Part	2	15	83
Eglinton	TTC	78	423	No	Part	5	21	74
Guildwood	TTC	22	398	No	Part	3	20	77
Rouge Hill	TTC	43	713	No	Part	9	10	81
Pickering	Pickering	24	1,133	Yes	Yes	41	6	53
Ajax	Ajax	4	974	Yes	Yes	47	4	49
Whitby	Whitby	0	1,194	Yes	Yes	28	3	69
Oshawa***	Oshawa	0	76	Yes	Yes	15	4	81
Total	—	5,285	5,285	—	—	19	22	59

Source: Ministry of Transportation of Ontario, Transportation Systems Planning Branch (1992), 1991 GO Rail Passenger Survey.
* Access mode statistics given for Union station.
** Includes park-and-ride, kiss-and-ride and taxi.
*** Partial GO Service.

the ridership benefits to the connecting transit agency where fares *and* services are integrated.

The effect on modal share for the *line-haul portion* of the trip (predominantly a choice between GO Transit and a private vehicle) is likely to be very limited. The intention of GO from the start of FISC was to use fare and service integration as a way to avoid constructing additional parking spaces at the stations (and, to a much lesser extent, to reduce traffic congestion around stations). While this objective has been met, the effects on the attractiveness of GO is probably negligible. GO already provides a higher standard of service than does local transit, so the move from car to GO would not be made more attractive by adding local transit unless for some reason the private vehicle becomes unavailable.

The effect on modal share at the work end of the trip (most often downtown Toronto) is different again. Sales of the Twin Pass, the medium that integrates GO fares with the Toronto subway system, represent a very small portion of overall ridership for either GO or TTC. In addition, sales have dropped significantly since their peak several years ago, due to increases in TTC pass rates and the end of active promotion of the program. It is believed (although there appear to be no data to isolate this) that the main effect of the Twin Pass has been to change the fare medium used for the TTC portion of the trip, but not to induce new ridership.

Transferability

GO is an agency of the Provincial Government, with jurisdiction across its entire service area. As such, there are no *legal* impediments to the implementation of integrated fare/service polices. The success of this strategy is rather, a function of *institutional* issues, which will determine the feasibility of such cooperative agree-

TABLE 42 Egress characteristics for the Georgetown line, PM peak

Station	Local transit	Ridership (PM peak)		Coordination		Egress mode(%)		
		On	Off	Service	Fares	Transit	Walk	Auto**
Union*	TTC	1,396	0	Yes	Part	25	74	1
Bloor	TTC	39	8	Yes	Part	0	88	12
Weston	TTC	7	121	Part	Part	4	45	51
Etobicoke	TTC	20	161	Part	Part	4	4	92
Malton	Mississauga	12	108	No	Part	1	6	93
Bramalea	Brampton/GO Bus	3	399	Yes	Part	24	2	74
Brampton	Brampton/GO Bus	4	435	Yes	Yes	18	13	69
Georgetown	–/GO Bus	0	169	Yes	Yes	6	13	81
Acton	–/GO Bus	0	18	Yes	Yes	5	26	69
Guelph	Guelph/GO Bus	0	60	Part	?	21	29	50
Total	—	1,481	1,479	—	—	11	30	59

Source: Ministry of Transportation of Ontario, Transportation Systems Planning Branch (1992), 1991 GO Rail Passenger Survey.
* Access mode statistics given for Union station.
** Includes park-and-ride, kiss-and-ride and taxi.

ments, as most problems with fare and service integration in other locations have ultimately come down to jurisdictional conflicts. Success relies on solid cooperation among the involved agencies (or a single regionwide agency) to achieve good fare and service integration.

What is also important, however, is a stable source of an operating subsidy. Because there are different agencies and hence, different sources of money at stake, there are ongoing fiscal (political) problems. Ongoing study, debate, and review are symptoms of limited funds, as is the often-heard cry of "Who pays? Not me! I'm not subsidizing system X."

Finally, there are inevitably issues of equity involved when dealing with the sharing of revenues and coordination of services. For example, in Ajax the transit emphasis on the GO stations greatly benefits Ajax Transit—the GO stations are major peak period origins/destinations in the community due to the high proportion of workers commuting to downtown Toronto and the comparatively limited road capacity for trips between Ajax and Toronto (when compared with other areas of the GTA). So while the FISC program may occupy buses which could be used in local service in Ajax, those vehicles are probably much more efficiently used for GO commuters than for local use. In addition, the result is more frequent local transit service, which does benefit other tripmaking needs within the community. It is a generally held belief that the community as a whole does benefit from FISC.

SUMMARY AND CONCLUSIONS

GO Transit has implemented a fare and service coordination program throughout the Toronto metro area. This program was initiated as a means to avoid building additional parking spaces at some of the agency's commuter rail stations, but has expanded since then with the general purpose of improving access throughout the system. Fares have been integrated with local transit agencies throughout metro Toronto with the use of revenue sharing agreements, and local services have been coordinated to better serve GO Transit stations.

With good local transit service focused on the rail station, and full ("seamless") service integration, FISC can perform very well. If either of these criteria is lacking, however, FISC performance is compromised.

The cost of parking provision, not GO ridership, was the driving force that got GO Transit into the "integration" game. The local agencies were attracted by increased revenue and ridership. The result is a more intensive local bus service in the peak period than would otherwise be realized.

While FISC has served GO Transit well in the past, new economic realities may soon make FISC uneconomical to GO, at least for stations that have sufficient existing or potential parking capacity. This will require changes in the FISC program with new finding arrangements being sought, including the possibility of a dedicated fuel tax.

APPENDIX J

MINNEAPOLIS *TEAM TRANSIT* EXPRESS BUS IMPROVEMENTS

INTRODUCTION

This case study examines the express bus service improvements implemented during the period of 1992 to 1995 by the Metropolitan Transit Commission in Minneapolis, Minnesota. These improvements were identified, designed, and implemented by an interagency group known as *Team Transit*, which was established specifically to improve the efficiency and competitiveness of the metro area's public transit system through a fast, low-cost process which removes bureaucratic and other institutional obstacles to implementation. The overall goals of the program can be summarized as follows:

- *Increase highway capacity* through transit-oriented infrastructure improvements;
- *Promote public transit use* by providing commute alternatives that are truly competitive with private vehicle use; and
- *Expedite the implementation process* by fostering cooperation among agencies and a team-based approach to planning at the highest levels of administration.

These goals are accomplished through a combination of interagency cooperation, a shared vision of metropolitan area transportation needs, and a specific set of improvements aimed at enhancing the performance of the transit system. These projects include shoulder bus lanes to allow express buses to bypass congested areas of highway, ramp meter bypasses to allow buses to bypass ramp meter queues, and the retiming of traffic signals to favor transit vehicles.

The following sections will provide an overview of the *Team Transit* organization and some background about the economic and demographic setting of the agency, as well as describe the history of the program and details of the specific improvements. Although little detailed data is available with which to analyze conclusively the ridership impacts of the strategies employed, some evidence as to the probable effects and other relevant factors are discussed. Finally, an analysis of implementation feasibility issues is presented, along with conclusions about the efficacy of the strategy and its potential for transferability to other localities.

REVIEW OF THE CONCEPTS

The concepts employed in the *Team Transit* improvements can be generally categorized as follows:

- *Exclusive transit right of ways*. This might include everything from dedicated transitways to freeway HOV lanes and bus-only lanes on city streets. *Team Transit* has converted sections of freeway shoulder to bus-only lanes, and has added bus-only bypass lanes to metered freeway entrance ramps.
- *Transit priority strategies*. These techniques generally involve using traffic signals or other devices to give priority to transit vehicles when in mixed traffic. *Team Transit* has employed signal retiming on downtown streets, used a device to give additional green time to approaching buses at traffic signals, and implemented an on-board system to speed up the ramp meter cycle for transit vehicles.

The first highway facility dedicated exclusively to high-occupancy vehicle use, and indeed the first *bus only* facility in the US, was the exclusive bus lane demonstration project on the Shirley Highway (I-395) in the Washington DC metropolitan area, which opened in 1969. As of 1992, there were 49 HOV projects in 22 metropolitan areas, constituting approximately 378 lane-miles in North America.* Another 540 miles of facility are under construction or in the planning stages. The list of facilities which allow only transit buses (as is the case in Minneapolis) is considerably shorter, including only the Pittsburgh transitways, the Ottawa transitway in Canada, and the Boulder Turnpike concurrent flow HOV lane in Colorado. These lanes began operation in 1977, 1982, and 1986 respectively. The first facility to use an existing paved shoulder lane was opened in Houston in 1981.[1]

A 1985 study of the effect of HOV ramp meter bypasses on vehicle occupancy did not find significant modal shifts resulting from the HOV bypass lanes, and cites several other studies which reached the same conclusion.[2] A more recent simulation study of Santa Clara County in California found that the HOV bypass lanes at metered freeway entrance ramps might produce some slight modal shift toward high occupancy vehicles under certain congested conditions.[3]

Transit signal priority has also been the subject of a good deal of study in the literature. Using simulation modeling, Yedlin and Lieberman found that under the right conditions, significant travel time benefits may be realized from signal preemption strategies without disrupting general traffic.[4] A 1982 evaluation of a system in Memphis found reductions in delays for both buses and automobile traffic.[5] A simulation for downtown Chicago performed by Rouphail found only small increases in bus travel speed under mixed traffic, but large increases when a reserved bus lane was assumed.[6] A review of a trolley priority system in San Diego found a typical savings of two to three minutes of travel time per trip.[7] The

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* A detailed inventory of North American HOV facilities is provided in:
Texas Transportation Institute (1992), *An Assessment of High Occupancy Vehicle (HOV) Facilities in North America, Executive Report*. College Station (TX):Texas Transportation Institute.

[1] Fuhs, C. E., "Concurrent-Flow High Occupancy Vehicle Treatment on Freeways—Success Story in Houston." *Transportation Research Record* 854, (1982) pp. 43–54. This facility used the median shoulder rather than the outside shoulder, in order to transition to a section of contraflow lane.

[2] Rogers, C. A., "Effects of Ramp Metering with HOV Bypass Lanes on Vehicle Occupancy." *Transporation Research Record* 1021, (1985) pp. 10–15.

[3] Singh, R., *Traffic Congestion, HOV Lanes & Ramp Metering—A Case Study*. ITE 1992 Compendium of Technical Papers.

[4] Yedlin, M. and Lieberman, E.B., "Analytic and Simulation Studies of Factors that Influence Bus—Signal-Priority Strategies." *Transportation Research Record* 798, (1981) pp. 26–29.

[5] Lipinki, M. E., McBride, P. R., and Sullivan, C. S., *Implementation and Evaluation of the Memphis Bus Priority System*. Proceedings of the Specialty Conference on Design Construction and Rehabilitation of Public Transit Facilities, San Diego, California (1982).

[6] Rouphail, N. M., "Operational Evaluation of Bus Priority Strategies." *Transportation Research Record* 994, (1984) pp. 30–34.

[7] Celniker, S. and Terry, E. W., "Trolley Priority on Signalized Arterials in Downtown San Diego." *Transportation Research Record* 1361, (1992) pp. 184–187.

TABLE 43 Population and employment growth in the Twin Cities metropolitan area

Year	Minneapolis–St. Paul MSA		City of Minneapolis	
	Population	Employment	Population	Employment
1980	2,137,000	n.a.	394,170	190,727
1990	2,464,000	1,350,200	368,383	197,439
1992	2,617,000	1,395,600	363,000	189,758
1994	2,688,000	1,580,400	n.a.	206,195

Source: US Bureau of the Census.

TABLE 44 Metropolitan Transit Commission service characteristics, 1993

Minneapolis–St. Paul MSA total land area (sq. miles)	8,113
Urbanized area (sq. miles)	1,063
MTC service area (sq. miles)	1,105
Service area population	2,098,064
Annual passenger miles	286,812,046
Annual unlinked trips	66,598,023
Annual vehicle revenue miles	24,218,627
Annual vehicle revenue hours	1,635,668
Total fleet/peak requirement	970 / 855
Operating expenses	$120,608,524
Capital funds expended	$13,035,409

Source: American Public Transit Association, 1993 National Transit Database.

most recent studies include an evaluation of the Powell Boulevard Pilot Project in Portland Oregon, which found small reductions in bus travel time with signal priority,[8] and an evaluation of priority strategies in Ann Arbor, Michigan.[9]

We have not found any evaluations that focused specifically on strategies to speed up ramp metering rates; the *Team Transit* implementation appears to be the first of its kind in the US.

BACKGROUND

The Minneapolis–St. Paul region is one of the largest metropolitan areas in the United States, according to the Census Bureau. As shown in Table 43, the population of the region has been growing since 1980, averaging 1.4% per year between 1980 and 1990. Growth in more recent years has been even more rapid, however, averaging 2.2% per year between 1990 and 1994. Like many metropolitan areas, this growth has been occurring primarily in the suburbs, where a great deal of new development has taken place. The table shows that the population of the city of Minneapolis itself has continued to *decrease*.

While the table does show employment for the city of Minneapolis increasing, it is increasing at a slower rate than that of the surrounding suburban counties, such that employment has been shifting away from the central city area. Unemployment has generally been low, however, even during the most recent years, averaging about 4% over the last few years. The metropolitan area ranks ninth in the United States in terms of per capita income.

History of the agency

Although the *Team Transit* program was developed only within the last few years, the genesis of the program was much earlier. The bus company serving the city of Minneapolis, like that of many metropolitan areas, had been privately run before the 1970s. In 1976, the Minnesota Department of Transportation (MnDOT) was created from what had been the state Highway Department. Government control of the Minneapolis/St. Paul transit system was ushered in with the formation of the Metropolitan Transit Commission (MTC) in 1967. A summary of the agency's service characteristics are provided in Table 44.

As the MnDOT organization matured, the staff looked for opportunities to improve the provision of transportation services within the metropolitan area, and began to realize that these opportunities would increasingly require *intermodal* solutions. Traffic in the Twin Cities area had been growing steadily and peak period congestion was beginning to reach critical levels, while the prospect of new freeway construction was extremely limited. These worsening traffic conditions only exacerbated the steady ridership decline experienced by the MTC during the 1980s by disrupting service

[8] Kloos, W. C., et al., Bus Priority at Traffic Signals in Portland: The Powell Boulevard Pilot Project. ITE 1994 Compendium of Technical Papers.

[9] Al-Sahili, K. and Taylor, W. C., *Evaluation of Bus Priority Signal (BPS) Strategies in Ann Arbor, Michigan.* Presented at the 75th Annual Meeting of the Transportation Research Board, Washington, DC, 1996.

reliability and lengthening bus travel times. It became clear that a more macrolevel, systemwide approach would be required to address these issues adequately. Doug Gifford, then Assistant Commissioner of MnDOT, agreed with MTC Chief Administrator Mike Christensen that the two agencies should work together to improve the efficiency and performance of the city's transportation system through *transit-oriented* improvements to the highway infrastructure and traffic control facilities.

History of *Team Transit*

The first meeting of the agencies to map out this strategy was held in 1991. At the meeting it was agreed that the agencies would meet regularly in informal sessions to discuss possible joint efforts in planning transportation improvements. These meetings brought to the table not only the representatives from MnDOT and the MTC, but also staff members responsible for transportation planning and related functions at the local and regional governments, including Minneapolis Director of Transportation Michael Monahan, St. Paul's Public Works Department Chief for Transportation and Planning Mike Klassen, and Natalio Diaz, the Executive Director for the Metropolitan Council (the regional government for the Twin Cities metropolitan area). In addition, representatives from Hennepin County, the State Patrol, and other local agencies became involved.

The meetings were, at first, informal or *ad hoc* in nature but they were formalized after participation grew and more organization was needed. In August 1991, the *Team Transit* name was officially adopted and MnDOT staff member Tom Johnson was transferred to *Team Transit* to become the program's first director. As the meetings grew to over 25 people, the *Team Transit* Executive Committee was formed to separate the group into two and to make the meetings more manageable.

The Executive Committee comprised the most senior level representatives from the respective core organizations (MnDOT, Metropolitan Council, etc.), and it met separately to develop macrolevel direction and strategy for the rest of the group. The other members would, in turn, plan and implement specific projects consistent with the general objectives coming out of discussions in the executive sessions. An FTA demonstration grant had, by then, been secured to fund these initiatives.

DETAILS OF THE STRATEGY

Types of projects

Each of the projects implemented by *Team Transit* has the purpose of improving a specific aspect of public transit service. The general types of projects which have thus far been undertaken by *Team Transit* are as follows:

- *Ramp meter bypasses*. The Twin Cities area has long been a leader in the use of freeway ramp metering to manage traffic flow on the highway system serving the metropolitan area. The metropolitan area now has 368 ramp meters, constituting about one-third of all of the ramp meters in the United States, and they control access at more than half of all of the freeway entrances in the metropolitan area. *Team Transit* has added HOV bypass lanes to the metered ramps in several locations. These lanes allow buses to bypass potentially long queues of cars waiting for access to the freeway. They have also tested a device known as a "Speedlight" which allows the bus driver to accelerate the meter rate in locations where physical or other constraints prevent bypass lanes from being constructed. Because the ramp meters also work to improve mainline flow, the ramp meter bypasses were designed with two objectives:
  - Improve bus travel time by eliminating the wait at the meter; *and*
  - Improve bus reliability by avoiding the uncertain amount of congestion at the meter.
- *Shoulder bus lanes*. *Team Transit* has converted approximately 70 miles of freeway shoulder for bus-only travel during the peak period. These shoulder lanes allow buses to get around areas of traffic congestion. They were created with essentially the same objectives as the ramp meter bypasses, namely to reduce express bus travel times and to increase reliability of the service.
- *Traffic signal priority for transit vehicles*. A number of downtown traffic signals have been retimed to favor buses. *Team Transit* has also conducted an operational test of a modified version of the Opticom™ system, which allows buses to preempt signals in much the same manner as that used by emergency vehicles. The system uses a lower level of priority to extend green phases for a short time to allow buses to clear the intersection. The retiming of signals simply gives more green time to the street containing the bus route. *Team Transit* has also tested a signaling device aimed at diverting transit vehicles around congested areas. This system, known as "Route-o-Matic," provides the bus driver with a simple signal indicating the direction of the fastest route at a particular location. In each case, the objectives are again increased reliability (schedule adherence) and reduced running times.

In total, 33 projects have been implemented through *Team Transit*. A listing of shoulder bus lanes, HOV lanes, ramp meter bypass locations, speedlight locations, and Route-o-Matic locations is provided in Table 45. The locations of the shoulder lanes and ramp meter bypasses are shown graphically in Figure 11.

Organizational structure

Figure 12 provides an overall view of the relationship among the various agencies that participate in *Team Transit*. As the figure shows, these agencies are independent from other, each serving various functions of the local, state, or regional government. The Minnesota Department of Transportation is the state agency responsible for the planning, development, and maintenance of the state's highway system. Responsibility within MnDOT is divided among districts, with the Metro Division in charge of the district which is comprised of the seven metropolitan area counties.† The Metropolitan Council is also a state agency, but it is completely separate from MnDOT. It provides regional government functions for the seven counties which make up the Twin Cities metropolitan area. These

† The official Census definition of the metropolitan area, the Minneapolis–St. Paul Metropolitan Statistical Area, actually comprises an additional four counties. The seven counties over which the MC has jurisdiction are those including and immediately surrounding the cities of Minneapolis and St. Paul, and they constitute the core of the region.

TABLE 45 Inventory of *Team Transit* projects

Facility	Route	Location
Shoulder bus lane	Coon Rapids Blvd.	Avocet to Mercy Hospital
	Hwy. 252	Mississippi River to I-694
	Hwy. 47	37th Ave. to 85th Ave.
	Hwy. 100	Culuth St. to 36th Ave.
	3rd and 4th St. ramp	
	Hwy. 100	Excelsior Blvd. to 36th St.
	I-94	Snelling Ave.
	Hwy. 77	66th St. to Hwy. 62
	Hwy. 77	Minnesota River
	Hwy. 61	Lower Afton to St. Paul Park
	I-394	W. of Xenia to E. of Hwy. 100
	I-35W	44th to 47th St.
	Cliff Rd.	I-35 W to Nichols Rd.
	Cedar Ave.	140th to 138th St.
	3rd St. Entrance	7th Ave. N to 25th Ave. N
	5th St. (St. Paul)	Washington to Broadway
	6th St. (St. Paul)	Washington to Broadway
	6th St. (Minneapolis)	11th Ave. S to 13th Ave. S
	Cedar St.	7th St. to 4th St.
	Minnesota St.	Kellogg Blvd. to 7th St.
	University Ave.	37th Ave. NE to 85th Ave. NE
Ramp meter bypass	I-94	Weaver Lake Rd.
	Hwy. 169	36th Ave. N
	Hwy. 169	I-394
	I-394	Hwy. 100
	Hwy. 100	Minnetonka Blvd.
	I-94	6th St. Minneapolis
	I-94	Cretin Ave.
	I-94	Snelling Ave.
	I-94	6th St. St. Paul
	I-394	Hwy. 101
Route-o-Matic	I-394	Plymouth Rd.
Speedlight	I-94	Hemlock Ln.

Source: Metropolitan Council Transit operations.

functions include regional planning, waste control, and all transit operations, including the MTC (the operating agency is known as Metropolitan Council Transit Operations). *Team Transit* is officially part of the MTC, as shown in Figure 13.

Figure 14 provides a general overview of the "management structure" of *Team Transit*. Although the program was designed to avoid bureaucracy and rigid administrative structures, the figure should provide a general idea of how the program functions. Essentially, macrolevel strategy and objectives are formulated through the Executive Committee, which in turn empowers the *Team Transit* Director to initiate specific projects with the cooperation of the other members of the program.

The Executive Committee, as previously described, comprises the top managers from the partner organizations. The role of the committee is threefold:

- To provide a general grant of authority to *establish the scope of work* to be undertaken by *Team Transit*, rather than details of specific projects;
- To facilitate direct cooperation among the agencies, and *remove bureaucratic obstacles*; and
- To work collectively at the highest levels of the budgeting process to *locate funding sources*.

The Executive Committee ensures that there is a consistent level of awareness among the constituent agencies regarding important or interesting transportation-related issues, and serves to promote a consensus of macrolevel objectives, and the means by which to accomplish them. For the first two years the committee met every two months, but now has only quarterly meetings as a smooth, and almost routine, operation of *Team Transit* has been achieved.

Although some ideas have come from other team members, specific *Team Transit* projects are primarily initiated by the Director. The role of the Director, while supervisory in nature, focuses on the specific details of identifying, designing, and implementing each improvement project. He works directly with key staff people at the other constituent agencies. He is empowered to act on anything within the general scope of work established by the Executive Com-

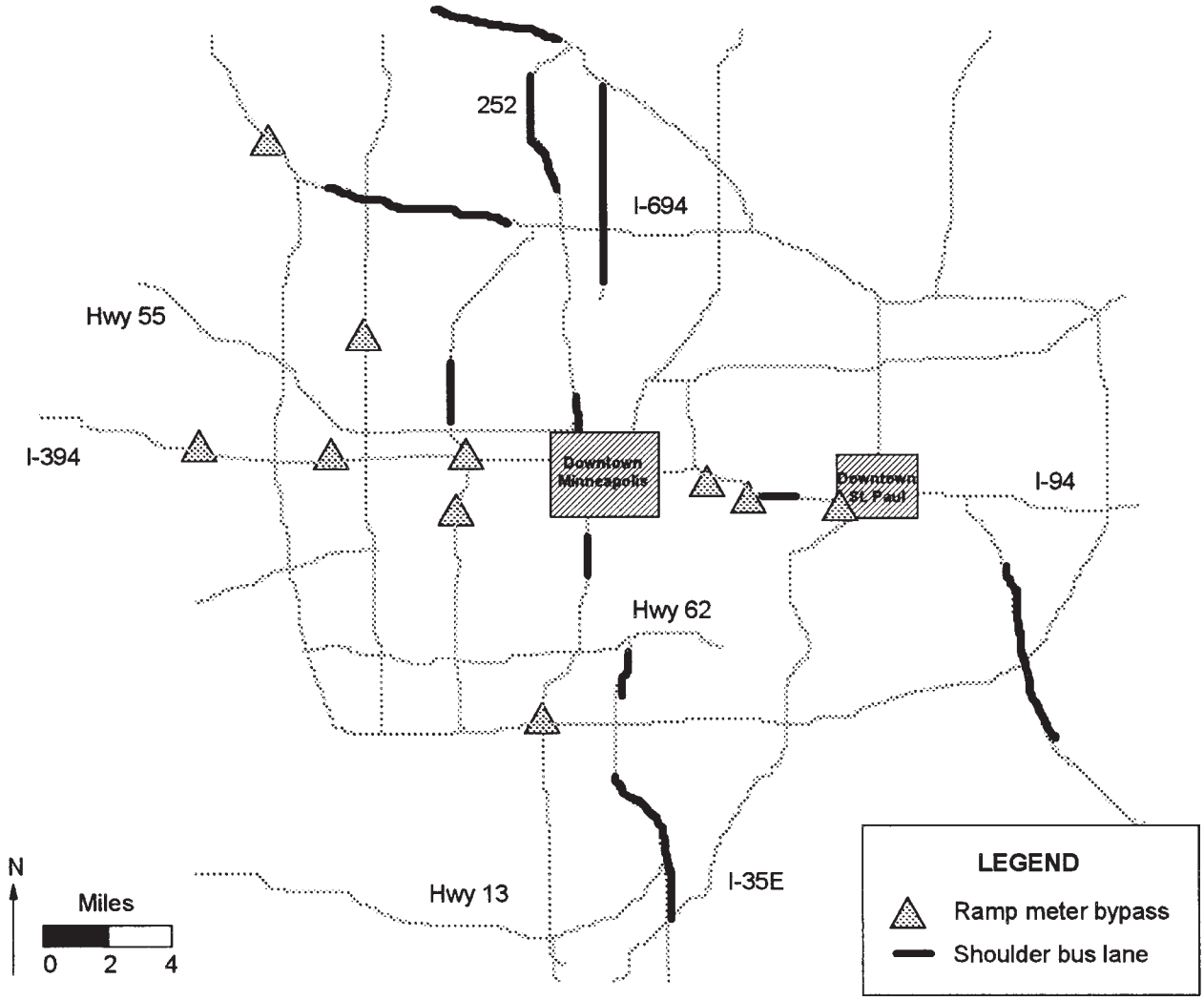


Figure 11. Locations of Team Transit projects.

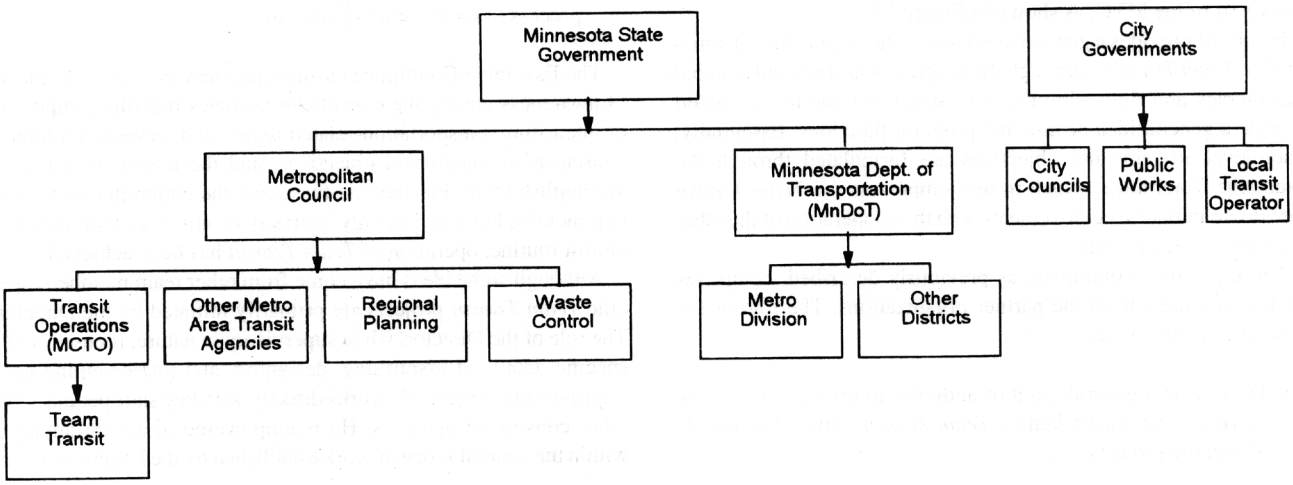


Figure 12. Organizational structure of Team Transit constituent agencies.

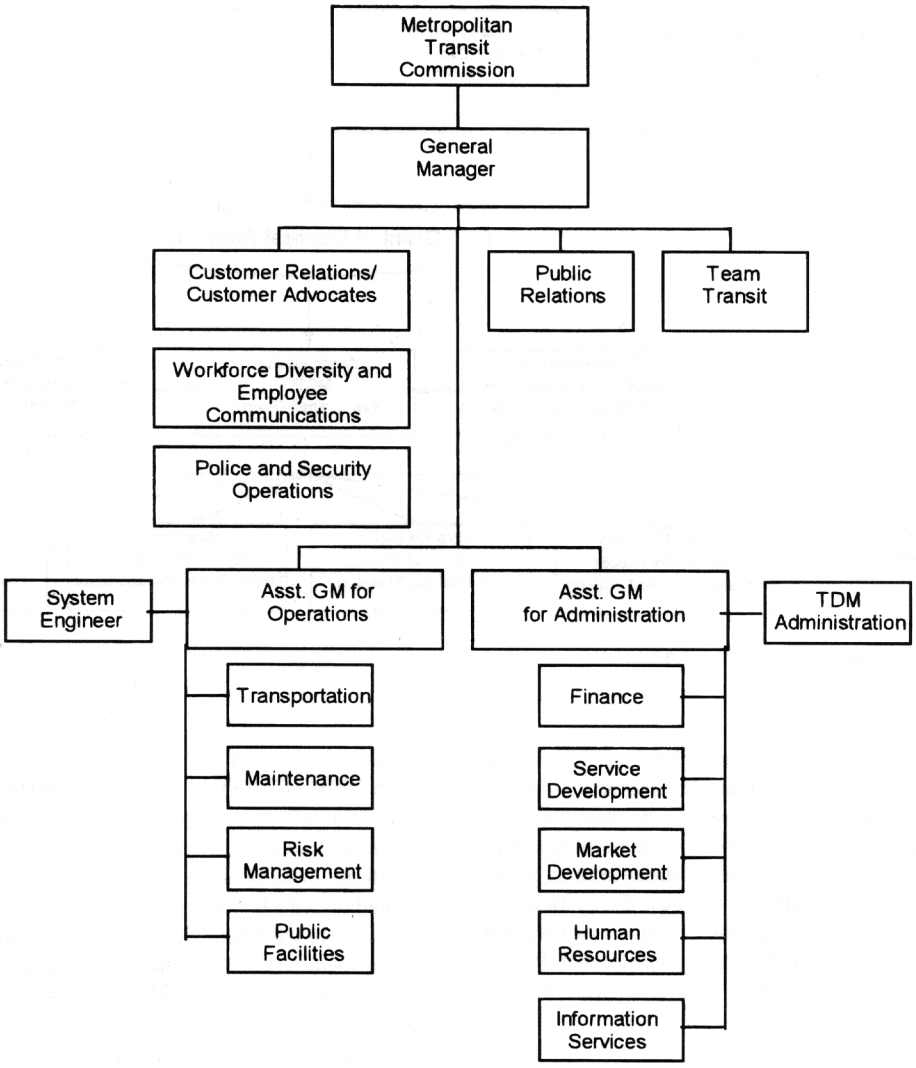


Figure 13. Metropolitan Transit Commission (MCTO) organizational chart.

mittee without their prior approval, and without any formal agreement between agencies.‡

For identifying potential improvements, the Director relies on his own first-hand experience, input from bus drivers, supervisors, and other staff members, as well as first-hand observation of real time traffic conditions from any of the 170 cameras in the MnDOT Traffic Management Center's traffic surveillance system, each of which can be monitored remotely from the MCTO dispatch center.

The remaining members of the Team consist of a few designated staff members within MTC who work primarily on *Team Transit* projects, and the designated technical staff members at the other constituent agencies.

Marketing and promotion§

Team Transit has used a variety of inexpensive marketing strategies to provide information and incentives to the traveling public. Specifically, they include the distribution of brochures at the location of new projects (to explain the operation of the transit improvement), community newspaper ads, and portable changeable message signs at new project locations (to display information about the project).

A 12-minute promotional video has also been created which describes the *Team Transit* program, its benefits, and some typical projects. The video has been shown to numerous civic groups. The MCTO also conducts an annual "Race the Bus" promotion, in which a transit bus using the shoulder lanes and other transit-favoring improvements competes with an expensive sports car traveling the same route from the suburbs to downtown. The promotion is done in association with "rideshare week," and obtains good radio and television coverage. Invariably the bus has won the race by a considerable margin.

EVALUATION OF IMPACTS

This section describes the evaluation of the impacts of the *Team Transit* improvements. We discuss the possible effects of the pro-

‡ An agreement is required in cases where funds must be transferred from one agency to another to complete a project.

§ Information for this section was provided by the MathCraft/JHK team as part of their evaluation for FTA.

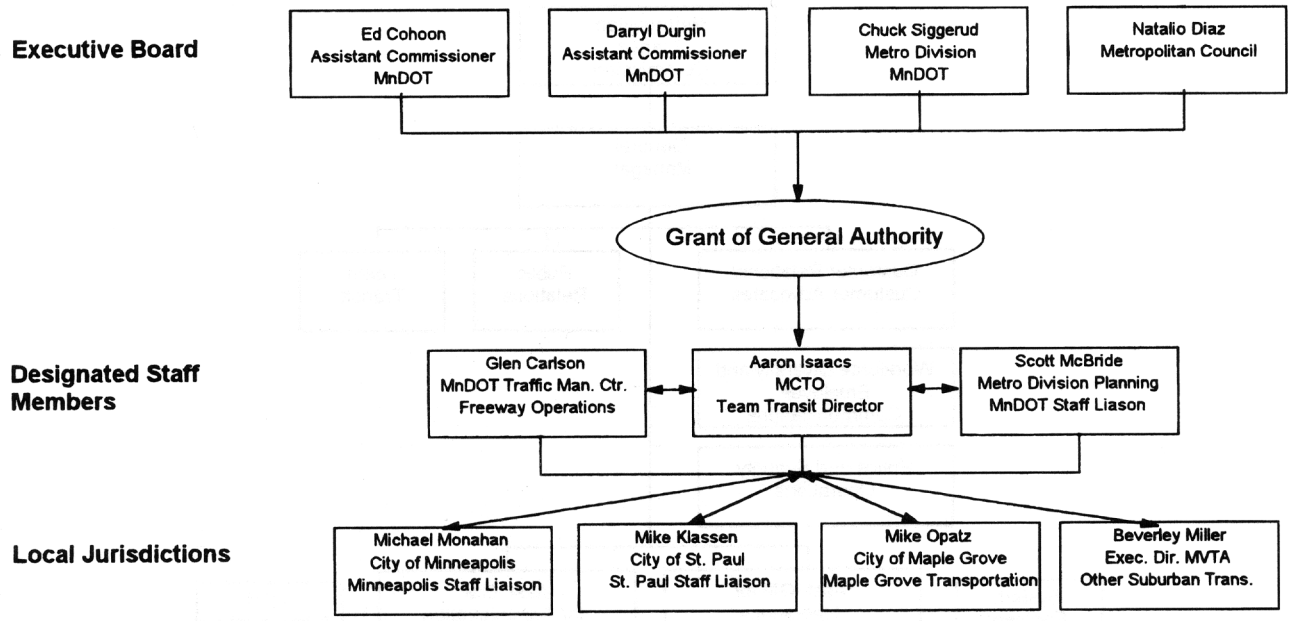


Figure 14. Team Transit operating structure.

gram on level of service, on operating and other costs, on ontime performance, and on public opinion about the program. Ridership impacts are examined to the extent that they can be identified.

A separate evaluation of the *Team Transit* program was conducted concurrently for the Federal Transit Administration by the firms of MathCraft Inc. and JHK Associates. For efficiency, JHK/MathCraft worked with CRA on the collection of data and other information on *Team Transit* during a joint site visit. Part of the documentation of the evaluation was prepared by the JHK/MathCraft team and is summarized as follows:

> Project evaluation includes improvements to transit travel time in terms of either reduced number or length of stops, reduced delay for the route, improved travel times, reduced overtime, improved reliability, increased ridership, and improved customer satisfaction. For each evaluation, (the assembled data included) the number of buses, estimation of patronage before and after the action, measured travel time and speed improvements, results of rider surveys, and amount of overtime from the bus schedule. Each evaluation also includes background information such as the lead and supporting agency, funding used, cost of the project, location and description of the projects and the date implemented.

Funding and costs

The funding of *Team Transit* projects has come from a combination of federal demonstration funds, state and local transit and highway and/or public works budgets, and a small amount of other ISTEA funds. There are some administrative costs associated with the *Team Transit* program itself, but these are limited to the salaries and related expenses of the few dedicated MTC staff members who are assigned to the program, including the Director.

Specifically, funding is broken down as follows:

- *FTA demonstration grant*. *Team Transit* Project Number 6320, *Team Transit Operations*, is funded through an FTA grant. To date, FTA has approved three grants providing funds from Section 26(b) of ISTEA. The grants provided a total of $350,000 in 1993; $500,000 in 1994; and $500,000 in 1995. They paid for salaries, marketing, engineering, design, and consultant services. A detailed breakdown of these costs is given in Table 46.
- *Metro Area Bonding*. The Minnesota State Legislature has authorized a bonding program to fund transportation improvements in the Twin Cities metropolitan area. From these bond proceeds, about $1 million has been allocated for *Team Transit* project number 3390, *Team Transit Improvements*. This money pays for actual capital and other construction costs of specific *Team Transit* projects. In addition, metro bonding provides funds for MnDOT, and about $1 million has been spent either directly or indirectly on *Team Transit* projects. This metro bonding program also provides part of the funds for *Team Transit* project number 3556, *Speedlight*. The metro bonding portion is roughly $440,000, and the remainder is paid from ISTEA funds as described below.
- *Other ISTEA funds*. The Intermodal Surface Transportation Efficiency Act of 1991 provides additional funding under the national planning and research program of Section 26(b). *Team Transit* has received about $160,000 from this program, all of which has been used for the Speedlight project.
- *Local budgets and other funds*. In addition to the funds received directly from the federal government and state bonding, portions of some improvements are funded through the transportation or public works budgets of the participating local agencies. These cases are typically situations where *Team Transit* has been unable to provide all of the funding for a project within one of the localities, but the agency views the project as important for improving local traffic conditions or transportation service.

The figures in Table 46 describe the total budget for all of the *Team Transit* projects in each year. Table 47 provides examples of the costs of some specific projects, as well as the agency or agen-

TABLE 46 Administrative cost breakdown for *Team Transit*

Category	1993 Budget*	1994 Budget	1995 Budget
Administrative salaries/personnel		$125,925	$272,200
Fringe benefits	$50,000	26,911	135,800
Technical/professional services			
Real estate consultant	30,000		
Engineering consultant	30,000	100,000	
Marketing and public relations	30,000	40,000	54,800
Equipment	5,000		
St. Paul transit hub leases	30,000		
Stations operations cost		207,164	
Overhead			37,200
Total	$350,000	$500,000	$500,000

* 1993 figures do not add to the total as not all funds were expended in that year.
Source: Metropolitan Council Transit Operations.

cies which provided the funds for implementation (as distinct from the original funding sources described above).

Level of service measures

The shoulder bus lanes have been very successful in providing improved transit times. They have resulted in improved reliability, as measured by driver overtime, which was reduced by two-thirds in some cases. The primary level of service impacts of each type of project are shown in Table 48.

The ramp meter bypasses have been very successful in reducing delays for transit vehicles. MCTO reports that, on average, the ramp meter bypasses have saved 2–3 minutes per bus during peak periods, with some savings of 10 minutes experienced at Weaver Lake Road and I-94. The time savings are often limited by queues that form back from the ramp, blocking vehicles from entering the bypass lane. In the case of Speedlight, the ramp metering is accelerated when a transit vehicle is recognized in the queue, and time savings for transit vehicles at Speedlight locations may sometimes be as high as 4 minutes.

Only two signal prioritization projects were evaluated for this study. Measures of effectiveness were measured for reduced delays, and travel times and reduced stops. Typically this information is modeled for a signal system. Empirical data were used to assist in the calibration of the model. The model was used to report before and after operations for signal timing changes for numerous measures of effectiveness. Specifically, bus delay at traffic signals was reduced by 32%, travel time was reduced by 7%, and stops were reduced by 19% for a simulation of signal timing which would give priority only to transit vehicles.

The Route-o-Matic project at I-394 and Highway 280 did not yield significant benefit to transit vehicles since the detour times were longer than the delay in the existing route. However, the simplicity of the equipment can allow for easy removal and installation for testing at other locations throughout the region.

Customer reaction and ridership

We had originally hoped to complete a fairly thorough examination of the ridership impacts of the *Team Transit* improvements,

TABLE 47 Total Costs and funding sources of *Team Transit* projects

Project type	Approximate cost	Funding sources
Shoulder bus lane	$25,000–$200,000, depending on length	MnDoT, local governments
Ramp meter bypass	$50,000–$200,000, depending on length	MCTO, local governments
Speedlight	$19,500	MCTO, MnDoT, local government
Route-o-matic	$5,000–$10,000	MCTO
Signal retiming	$265,000	MnDoT, local government
Opticom signal priority	$60,000	MnDoT, MCTO

Source: Metropolitan Council Transit Operations.

TABLE 48 Summary of level of service improvements from *Team Transit* projects

Project type	LOS improvement
Shoulder bus lane	1–20 minutes saved per bus
Ramp meter bypass	2–10 minutes saved per trip
Speedlight	0–4 minutes saved per trip
Route-o-matic	time saved on 10–15% of trips
Downtown signal retiming	bus delay reduced 32%; bus travel time reduced 7%
Opticom signal priority	38% reduction

Source: Metropolitan Council Transit Operations.

including an econometric analysis of ridership by route segment which would attempt to identify statistically significant impacts of specific improvements. Unfortunately, all of the data required for this analysis could not be produced by the agency.

As an alternative, we attempted to compare total ridership by route before and after the improvements were implemented. Because detailed historical data on ridership at the route level was not available on a monthly basis for the entire system, we were only able to compare the most recent route totals to the annual figures for the year before the program began. This also proved problematic, due to the many service changes that had occurred during that several-year period. While we were able to make a somewhat crude adjustment to account for the "overall" service level on each route, we still could not compare all of the routes since some routes had been modified, added, or discontinued. We were, therefore, only able to reach the very general conclusion that ridership along routes with shoulder bus lanes has improved somewhat, at least when compared to trend patronage increases.

We do also have the results of customer surveys as evidence, albeit much more qualitative, of possible ridership impacts. These surveys indicate that the use of shoulder bus lanes did influence people to use transit, and that there were perceived time savings. The surveys also indicated that the shoulder bus lanes did not impact other traffic negatively. Finally, we simply have no data with which to assess the impact of the signal prioritization project, as the general public and transit patrons along the route were not included in the customer surveys.

SUMMARY AND CONCLUSIONS

Through a cooperative, interagency program known as *Team Transit*, the Metropolitan Transit Commission has successfully implemented a series of improvements to its express bus service. These projects make use of the existing highway infrastructure to improve the level of service of the bus and, therefore, make it more competitive with the private vehicle. They include shoulder bus lanes which allow the bus to avoid congestion, and bus-only ramp meter bypass lanes which reduce delays.

Surveys of riders and some other measures have shown that the level and quality of service have improved as a result of the program. Ridership impacts are hard to isolate, but there is limited evidence that suggests that the improvements may have had a positive effect.

Transferability

Some limited experience is already available with which to assess the transferability of at least the interjurisdictional cooperative aspects of *Team Transit*, if not the applicability of the specific projects themselves. We conducted telephone interviews with the New York State DOT and Connecticut Transit, two agencies that have heard about *Team Transit* and tried to apply its principles to their own situation.

The New York State DOT has been given a federal grant for a multimodal ITS study which will analyze public transit and the highways as one integrated system, and will identify a series of "early start" projects that could be implemented in the short term. In the future, the agency plans to promote a "Mobility Task Force," which would be modeled on the Minneapolis *Team Transit*. Generally, the important differences evident in the New York situation are

- *Many more actors*. The New York Metropolitan area has many more legal jurisdictions as well as more agencies involved in transportation for the region. As such, "interagency cooperation" is that much harder to achieve.
- *No history of cooperation*. Unlike Minneapolis, there is no history of cooperation among the "big players," and thus the concept of a coordinated planning effort is much newer and therefore "harder to sell."
- *More difficulty obtaining funding*. Because of this more competitive environment—with many more actors vying for what is probably proportionally less money—it is unlikely to be as easy to secure funding for these kinds of initiatives.

Although Connecticut Transit has not attempted to use a *Team Transit*-type program to implement specific projects, the agency has adopted some of the general principles and goals of the program into its management philosophy. They have created a "big picture" planning process which solicits input from all the major players rather than just the transit management staff. In this process, they seek to form a consensus view or "vision" of what transit should do, where it should be going, and so on. It is their intention that this consensus view will facilitate the strategic planning process by avoiding downstream resistance to ideas.

This principle may not be useful for planning the *specifics* of projects, but once all of the major players have agreed to the "big picture" goals, the specific programs necessary to achieve these goals

may prove easier to implement. As in New York, the local situation is not as conducive as the Twin Cities to a *Team Transit*-like program because there are many different jurisdictions to deal with. As a state agency, Connecticut Transit must deal with authorities for police, traffic, signage, and the local streets in each of the many cities and small towns in which the agency provides service.

Institutional issues

In interviews with the members of *Team Transit* and the local actors involved in specific projects, the strong consensus was that the success of the program rests on the following factors:

- *History of progressive thinking*. Minnesota has a history of pioneering and proactive thinking in transportation planning, having been a leader in the implementation of ramp meters, HOV facilities, and ITS (they currently have one of the largest operational test projects in the United States).
- *Shared intermodal view*. Minnesota was also one of the first states to begin to plan transportation needs from a "big picture," intermodal view. One of the highway-side founders of the *Team Transit* program remarked, ". . . many agencies were brought kicking and screaming to ISTEA—we came willingly."
- *Interagency cooperation*. While the *Team Transit* initiatives are improvements to the *transit system*, they would be impossible without the active cooperation of the highway department. This cooperation may stem from the mindset described above but may, to some extent, result from "Minnesota nice," the stereotypical attitude thought to pervade the region.

Other factors

There evidently were no important legal factors in the success of the program, but there are some political issues that may be relevant. While the actors involved have, for some time, taken an intermodal view of planning, the political reality seems to be that additions to highway capacity are simply not possible unless they are HOV facilities. It is, therefore, in the interest of the highway side to cooperate in the *Team Transit* improvements, to the extent that they further their own goals of improving service for those who continue to drive.

APPENDIX K

TIDEWATER REGIONAL TRANSIT TIMED TRANSFER SYSTEM

INTRODUCTION

This case study examines the timed transfer system implemented during the period of 1989 to 1991 by Tidewater Regional Transit in Norfolk, Virginia. An overview of the transit agency is provided, as well as some background as to the economic and demographic setting of the agency. The history of the project within the agency is described, as well as the design implementation of the system as it is currently configured. Although little detailed data are available with which to analyze conclusively the ridership impacts of the strategy, some evidence as to the probable effects and the other relevant factors are discussed. Finally, an analysis of implementation feasibility issues is presented, along with conclusions about the efficacy of the strategy and its potential for transferability to other localities.

REVIEW OF THE TIMED TRANSFER CONCEPT

The timed transfer concept is hardly new. In principle anyway, it dates at least as far back as 1910, when pulse scheduling was used in Eugene, Oregon to attempt to allow trolleys to meet intercity trains, and was used at several other properties before they were publicly controlled. The concept itself is fairly simple: schedules are arranged such that transit vehicles (usually buses) on two or more routes meet at predetermined times at a central location (called a "transit center" or "transfer center") to exchange passengers. When many routes are scheduled in this fashion, a potentially large number of passengers can be exchanged, and therefore a large number of potential origin-destination flows can be served by a lower number of routes. The process is exactly analogous to the "banks" used by the airlines at so-called "hub" airports.

Literature review

The study of timed transfer systems in the literature has generally tended not to concentrate on their ridership impacts, but has instead focused on the theory of their operation and other design and implementation issues. The first comprehensive review of timed transfer applications was performed by Charles River Associates in 1980.[1] A 1981 study prepared by Vuchic for UMTA (now the FTA) outlined the general parameters for designing an effective timed transfer system, and suggested the kinds of systems that might benefit from its implementation.[2] Kyte *et al.* studied a specific implementation of the concept for the city of Portland, Oregon. This project, which used two transit centers as part of a network redesign of the Westside section of the city, was successfully implemented in 1979.[3] The study found that a high degree of service reliability could be maintained and schedule efficiency was improved. Ridership increased significantly, but the effect of the timed transfer system could not be isolated from contemporaneous increases in service levels.

The Portland system, along with systems in Ann Arbor (Michigan) and Boulder (Colorado) served as case studies for a 1983 UMTA report that reviewed the design and cost effectiveness of timed transfer networks.[4] This study also found large increases in unlinked trips for the Boulder and Ann Arbor systems, but was unable to determine the extent to which this was caused by the increased transfer rate inherent in timed transfer design.

In 1984, a case study of the application of the timed transfer/transit center concept in Tacoma (Washington) was performed by Schneider *et al.*,[5] who found that the Pierce Transit District was able to convert from a radial system to a multifocal point system with six transit centers. The authors noted that the transit center based system could better accommodate the low-density, dispersed land use patterns observed in the service area, and public opinion polls showed that 80% of users found the service easy to use. Unlinked trips were shown to have increased, as in the Ann Arbor and Boulder cases.

Mathematical simulations of a variety of timed transfer strategies were performed by Abkowitz *et al.*, who found a broad range of route conditions where a transfer strategy can be shown to be effective and preferable to an uncoordinated system.[6] Finally, Bakker *et al.*, reviewed the design of a timed transfer system for Austin (Texas), and detailed the process whereby a timed transfer network is developed.[7]

North American experience

There have been several other implementations of timed transfer systems in North America besides those described above. Generally, timed transfer may be described as belonging to one of three categories:

- "Simple timed transfer," where two routes are operated so that some vehicles will meet at a transfer point;
- A "line up," usually used in offpeak or evening hours with low frequencies and long layover times; and

[1] Charles River Associates, *State of the Art of Current Practices for Transit Transfers.* US Department of Transportation, Transportation Systems Center (1980).
Charles River Associates, *Transit Operator Guidelines for Transfer Policy Design.* US Department of Transportation, Transportation Systems Center (1980).

[2] Vuchic, V. R., *Timed Transfer System Planning, Design and Operation.* Prepared for the Urban Mass Transportation Administration (1981).

[3] Kyte, M., Stanley, K., and Gleason, E., "Planning, Implementing, and Evaluating a Timed-Transfer System in Portland, Oregon." *Transportation Research Record* 877 (1982).

[4] US Department of Transportation, Urban Mass Transportation Administration, *Timed Transfer: An Evaluation of its Structure, Performance and Cost, Final Report*, Washington, DC (1983).

[5] Schneider, J. B., Deffebach, C., and Cushman, K., "The Timed Transfer/Transit Center Concept as Applied in Tacoma/Pierce County Washington." *Transportation Quarterly*, Vol. 38, No. 3 (1984).

[6] Abkowitz, M., Josef, R., Tozzi, J., and Driscoll, M. K., "Operational Feasibility of Timed Transfer in Transit Systems." *Journal of Transportation Engineering*, Vol. 113, No. 2 (1987).

[7] Bakker, J. J., Calkin, J., and Sylvester, S., "Multi-Centered Time Transfer System for Capital Metro, Austin Texas." *Transportation Research Record* 1202 (1988).

TABLE 49 Summary of selected agencies with timed transfer experience

City	System	Type	Area	Population	Budget	Directional Route Miles	Rides
Albany, NY	Capital District TA	S	150	509,106	25,283,047	1,137	39,736
Austin, TX	Capital Metro	P	572	604,621	72,452,025	762	93,937
Columbus, OH	Central Ohio TA	L	543	961,437	46,207,197	1,029	61,983
Denver, CO	RTD	NP	2,406	2,000,000	229,412,309	3,936	221,942
Fresno, CA	Fresno Area Express	P	168	452,000	15,768,641	339	28,443
Knoxville, TN	Knoxville TA	L	80	162,161	7,148,772	356	8,988
Lafayette, IN	Greater Lafayette PTC	P	29	107,344	3,449,935	97	6,961
Memphis, TN	Memphis Area TA	L	347	702,512	27,107,446	766	44,118
Portland, OR	Tri-County Metro TD	L	592	988,284	251,489,553	1,471	209,507
W. Covina, CA	Foothill Transit	P	293	1,344,166	23,726,113	793	37,545
Tacoma, WA	Pierce Transit District	P	275	575,000	52,209,179	954	43,000
Norfolk, VA	Tidewater Reg. Transit	P	253	910,000	22,713,989	602	30,401
Toledo, OH	Toledo Area Reg. TA	L	149	417,624	19,216,991	741	18,175
Washington, DC	WMATA (MetroBus)	S	1,486	3,005,757	955,533,638	2,834	490,615

Note: The "type" column refers to the categories of timed transfer described above: s=simple timed transfer, p=pulse scheduling, np=neighborhood pulse, a limited variation of pulse scheduling, and l=line up.
Sources: Population and area served from 1995 APTA Membership Directory; ridership from APTA Transit Ridership Report for Second Quarter 1995; directional route miles from 1992 APTA Transit Operating and Financial Statistics; transfer type from Charles River Associates.

- "Pulse scheduling," the most complicated form of timed transfer where common headways coordinate the meeting of all routes at several transfer centers.

Although we could find no definitive source detailing the *current* state of timed transfer applications in North America, Table 49 presents a summary of systems that use (or have used) a timed transfer system.

BACKGROUND

Tidewater, Virginia lies in the southeastern corner of the Commonwealth, where the James River meets the Atlantic Ocean. The southernmost portion of this area, known as South Hampton Roads, is a five-city region comprising the cities of Norfolk, Portsmouth, Chesapeake, Suffolk, and Virginia Beach. The area is quite large in size because several of these localities were counties that were incorporated as cities to avoid being annexed by the city of Norfolk.* There are a wide variety of settings, including urban downtown Norfolk, the busy beachfront resort community of Virginia Beach, very rural areas in the southern portions of Suffolk and Chesapeake, and the Norfolk Naval Station, the largest military installation in the United States.

* Under Virginia law, a locality must be either a county or a city, but cannot be both. Therefore, either a municipal or county government provides local services.

Economic environment

The economic base of the region is also quite diverse, with the dominant industries being defense and tourism. In addition to the Naval Base in Norfolk, there are several other naval installations (including a naval shipyard) and an army base. Virginia has the highest per capita defense spending in the nation—$2,785 per person in 1991, or over $17 billion in total—and over 15% of this total was spent in the city of Norfolk alone.[8] Nearly 100,000 military personnel are stationed in South Hampton Roads, and defense-related employment is estimated at almost 150,000.[9] Tourism is also a very important industry, particularly in the resort area of Virginia Beach. It is estimated that about four million visitors come to South Hampton Roads each year.[10] In the rural areas of the southernmost part of the region, agriculture is a major industry.[11]

[8] Hampton Roads Planning District Commission, *Hampton Roads Military Impact Study*. Norfolk, VA (October 1992). The entire Hampton Roads area, including the Virginia Peninsula and therefore the Newport News Shipbuilding and Drydock Company (the Commonwealth's largest private employer), accounted for about 40% of total defense spending in Virginia.

[9] Ibid.

[10] The Wessex Group Ltd., *A Synthesis of Marketing Research*, prepared for the Tidewater Transportation District Commission (1995).

[11] Echols, J. C., "Use of Private Companies to Provide Public Transportation Services in Tidewater Virginia." Lave (ed.), *Urban Transit: The Private Challenge to Public Transportation*. Cambridge, MA, Balinger Publishing Company (1985). Mr. Echols is the Executive Director of the Tidewater Transportation District Commission.

TABLE 50 Tidewater Transportation District Commission service characteristics for fixed-route bus system (1994)

South Hampton Roads total land area (sq. miles)	1,100
TTDC service area (sq. miles)	253
Service area population	910,000
Annual passenger miles	34,614,572
Annual unlinked trips	7,942,054
Annual vehicle revenue miles	5,036,246
Annual vehicle revenue hours	404,615
Total fleet/peak requirement	167/128
Operating expenses	$18,092,306
Capital funds expended	$1,139,938

Source: Federal Transit Administration Section 15 data provided by the American Public Transit Association.

History of the agency

The new service examined in this case study continues a long history of innovation for the Tidewater Transportation District Commission (TTDC), a transit property which has worked aggressively to address vexing problems—like the provision of service to low-density areas and the inefficiency of peak period fixed-route service—through such new concepts as vanpooling and contract taxi services. The TTDC is a regional agency authorized under state law to plan, operate, and regulate public transportation services in South Hampton Roads. It was created in 1972 when the local transit provider came under public control.

The operating agency of the TTDC is Tidewater Regional Transit, which currently provides both fixed-route bus service and paratransit, trolley, and tour services, as well as a ferry service across the James River. It operates a total fleet of 285 active vehicles over a network of 34 fixed bus routes and provides over 100 large capacity passenger vans for vanpooling, elderly and handicapped service, and demand responsive "dial-a-ride" type of service. A summary of the agency's service characteristics are provided in Table 50.

As a regional agency, the Commission must provide service in each of the five cities in which it operates. An agreement with the agency allows each city to receive as much transit service as it is willing to pay for, with costs allocated based on route miles and revenues allocated based on fares.[12] Although state funds are provided for operating assistance, there is no *dedicated* local funding source (such as a property or sales tax). In 1976 the agency realized that rapidly rising expenses and declining ridership would soon require drastic reductions in service if costs could not be reduced. In the years that followed, the agency developed lower cost services by converting some fixed bus routes in lower density areas to vanpool services, and by purchasing services from private contractors.

During the 1980s, ridership continued to decline as fares were raised and service reduced.[13] Headways in the peak period were as high as 40 minutes on some routes and offpeak headways were an hour or more. The headways were also oddly timed because the schedules were written to maximize frequency within a given roundtrip time.[14] More routes were converted to paratransit and ridesharing services during this time.

In an effort to understand the needs of existing customers better, as well as to identify areas which were contributing to the ridership losses, market research studies were commissioned by the agency. These studies revealed that quality of service issues were very important in the minds of riders. Specifically, their three main concerns were:[15]

- *Schedule adherence*. The number one concern of riders was that the bus be on time.
- *Ease of transfer*. Many trips required more than one route, and riders wanted easy and convenient transfers.
- *Service frequency*. Riders wanted more consistent and regular service.

Shortly after the agency obtained these results, Professor John Bakker of the University of Alberta presented a paper on timed transfer at the TRB Annual Meeting in 1988.[16] Based on this presentation, the TTDC decided to study the application of timed transfer to their current system, and hired Professor Bakker to undertake an analysis. The results of this study were completed in March 1989, and they outlined a series of proposed changes to the route network to accommodate the initial phase of implementation.[17] These changes were implemented in September 1989 and a subsequent review was completed in January 1990, which also contained recommendations for the next phase.[18] Over the next year the remainder of the system was implemented, so that by 1991 all of the system's 34 routes served at least one of 19 transit centers. Four of these centers were subsequently eliminated.

DETAILS OF THE TIMED TRANSFER SYSTEM

System development

Figure 15 shows the current fixed-route service network with the remaining 15 transfer centers. The timed transfer system was developed as follows:[19]

[12] Echols, J. C., *op. cit.*
[13] Bakker, J. J. and Becker, J., *The Design of Timed Transfer Networks* (1993).
[14] Bakker, J. J. and Becker, J., *op. cit.*

[15] *Ibid.*
[16] Bakker, J. J., Calkin, J. and Sylvester, S., *op. cit.*
[17] Bakker, J. J., *A Recommended Timed Transfer Route Network for the Tidewater Regional Transit System.* Prepared for the Tidewater Transportation District Commission (1989).
[18] Bakker, J. J., *Direct Transfer Route Network for the Tidewater Regional Transit System: A Review of Phase One and The Next Phases for Implementation.* Prepared for the Tidewater Transportation District Commission (1990).
[19] Bakker, J. J. and Becker, J., *op. cit.*

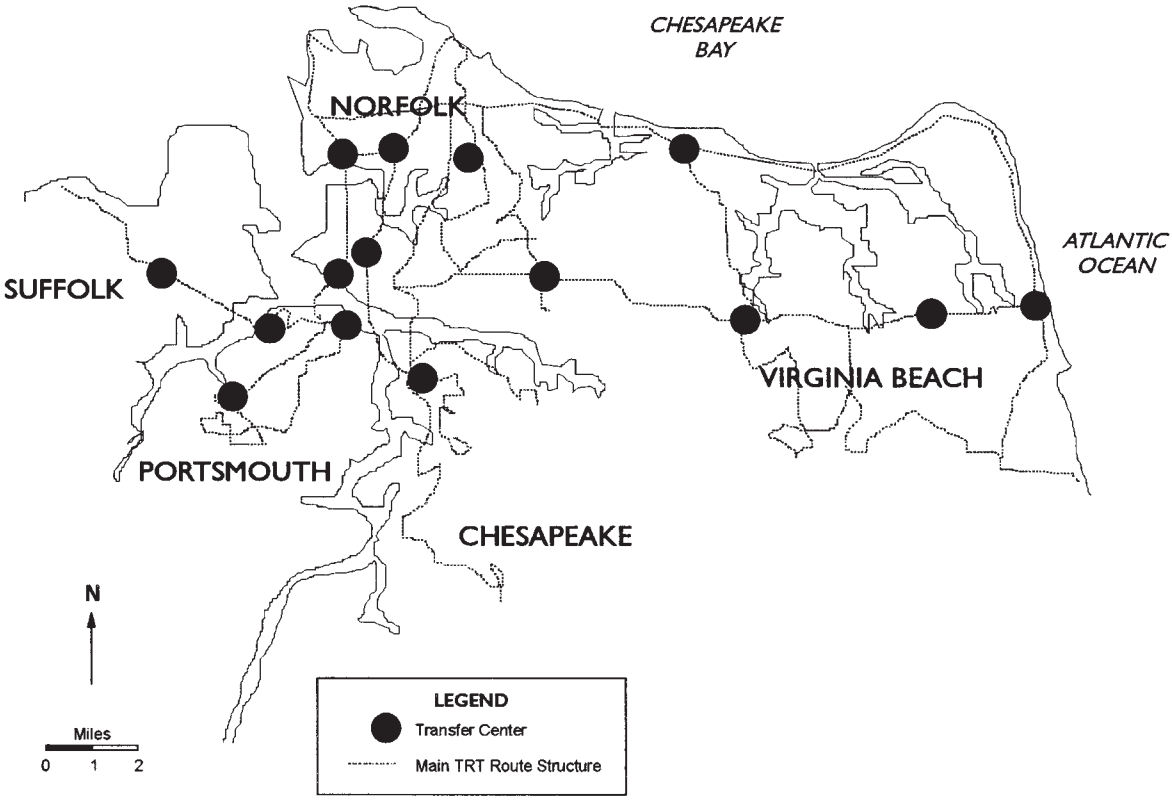


Figure 15. TTDC timed transfer system.

- A *common headway* was chosen—30 minutes for peak and 30 or 60 minutes for off-peak services. Part of the theory of timed transfer network design requires this common headway (or "schedule module") to allow the regular meeting of routes at transit centers.
- Optimal *transit center locations were identified*, by studying the existing network for places where routes come together.
- An *initial transit center was chosen*, and the clock time for connections was established (a certain number of minutes past the hour).
- *Other transit centers were established* based on locations where routes connected and where locations were about 30 minutes (or some multiple thereof) away. Situations were identified where route modifications would be required.
- *Schedules were developed*, based on connections with the initial transit center and written in minutes past the hour, and connection times were established for each transit center.

The initial transit center was located at the Military Circle shopping center, located near the intersection of Interstates 64 and 264 in the southeast corner of Norfolk. Although the transit center need only be a location where several buses can meet and exchange passengers, the other transit centers were also located, wherever possible, at or near popular destinations such as malls or large employers. This was made possible by minimizing the amount of space required for the transit center. While some analysts have stressed the importance of separate off-street facilities, the philosophy of the TTDC was that the purpose of the transit center was to make transfers as quickly and efficiently as possible, and thus a "building" was not needed. In some locations the shoulders of the street were widened to accommodate the temporarily parked buses, while in other locations the transfer center was simply an existing bus stop on a long stretch of wide road. In general, costs were kept to a minimum by avoiding additional land acquisition and construction.

All of the agency's schedules had to be redesigned and many route modifications were required, so the timed transfer system was not developed all at once. Rather, the implementation process was completed in five phases, each at six-month intervals during the three-year period between 1989 and 1991. After each phase was completed, problems were identified and corrected before the next phase began.

As shown in Figure 15, the timed transfer system allows a far larger number of origins and destinations to be connected. Table 51 provides a summary of the routes connected at each of the 19 transit centers.

System operation

Each route is scheduled so that it arrives at a transit center every 30 minutes, or in some cases every 60 minutes. Routes meet at the transit center at a fixed number of minutes past the hour (10 minutes and 40 minutes, for example). All buses do not necessarily arrive and depart at exactly the same time, but merely within a "window" of a few minutes, allowing passengers sufficient time to transfer but without delaying the schedule of any route.

As we have noted, many route modifications were required to implement the timed transfer system. This is because the route net-

TABLE 51 Routes served by each transit center

Transit Center	Location	Routes served
1	Near Naval Base, Norfolk	2,15
2	Near Naval Base, Norfolk	2,15
3	Near Naval Base, Norfolk	1,15
4	Central Norfolk	3,8,9,15,61
5	Amphibious Base, Virginia Beach	1,8
6	Northern Norfolk	1,3,80
7	Military Circle Mall, Southeast Norfolk	15,18,20,25,27
8	Norfolk Medical Complex	2,10,23,44
9	Southern Norfolk	1,4,10
10	Northern Virginia Beach	1,38,27
11	Pembrooke Mall, Virginia Beach	1,20,29,36,39,61
12	Near Oceana Naval Air Station, Virginia Beach	20,29
13	Eastern Virginia Beach (waterfront)	20,31,32,33
14	Tower Mall, Portsmouth	41,44,45,50,61,82,83
15	Eastern Portsmouth	41,45,46,47,50
16	Central Portsmouth	44,46,47
17	Churchland Shopping Center, Portsmouth	47,84,85
18	Northwest Chesapeake	6,13,86
19	Downtown Norfolk	1,2,3,4,6,8,9,11,13,18,20,45

Source: Tidewater Transportation District Commission, 1995.

work must be made to accommodate the basic 30-minute headway or "schedule module." While the initial transit center at Military Circle Mall happened to be about 30 minutes from downtown Norfolk, the other transit centers were not all so conveniently located with respect to one another. More than half of the existing routes had to be modified in some way to conform to the new schedules. Some routes were shortened while others were actually lengthened beyond their optimal total round-trip time. Timed transfer systems are designed for *network* optimization rather than for optimization of the individual *routes*.

Headways also needed to be changed to accommodate the schedule. Because a uniform "pulse" headway was instituted for all routes, all headways needed to be adjusted to 30 minutes, or some integer multiple thereof. In one case, a route was given a 15-minute headway (this will still work operationally, but the route will meet connections at the transit center only every other time).

The fare structure was also changed to be more appropriate for the timed transfer system. First, all transfer charges were eliminated. By making transfers free, the disutility of transferring was further reduced, and the passengers didn't need to understand a complex transfer policy. This also eliminated the costs associated with printing and distributing transfer slips, which would have only increased. The number of fare zones was also reduced, and subsequently, the zone structure was eliminated entirely. A zone structure is probably less appropriate where most trips are not routed directly but instead flow through transfer centers (it might arbitrarily penalize certain trips if their routing made them longer then the shortest path distance). Also, elimination of zone-based fares obviously made the system easier to use for patrons.

Marketing and promotion

The "Direct Transfer" system was initially promoted through brochures, fliers, vehicle signage, and bus schedules.[20] The agency also issued news releases, and used radio advertisements and in-person discussions with riders to inform the public about the system. Management scheduled a series of photo opportunities and radio talk show appearances, and the agency developed a Direct Transfer system press kit and a map of affected routes for distribution on board buses and at bus shelters.

A special promotion was developed to encourage people to ride the new system. Called the "Lucky Route 20 Rider Game," it involved the distribution of over 300,000 scratch-off game cards distributed on board the buses for a six-week period.[21] From these cards passengers could win free ticket books, bus rides, as well as food prizes at a local fast-food restaurant. The contest was judged a public relations success due to the high rate of prize redemptions (78% of free ride coupons), but turned out not to be cost effective, losing overall, about $10,000 for the agency.[22]

More recently, a new marketing campaign has been undertaken, known as "Guaranteed Connection."[23] This promotion, during the months of June and July 1995, offered free ride tickets to all pas-

[20] The Wessex Group, Ltd., *op. cit.*

[21] *Ibid.*

[22] The Wessex Group, Ltd., *op. cit.*, and *Cost Benefit Analysis of the Lucky Rider Promotion on Direct Transfer Routes*, prepared for Tidewater Transportation District Commission (1991).

[23] Southeastern Institute of Research, *Effectiveness of Guaranteed Connection Marketing Campaign.* Prepared for Tidewater Transportation District Commission (1995).

TABLE 52 Fixed-route bus level of service before and after implementation

Service measure	Before (1989 Q1)	After (1992 Q1)	Percent change
Number of route segments	44	44	—
Total in-service hours	1,335	1,196	-10%
Total in-service miles	16,310	14,292	-12%
Total peak vehicles	128	104	-19%

Source: Tidewater Transportation District Commission.

TABLE 53 Fare history for fixed route bus service

Year	Base fare	Zone fare	Transfer charge
1988	$0.80	$0.40	$0.10
1989	$0.80	$0.40	$0.10
1990	$1.00	$0.50	None
1991	$1.00	$0.50	None
1992*	$1.00	$0.50	None
1993	$1.10	$0.55	None
1994	$1.10	$0.55	None
1995	$1.50	None	None

Source: Tidewater Transportation District Commission.

* A temporary 10% fare surcharge was instituted for six months during 1992.

sengers who missed connections at a transfer center during the period. This program was advertised in buses, in the newspapers, and on the radio.

EVALUATION OF IMPACTS

This section describes the evaluation of the impact of the timed transfer system. The possible effects of the new system on level of service measures, the number of passengers needing to transfer, operation and other costs, ontime performance, and public opinion about the service are discussed. Ridership impacts are examined, to the (limited) extent that they can be identified.

Level of service

As has been described, a large number of route modifications proved necessary in order to implement the timed transfer system fully. These changes involved both the lengths and locations of routes, and also the frequencies of service on those routes. It is therefore important to compare the level of service provided before and after implementation. Table 52 compares some common level of service measures for the entire fixed-route bus system before and after the implementation of the timed transfer system.†

While the total number of separately identified route segments remains the same at 44, there were marked declines in each of the other service measures, indicating that, on balance, both the amount of coverage and the service frequency were reduced. The largest decline was in the number of peak period vehicles, which probably reflects the fact that some peak headways needed to be lengthened to accommodate the 30-minute schedule module (some were as low as 12 minutes before the timed transfer program).

It is important to note that these reductions, notwithstanding the above observation, are not necessarily the result of the transition to the timed transfer system *alone*. The agency continued to be pressured by budgetary constraints during this period, and therefore service reductions may have been required regardless of whether or not timed transfers were implemented.

Fares

In addition to the declines in the overall level of service which were experienced over the implementation period, the fare structure was also changed. Table 53 shows that fares were increased during this period, as well as in subsequent years. The transfer charge was eliminated, as well as the zone structure.

Transfer activity

It is expected that the number of passengers required to transfer will increase with the implementation of timed transfer, since transit centers are used to collect riders from many origins and distribute them to many destinations (like the airlines "hub and spoke"

† The first quarter of 1989 is compared with the first quarter of 1992 for consistency (to avoid any seasonal distortions), and also because a temporary fare surcharge was instituted in the middle of the *second* quarter of 1992. While this surcharge will not affect level of service measures, we use the first quarter to ensure compatibility in subsequent comparisons.

TABLE 54 Comparison of transfer activity

	Before (1989 Q1)	After (1992 Q1)	Percent change
Transfer rate	35%	45%	+29%
Average number of transfers*	N/A	1.4	—

Source: Tidewater Transportation District Commission.

* 61.5% of passengers reported transferring only once, while 23.6% transferred twice.

system). While these transfers are made easier (more available connections, less time for transferring, and at no cost), it is also important to note that there is a widely acknowledged "disutility" associated with having to transfer[24] which may have a mitigating effect on ridership.

According to a market research study undertaken by the agency, the transfer rate rose from 35% before implementation to 45% at the end of 1991 when the full system was in place.[25] The current transfer rate is now up to 51%.[26] A one-day transfer survey performed periodically by the agency shows that the absolute number of transfers in 1990 was 6,266; in 1994 it was 7,007, a 13% increase. These results are summarized in Table 54.

The market research study also showed that even riders who were new to the system were transferring at a relatively high rate of 42%,[27] and casual interviews with passengers at transit centers suggested that even infrequent riders can use the system with little difficulty. Overall, 90% of passengers in the survey thought that transfers were made easier with the timed transfer system.[28]

An evaluation of a recent marketing campaign aimed at promoting the system revealed that as many as one-third of the passengers missed a connection at least once during the two-month study period.[29] However, this figure is somewhat misleading since the same research also showed that 60% of passengers take the bus at least three times per week, and 30% use it five or more days per week. If we assume that the average rider made three round trips per week, this would translate into about 48 one-way trips over the two months. Even if we assume one connection is missed *per week*, this would still imply that overall connections are made almost 95% of the time.**

On-time performance was also perceived to have improved. Over 80% of riders thought that schedule reliability had improved as a result of timed transfer.[30] The more recent 1995 survey confirmed this result—over two-thirds of respondents thought buses were more likely to be on time or that the service was more reliable.[31]

Financial performance

Table 55 provides a before-and-after comparison of financial performance measures including operating costs and revenues, as well as the subsidy per passenger, the standard measure of efficiency.

As the table shows, costs increased in the aggregate while revenue declined, leading to a higher subsidy per passenger.

As shown in Table 52, the number of peak period buses declined over the implementation period, as did service hours and miles. It can be reasonably assumed, therefore, that capital costs were not increased by the advent of timed transfers. Some bus shelters were added at new transfer center locations, but presumably no new bus purchases were required. In at least one case, the street was widened to accommodate the buses, but this expense was borne by the city.

Customer reaction and ridership

The market research studies described above surveyed both current riders as well as residents who were not necessarily users of the system. Generally, the results of onboard surveys were very positive with respect to the Direct Transfer system. Highlights of the responses from the *current riders* are as follows:[32]

- Sixty-five percent of respondents were aware of the Direct Transfer system;
- Of the riders, 62% viewed the system favorably, 77% felt that schedules had improved, and 71% experienced decreased travel times;
- Twenty-two percent of the riders who were riding more frequently than they did one year before cited Direct Transfer as the main reason, while another 20% cited the free transfer policy; *and*
- Sixty-two percent of respondents rated TRT's service overall as being "good" or better.

The telephone survey of *residents* did not focus primarily on the Direct Transfer system, but rather on transportation issues in general in an attempt to understand each of the agency's potential market segments and the reasons why non-users did not take transit. However, the results do contain some useful information:[33]

[24] See for example Vaga, K. and Shortreed, J., *Impact of Transfers of Transit Ridership*. Presented at the Annual Conference of the Roads and Transportation Association of Canada, Ottawa, ON (1981).

[25] BRW, Inc. and LKC Consulting, *Short Range Transit Development Program.* Prepared for Tidewater Transportation District Commission (July 1993).

[26] Southeastern Institute of Research, *Effectiveness of Guaranteed Connection Marketing Campaign.* Prepared for Tidewater Transportation District Commission (October 1995).

[27] BRW, Inc. and LKC Consulting, *op. cit.*

[28] *Ibid.*

[29] Southeastern Institute of Research, *op. cit.*

** One missed connection per week would be approximately eight misses in the two-month study period. The proportion of trips with a missed connection would hence be (8 ÷ 48 =) 17% of trips. Since only one-third of the sample reported any missed connections, the overall rate would be 17% ÷ 3, or less than 6%.

[30] BRW, Inc. and LKC Consulting, *op. cit.*

[31] Southeastern Institute of Research, *op. cit.*

[32] BRW, Inc. and LKC Consulting, *op. cit.*

[33] *Ibid.*

TABLE 55 Cost comparisons for fixed route services

Measure	Before (1989 Q1)	After (1992 Q1)	Percent change
Total operating cost	$37,498	$40,342	+8%
Cost per incremental hour	$15.33	$19.33	+26%
Cost per incremental mile	$0.83	$1.03	+24%
Cost per incremental vehicle	$32.18	$48.58	+51%
Revenue	$19,643	$18,138	-8%
Required subsidy	$17,855	$22,204	+24%
Subsidy per passenger	$0.63	$0.88	+40%

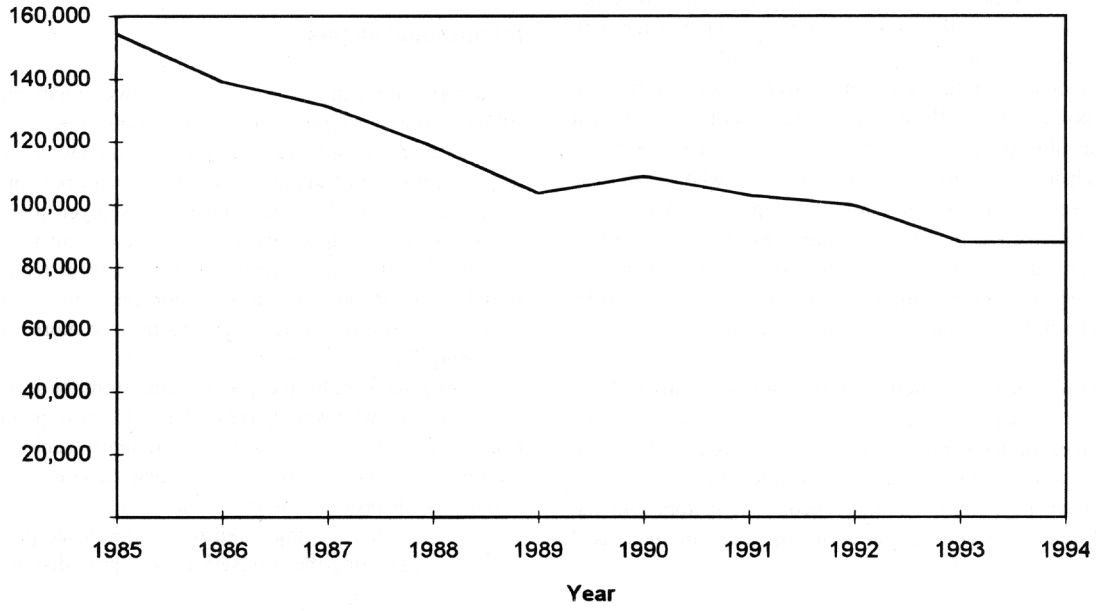
Source: Tidewater Transportation District Commission.

- Twenty-four percent of all respondents were aware of the Direct Transfer service;
- Fifty-seven percent of all respondents said they would be more likely to use the bus if they knew they could get direct or fast connecting service; and
- Fifty-five percent rated TRT's service as "good" or better.

Despite these optimistic responses, however, systemwide ridership has declined since implementation, following both the national experience and the local trend over the last several years. Figure 16 presents TRT's total ridership over the last 10 years.

As the graph shows, ridership did improve briefly in 1990, during the latter portion of the implementation, and the decline has most recently leveled off. The generally negative trend is consistent, however, with the large decreases in service and the accompanying fare increases that occurred during the period of timed transfer implementation, as shown in Tables 52 and 53. Because of these simultaneous changes, it is difficult to isolate the ridership impact of the timed transfer system. The relevant question in this case is not whether ridership increased or decreased, but rather, what would have happened to ridership had the fare and service levels remained constant. Here the evidence is largely circumstantial.

The survey results described above do suggest that some riders increased their transit trips because of the Direct Transfer system, and riders generally felt strongly that transfers were easier, total travel times were lower, and schedules were better. We know that these factors are positively related to transit ridership and therefore we can at least speculate that their effect was positive. The surveys also reveal that the fare increases and service reductions were far and away the major reason (77%) that riders used the bus less often. Moreover, about a third of respondents in the resident survey said they would be much more likely to use the bus if the service were more frequent or cost less.



Source: Tidewater Transportation District Commission.

Figure 16. Average weekday ridership, 1985–1994.

There are some other factors that tended to reduce ridership on the system, however, independent of the fare and service levels. Specifically, they include

- The 1991 recession, which increased unemployment rates in the region;
- Operations *Desert Shield* and *Desert Storm*, which drew tens of thousands of military personnel from the region during the period of November 1990 through July of 1991;[34] *and*
- A small decline in tourism during the period, as measured by hotel and lodging tax receipts.[35] TRT estimates that up to four million visitors per year come to the area and use the transit system.

Finally, it is possible that the additional marketing efforts were needed to communicate more fully the improvements in service resulting from the timed transfer system. The resident survey showed that over 50% of all respondents said they would be more likely to use the bus if it ran every 30 minutes (despite the fact that most routes operated at this frequency at least in the peak period) or if schedule information was easy to understand (despite the fact that all routes operate on clock headways). While overall, 24% of the respondents were aware of the Direct Transfer system, among heads of household with family members who never rode the bus, awareness was dramatically lower at only 3%.

SUMMARY AND CONCLUSIONS

The Tidewater Regional Transportation District Commission has implemented a timed transfer system for its fixed-route bus service. Called "Direct Transfer," this system collects passengers from many dispersed origins and efficiently distributes them to many dispersed destinations. This is accomplished by coordinating the meeting of many routes at a series of 19 transit centers throughout the service area. A fixed headway of 30 minutes allows the coordination of the schedules for all routes, and schedules are written with clock headways for simple use of the system by riders.

The implementation of the system has proved successful from an operational point of view. Buses are generally on time, and most passengers are able to make connections without difficulty. Surveys indicate a high degree of satisfaction among riders, who feel that the system has improved the service in many important areas. Interviews of the Service Development Manager, Marketing Coordinator, Scheduler, and Executive Director reveal a high degree of enthusiasm and satisfaction within the agency, and casual conversations with both drivers and riders suggest that the system is easy to use.

Ridership impacts of the system cannot be independently isolated from the effects of major service and fare changes that occurred during the period of implementation. Marketing research suggests that these changes may be the major factor in the ridership decline experienced by the agency, along with macroeconomic factors, and that the Direct Transfer system may have encouraged some increased tripmaking.

[34] Based on telephone interview with economist John Whaley of the Hampton Roads Planning District Commission.

[35] The Wessex Group, Ltd., *op. cit.*

Transferability

Timed transfer systems have been implemented at a variety of properties, large and small, for many years now. However, this should not be taken to imply that the concept is applicable at *any* agency. The literature describing the design of timed transfer systems is virtually unanimous in outlining the characteristics of the best candidate systems. Based on a review of this literature, and the more detailed study of the Tidewater system, they can be summarized as follows:

- Dispersed origins and destinations;
- Suburb-to-suburb flow;
- Low densities;
- Infrequent headways (offpeak); *and*
- Primarily bus service.

The first three features are mainly a function of local demographics, whereas the latter two reflect operational considerations. The dispersed origin-destination pattern may itself be the result of a reorientation of tripmaking towards suburb-to-suburb flow, but could also reflect a less developed area without a central core, such as that served by TRT. Likewise, low density could describe a typical suburban or rural area. These aspects are, of course, related to the operational features of candidate systems.

Where densities are low and the area lacks a concentrated origin-destination pattern, service tends to be less frequent as there is less demand. In central city areas where demand is high and service very frequent, timed transfers become less beneficial or unnecessary when buses come every few minutes. As such, the application of timed transfer may be suited to larger urban areas only in the off-peak where headways are longer. Service in suburban and other low-density areas is most often provided only by buses, since patronage would be insufficient to justify a rail system, and buses can more easily serve the many origins and destinations.

Institutional issues

Factors within the agency or local government may also contribute to the transferability of a timed transfer system. Despite the fact that many systems have used this technique, there is nonetheless a great deal of skepticism among transit operators that such a system can work effectively, particularly given the uncertainties created by traffic congestion and other factors outside the agency's control. The Tidewater Transportation District Commission has been known for some time as being innovative in its approach to the provision of transit service, and thus may be more willing to "try new things" compared with other agencies.[36]

The original idea for the system came from the service development manager, who was also responsible for its implementation. As Figure 17 shows, his position is sufficiently senior so as not to require a lot of internal approvals to make such major changes to the system. While proposals to *cut* service would apparently draw large crowds at public meetings, and may have raised political issues, simply reorganizing the way service was provided was not gener-

[36] For a more thorough discussion of the history of the agency, see Echols, J.C., "Use of Private Companies to Provide Public Transportation in Tidewater Virginia." (Chapter 4 of Lave, C. (ed.), *Urban Transit—The Private Challenge to Public Transportation*, San Francisco, CA, Pacific Institute for Public Policy Research (1985).

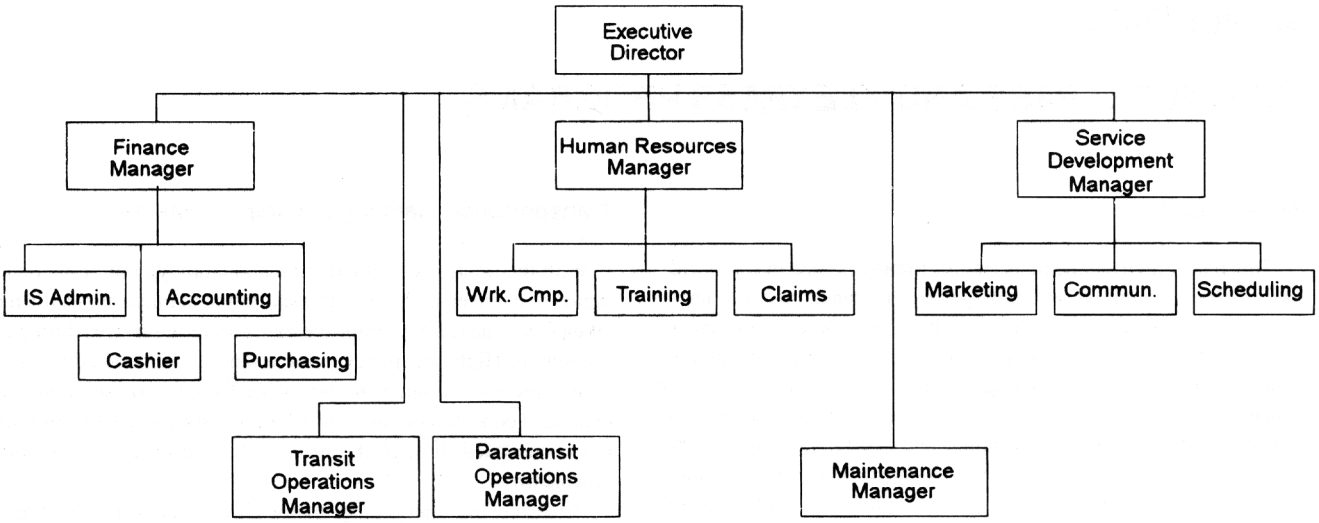


Figure 17. TTDC organizational chart.

ally a political problem. The constituent cities "purchase" transit service from the agency and generally do not get involved in operational matters. However, it was the opinion of the agency that this situation was not at all critical to the success of the program.

Other factors

As we have described, cost was evidently not a major factor in the implementation of timed transfer. In the present case, no new buses were required, and although operating costs did increase after the system was implemented, the increase was not necessarily caused by the timed transfer system. On the other hand, the TTDC made it a point not to construct elaborate off-street transit center facilities, which could have added markedly to the costs, or to increase service by adding routes or extensively increasing frequencies. The experience of other agencies shows that cost is a considerable factor. With the Portland timed transfer system, for example, operating costs were estimated to increase by $1,125,000 per year, and the cost of building off-street transit center facilities averaged over $1,000,000 each. Costs for the permanent facilities in Tacoma (Washington) were estimated to average about $500,000.[37]

Finally, the nature of the program required a relatively long timeframe for implementation (almost two years). While this system was complex even relative to other timed transfer systems (and therefore may have required more development time than would other systems), the longer timeframe necessarily implies a longer period before any potential benefits may be realized.

[37] Kyte, M., Stanley, K., and Gleason, E., *op. cit.* and Schneider, J. B., Deardorf, R., Deffebach, C., Latteman, J., McCormack, E., and Wellander C., *Planning, Designing and Operating Multi-Center Timed-Transfer Transit Systems: Guidelines from Recent Experience in Six Cities.* Prepared for the Urban Mass Transportation Administration (1983).

APPENDIX L

SEATTLE *U-PASS* AND *FLEXPASS* PROGRAMS

INTRODUCTION

This report reviews the potential for improvements in transit ridership through innovative employer-based transit fare products. Over the past decade or so, there has been considerable interest on the part of transportation planners to have employers take greater responsibility for the commuting patterns of their employees. This has led in some cases to local ordinances that require employers to ascertain employee commuting habits and develop plans to increase the use of public transit and other higher-occupancy travel modes. In response, a number of transit agencies and ridesharing organizations have tailored service and fare products to these employers, in the hopes of attracting more riders to transit.

A parallel Transit Cooperative Research Program study (Project H-6) is currently conducting a more extensive review of transit fares and innovative pricing ideas. To avoid duplication in the research effort, this appendix examines the particular experience of a set of employer-based transportation programs that were recently introduced in Seattle (Washington). The University of Washington, in cooperation with the King County Department of Metropolitan Services (Metro), introduced a special university pass (the *U-Pass*) for students, staff, and faculty at the university in 1991.

Based on the success of that program, Metro has introduced a second program for employers in the Metro service district called *FlexPass*, in which an employer may purchase passes for all employees. Employees may then have access to a large bundle of transportation services, including unlimited transit use. By reviewing the history and ridership impacts of this program, this case study documents the experiences of these two programs to date. From this, the ability of such pass programs to induce mode shift to transit can be evaluated, and the ultimate transferability of such programs can be assessed.

THE SEATTLE CONTEXT

Regional growth

The population and employment in the greater Seattle area has grown considerably over the past 10 to 15 years. According to the data in Table 56, the population in the Seattle-Bellevue-Everett PMSA grew by over 23% during the 1980s, and into the early 1990s it was still growing at a rate of about 2.1% per year. Most of the regional growth is occurring outside of Seattle proper; population within the city has grown only modestly since 1980, and is likely to still be below 1970 levels. In addition to population, employment in the greater Seattle area had grown by over 23% between 1980 and 1990. Moreover, the *employment* growth rate in the early 1990s has been considerably higher (by over 4.3 percentage points) than that for the resident population. While more recent statistics are unavailable, it is widely believed that Seattle is maintaining this rate of growth right up to the present.

Transportation planning and improvements

With the rapid rise in population and employment in the Seattle region over the past 15 years, transportation planners in Seattle have taken many measures to improve transportation services throughout the region. High-occupancy vehicle lanes have been added to the major freeways running through King County, transit service has expanded considerably over the past 20 years, and a new bus tunnel has been added through the heart of Seattle to improve mobility downtown.

However, like many other major cities in America, Seattle has experienced significant growth in traffic congestion and transportation problems. Partly in response to general growth in travel, and also due to declines in vehicle occupancies and transit usage, King County introduced a Commute Trip Reduction (CTR) ordinance that requires employers to reduce SOV use, either by increasing vehicle occupancies or by encouraging the use of non-motorized travel modes. While not mandatory, the CTR ordinance identifies target vehicle occupancies for different employers in various areas of the county. The *U-Pass* and *FlexPass* programs grew out of the transit agency's efforts to promote its services to these employers.

Seattle's transit service was assumed by the Municipality of Metropolitan Seattle (Metro) in 1972, through a local ballot measure. More recently, in 1993 this agency was merged with other countywide agencies into the King County Department of Metropolitan Services (also Metro). The current transit service characteristics of Metro are given in Table 57. Although perhaps most known for its operation of fixed-route and demand-responsive transit service in King County, Metro encompasses and supports a broad scope of transportation-related activities, such as services for carpoolers, vanpoolers, bicyclists, and pedestrians.

HISTORY OF THE PASS PROGRAMS[1]

U-Pass planning, implementation, and financing[2]

The University of Washington is one of the major employers and trip generators in Seattle. It is the second largest activity center in King County, after the Seattle central business district. The university itself has more than 33,000 students and 17,000 faculty and staff. As a result, it attracts a large number of trips each weekday. To meet this challenge, the university has taken considerable responsibility for improving transportation and travel options to and from the campus.

[1] Documentation of the details of the pass program was taken in part from King County Department of Metropolitan Services, Service Development Division, "Innovative Transportation Products for the Commuter Market." Unpublished discussion paper (1995).

[2] Details on the history of the *U-Pass* program are from Williams, M. and Petrait, K., "U-PASS: A Model Transportation Management Program That Works." *Transportation Research Record* 1404 (1993) pp. 73–81.

TABLE 56 Population and employment growth in the Seattle area

	City of Seattle		Seattle-Bellevue-Everett PMSA	
Year	Population	Employment	Population	Employment
1970	528,415	n.a.	1,424,605	n.a.
1980	493,846	n.a.	1,651,666	868,000
1990	516,259	n.a.	2,033,156	1,075,314
1992	519,598	311,437	2,122,126*	1,171,481

* = Extrapolated from 1990 and 1991 Census data
Source: US Department of the Census.

TABLE 57 Seattle Metro service characteristics, 1993

Service area (sq. miles)	2,128
Service area population	1,587,700
Annual passenger miles	487,695,058
Annual unlinked trips	83,712,089
Annual vehicle revenue miles	40,352,032
Annual vehicle revenue hours	2,354,016
Total fleet / peak requirement	2,535 / 1,708
Operating expenses	$225,756,985
Capital funds expended	$49,882,746

Source: National Transit Database, 1993.

Beginning in 1983, the City of Seattle and the university agreed that the university should create a transportation management program (TMP) to limit the growth in traffic to and from the campus, and to restrict parking both on campus and in neighborhoods that abut the campus. In response, the university offered carpool and vanpool programs and parking restrictions and sold transit passes to employees and students. By the late 1980s, initial gains from these programs seemed to be tapering off. In addition, significant growth in development at the university was projected to require considerably more need for transportation to and from campus.

During the 1989–1990 academic year, a committee of Seattle Metro staff and university faculty, staff, and students was set up to examine new transportation options for the campus. This committee agreed on several important factors for the university's TMP. Many transportation options would have to be supported, and a successful program would have to include both incentives and disincentives for travelers. The committee recommended a universal pass (hence *U-Pass*) that would allow all passholders access to many different transportation services around the campus, intending to reduce single-occupancy vehicle use and alleviate campus parking problems.

During the 1990–1991 academic year, the university transportation office put considerable effort into marketing the proposed *U-Pass* program. Elements of the marketing program included:

- A full-time staff position to provide information on the *U-Pass*;
- Marketing materials on Metro and Community Transit buses;
- Distribution of *U-Pass* program brochures on campus;
- Establishment of nine campus commuter centers and information kiosks; *and*
- An annual transportation fair.

In addition, several surveys on student and faculty/staff travel patterns were conducted on campus in the fall of 1990, creating some awareness of the proposed *U-Pass* program. The *U-Pass* program was approved in the spring of 1991 and was officially begun during September 1991. There was some discussion on campus about whether to make the program mandatory or optional for students. A majority (60%) of students were in favor of keeping the program optional, although the program would have been easier and probably less expensive to administer if it had been mandatory. Ultimately, the Regents of the university decided to make the *U-Pass* optional.

The program itself allows students, faculty, and staff to buy a monthly *U-Pass* at a considerably lower fee than a monthly bus pass or the monthly parking fee. Currently, the *U-Pass* costs $9 per month ($27 per quarter) for students, and $37.50 per quarter for faculty and staff. For those faculty and staff who normally drive, parking permits cost $42 per month ($126 per quarter), but include a free *U-Pass*. With the *U-Pass*, the following program elements are supported:[3]

[3] University of Washington Transportation Office, "U-PASS User's Guide." Seattle, WA, (1994).

- Free travel on Metro and Community Transit buses;
- 60,000 additional service hours in the university district by Metro and Community Transit;
- Reduced cost for daily commuter parking ($1.50/day with *U-Pass* versus $2.50/day normally);
- Free parking for carpools on campus if all riders hold a *U-Pass*;
- Up to $40 off the monthly vanpool fare;
- Free *U-Pass* and personal use of van to vanpool drivers;
- Free use of the Night Ride shuttle service (off-campus shuttle for trips after dark);
- A merchant discount program; *and*
- Reimbursement of 90% of taxi fare for "emergency" trips from the university, up to 50 miles per quarter.

This wide range of transportation options has been one of the strengths of the program. It allows participants considerable flexibility in their travel options, depending on their commuting patterns. For example, one may take advantage of a vanpool or transit on three days out of a week, but may also receive discounts on parking with a private automobile on the other two days.

Financing for the *U-Pass* is derived from three different sources:

- User fees, currently accounting for about 50% of the funding;
- Parking fee increases, providing an additional 35% of the funding; and
- The university itself (15%).

Of particular note is the fact that the parking rates on campus increased significantly in conjunction with the *U-Pass*; the $24 monthly rate was raised to $36 in October 1991, and has since been raised to $42. It was widely believed incentive to use the *U-Pass* would be more effective if it was implemented simultaneously with a significant disincentive for the single-occupancy vehicle.

Annual costs of the program run approximately $7.2 million, of which almost 75% goes directly to Metro and Community Transit. For these transit agencies, the university reimburses them at a rate of 25% of their operating costs for services through the university district. As agreed by the transit agencies and the university, this represents the approximate farebox recovery ratio for Seattle. The remainder of the operating costs of the Metro and Community Transit services are paid for from normal sources (such as county tax revenues).

FlexPass planning, implementation, and financing

From the early success of the *U-Pass* program, Metro in 1991 began to develop a similar program, called *FlexPass*, that could be targeted to employers who were judged to be in violation of the requirements of the Commute Trip Reduction ordinance. The *FlexPass* program was first introduced in the fall of 1993 and had five participating employers in its first year of operation. Twelve companies are now participating in the second year.*

*As of this writing, Metro had not made a decision whether to promote *FlexPass* as a fully-fledged program. The initial participating firms were identified and recruited, for a fairly low level of effort, through established relationships with TMAs and company transportation coordinators. The agency appreciates that the level of marketing effort necessary to recruit further firms, should a decision be taken to expand the program, could be considerably more than the experience to date.

The *FlexPass* program operates as follows. The employer pays a certain fee (described below) based on the company size and current level of transit use by employees in the company. For this fee, *all employees* receive a pass that entitles them to unlimited transit travel and other benefits from a host of other transportation programs. In this way, the *FlexPass* offers a form of "universal" benefit that the employer may purchase for their employees. In all cases, the fee charged to the employer is completely tax deductible to the company, falling beneath the $60/month maximum deduction for transit passes as an employee benefit.

FlexPass offers employers considerable flexibility in designing a transportation program that suits their needs and interests. Indeed, one of the selling points of the *FlexPass* program is the variety of services one receives for the pass. In addition to unlimited transit ridership, the employer may also choose among several of the options to add value to their pass. These options include a guaranteed ride home program, parking discounts, preferential carpool and vanpool parking, discounted vanpool and ferry fares, merchant discounts, and noontime shuttle services.

A typical set of marketing tools is being used to sell this program to employers. First, employees are targeted directly through signs on buses and print advertisements in local newspapers. These ads encourage employees to contact their company's transportation coordinator about participating in the program. Metro also has access to information on employers' conformance with the Commute Trip Reduction ordinance, and has thus targeted mailings to firms in violation of it.

Metro originally designed the *FlexPass* to be approximately revenue-neutral to the transit agency. Toward this goal, the costs of *FlexPass* to the employer are as follows. At the beginning of the program, the employer pays a certain cost based on several factors, including the current number of transit riders at the company, the mean commuting distance for transit riders at the company, and the company location (urban, suburban, etc.). The fee is directly related to the number of transit users at the firm and their commuting distance. For the company location, Seattle has adopted a strategy whereby the price of the program is *higher* for companies in suburban areas. This is largely due to a local planning philosophy to keep land use densities high and not reward suburban business development.

The number of regular transit users is reviewed every year to determine the employer's cost. Due to the early success of this program, Metro has decided to pro-rate the cost for new transit riders from year to year. After the first year, the employer pays for one-third of the new transit riders, two-thirds after two years, and the full cost after three years in the program.

RIDERSHIP IMPACTS

U-Pass participation and transit patronage

Though it has only been in operation for about four years, the *U-Pass* program is considered very successful. Currently, approximately 34,000 passes are sold at the university during any one quarter, yielding a 76% participation rate among those on campus who are eligible. For the 1993–94 academic year (the latest on record), student participation rates were about 80% and faculty and staff participation was about 68%.

Specific goals of the *U-Pass* program were to reduce parking problems in and around the campus, and also to reduce vehicle trips

TABLE 58 *U-Pass* performance measures

Measure	Pre *U-Pass* 1990	1991	1992	1993	Percent change 1990-1993
Trips to campus, 7-9 AM	7,800	6,628	6,456	6,458	-17%
Trips from campus, 3-6 PM	8,979	8,205	8,246	8,267	-8%
Total vehicle trips, 24 hours	59,132	56,316	54,596	55,870	-6%
Transit mode (%)	21%			34%	+13%
SOV mode (%)	33%			24%	-9%
Carpool/vanpool mode (%)	10%			12%	+2%
SOV parking permits	7,467	6,347	5,664	5,400	-28%
Annual university transit ridership on metro		4,644,639	7,226,156	7,420,420	+60% (1991-93)
Daily carpool users	1,458	1,637	1,736	1,849	+27%
Daily vanpool users	79	116	216	204	+158%

Source: *U-Pass* Annual Report, September 1994.

to and from campus. The Transportation Office at the university has developed an intensive program evaluation and monitoring effort, producing annual reports[4] on the *U-Pass* program that contain specific performance measures, a sample of which is given in Table 58. The first block in this table shows vehicle trip counts from the university's survey conducted each October.[5] These results indicate a sharp drop in vehicle trips when the *U-Pass* program began, with little or no growth in vehicle travel since that time.

A second goal of the *U-Pass* program was to reduce parking problems on campus and in the surrounding neighborhoods. According to the data in Table 58, applications for SOV parking permits have been down considerably since 1990. This sizable reduction (28%) in parking permit purchases is, for the most part, due to the considerable increase in parking costs instituted in conjunction with the *U-Pass* program.

Perhaps more directly for this study, Table 58 also indicates considerable growth in transit usage. Transit mode share on trips to and from campus has increased from approximately 21% in 1990 to 34% in 1993, while SOV mode share has decreased from 33% to 24% over that same time period. Transit ridership going to and from the university has grown about 60% since 1991, and now makes up about 10% of the annual ridership on Seattle Metro. The increased ridership on campus, however, reflects not only the impacts of the *U-Pass* program but also of the 60,000 additional service hours to the university that Seattle Metro and Community Transit introduced in late 1991.

It is also interesting to note that the newer transit ridership is not necessarily at the expense of other higher-occupancy commuting modes. While the data in Table 58 suggest carpool and vanpool use has grown only modestly over the past few years, the fact that these statistics have grown at all, in the midst of significant improvements in transit service to campus, is remarkable. Overall, these results suggest that the *U-Pass* program has been effective not only in inducing mode shift to transit and other higher-occupancy vehicle modes, but it has also been effective at retaining these riders over a longer period of time.

FlexPass impacts on transit patronage

The *FlexPass* program, while only in place for slightly over two years, has also recorded some significant increases in transit use. Table 59 gives a brief summary of the first year of the program (primarily, calendar year 1994). Similar data for the twelve employers enrolled for 1995 are not yet available.

The results show significant percentage increases in transit ridership, an average of 85% more trips per employee across the five firms participating in the program. Increases at specific firms run from 18% improvement to 410% improvement in transit trips per employee. At the same time, the current scale of the *FlexPass* program is very small. For this reason, the absolute number of transit trips induced through the *FlexPass* program is on the order of only 4,000 trips per month, or about 150–200 trips per day. Considering that these five companies represent only about 0.1% of the total employment in the Seattle PMSA (from Table 56), the gains are modest but not necessarily insignificant. A simple linear extrapolation of these results suggests that penetrating one percent of the employment base with the *FlexPass* program may yield ridership gains on the order of one percent of the total ridership.

One other interesting note here is that the program is doing slightly better than being revenue-neutral. Metro claims to be gaining additional revenue from the program. In turn, this extra revenue is being used to support additional service and fare product development and marketing at Metro.

EVALUATION OF IMPACTS

Summary of experience

Several conclusions can be drawn from this review of the Seattle experience with the *U-Pass* and *FlexPass* programs:

[4] University of Washington Transportation Office, "U-PASS Annual Report." Seattle, WA, (1995).

[5] Gilmore Research Group, "The U-PASS Telephone Survey." Prepared for the King County Department of Metropolitan Services, Research and Market Strategy Division, and the University of Washington Transportation Office (1994).

TABLE 59 Summary of *FlexPass* results

Statistic	Before *FlexPass* (1993)	Start of Year 2 (1994)
Number of employers	5	5
Pass-eligible employees	1,379	1,280
Average transit trips per employee, per month	3.97	7.33 (+85%)
Total transit trips, per month	5,469	9,380 (+72%)
Total metro revenue per month	$5,559	$8,256 (+49%)

Source: Metro *FlexPass* Program Update, August 1995.

- Considerable effort is being made in Seattle to have employers accept some responsibility for the commuting habits of their employees. In the case of the *U-Pass*, the University of Washington and the Municipality of Seattle had begun discussing transportation options to the campus as early as 1983, and the university was willing to develop a transportation management program that ultimately included the *U-Pass*. The *FlexPass* program was also borne out of King County's Commute Trip Reduction ordinance, requiring employers to plan for their employees' transportation needs.
- Both the *U-Pass* and *FlexPass* offer free and unlimited use of transit services, but also include a considerable range of transportation benefits. The pass includes incentives for vanpools, carpools, guaranteed ride home, and even infrequent SOV parking benefits. This broad suite of options increases the value of these programs to the traveler.
- Both the *U-Pass* and *FlexPass* offer considerable discounts below the normal cost of transit passes. In this way, the financial benefit to the employees in the program are experienced directly.
- In the *U-Pass* case, the benefits of the pass were augmented by increases in transit service to the campus. At the same time, however, these incentives were coupled with sharp increases in parking rates, thus providing both a "carrot" and a "stick" for commuters to reconsider their commuting options.
- Finally, both programs were able to find stable and very acceptable sources of funding. In the university's case, funding for the *U-Pass* was available primarily through user fees and the (dedicated) increase in parking charges on campus. The cost structure for the *FlexPass*, on the other hand, while intended to be revenue-neutral for Metro, actually has financial incentives for both employers and employees. The pass can be provided as a tax-free benefit to the employee, and the employee has lower out-of-pocket costs for transit and other transportation services with the pass.

Comparison with other employer-based pass programs

Another transit agency adopted a similar employer-based pass program. The Denver Regional Transit District (RTD) initiated its ECO Pass program in September 1991.[6] Like the Seattle *FlexPass*, an employer participating in the program purchases a transit pass for every employee in the company at a substantially discounted rate. The pass is then available to all employees; those choosing to use the pass receive a photo identification card that allows them unlimited and free use of transit services in the Denver area. The program also includes a guaranteed ride home, so that employees are not caught waiting for a bus (or without a bus), if circumstances require it.

In the Denver case, the annual cost to the employer is determined by the employer's location (suburban, urban fringe, CBD) and on the size of the firm. Annual costs range from $25 per employee, for a firm of 250+ employees in a suburban location, to $180 per employee, for a firm of up to 24 employees in downtown Denver. At any rate, the full cost of the pass is entirely tax deductible to the employer. Employees who are bus riders receive about a 75–80% discount from the RTD's cash fare. More recently, the RTD has allowed employers to share the cost of the program with their employees directly. About 50–60% of the participating firms have their employees contribute to the program, with the average employee contribution at these firms at 50% of the total cost.

Unlike the lower levels of participation thus far in Seattle, over 730 companies are involved in the Denver program, accounting for over 30,000 employees in the Denver and Boulder areas. Many participating employers have also reported 10% to 700% increases in the number of transit riders. However, to date, the RTD has only undertaken limited survey work to determine the net impact on transit ridership and mode choice from the ECO Pass program. An independent consultant is currently conducting an evaluation of the program.

The *FlexPass* program is somewhat similar to Denver's ECO Pass program, but with several important differences:

- Employer costs are based on the number of transit users in Seattle, rather than on the total number of employees;
- Employer costs are higher for employers outside the urban area in Seattle, rather than lower; *and*
- Metro is able to provide a broader range of alternatives to SOV than just transit service and the guaranteed-ride-home program.

It appears from the Denver case, however, that with significant marketing and program design, a large number of employers may be attracted to an employee-oriented pass program. Given the longer history in Denver, it remains to be seen whether similar market penetration among employers in the greater Seattle area is possible. Even so, there appears to be a friendly rivalry between Den-

[6] Documentation of the ECO Pass program is taken from Schwenk, J., "Case Study of the Denver Regional Transportation District ECO Pass Program." Prepared for the Federal Transit Administration, Services Assistance Division, Report No. FTA-MA-26-0006-94-1 (1993).

ver and Seattle to keep these programs productive and generating new transit ridership.

Transferability

There appear to be a number of key elements of these employer-based transportation programs that enhance their success. At least the limited experience to date in Seattle and Denver suggests the following conditions for success:

- **Political/institutional interest in employer-based transportation programs.**
  Many urban areas in the US have instituted employer trip reduction ordinances, which provide at least local political support for having employers take responsibility for their employee's commuting habits. While the ordinances themselves may not be sufficient to achieve results (as was the case for Los Angeles' Regulation 15), in many cases they can result in opportunities for dialogue and in cooperative, innovative programs between the transit agency and employers.
- **Employee interest and support.**
  In Seattle, considerable effort was expended in the *U-Pass* program to ensure the support not only of the campus transportation officials but also of the students, staff, and faculty. Significant effort in early publicity, outreach, and surveys can help tailor specific programs to the travelers' needs, even before the program begins.
- **Significant range of options to employee.**
  Employer-based pass programs may be enhanced by including a broad suite of travel options, such as carpooling, vanpooling, guaranteed ride home, and other benefits. Such flexibility means that employees are not specifically tied in to one commuting option. In addition, this broad suite of options also allows employees to experiment with different travel options; even somewhat infrequent use of the pass for transit or carpooling should appear as beneficial to both the employee and to the transportation agency.
- **Coupling of incentives and disincentives.**
  While a greater suite of options and benefits is important to the program, significant changes in traveler behavior may not be possible without accompanying disincentives for other travel options. A significant increase in parking charges, for example, is one tool employers may use to achieve changes in commuting modes.
- **Potential financing options.**
  With some of these pass programs, the need for additional financing is small. Seattle's *FlexPass* and Denver's ECO Pass are largely revenue-neutral or even money-makers for the transit agency. In other cases, such as the *U-Pass*, dedicated sources of funding are necessary. One potentially fruitful source could be program-specific, financial disincentives, such as increased parking costs or other user fees, that are directly tied to the benefits of the new pass program.

APPENDIX M

PORTLAND *FARELESS SQUARE* PROGRAM

INTRODUCTION

This case study reviews the potential for significant transit ridership in response to fare-free programs. It is widely believed that substantial reductions, or even elimination, of transit fares may result in more substantive gains in transit ridership. Chapter 4 of this report summarizes the major impacts of fare levels on ridership, and cites a number of review articles that survey the changes in transit ridership resulting from a broad range of changes in fares. In addition, a parallel Transit Cooperative Research Program study (Project G-6) is conducting a more thorough review of transit fares and their impact on transit ridership.

This case study examines the particular experience of one fare-free program that has been in operation for over 20 years. The Tri-County Metropolitan Transportation District of Oregon (Tri-Met) instituted a fare-free district in downtown Portland in 1975. By reviewing the history and ridership impacts of this program, this report documents more thoroughly the experience of one program. From this, conclusions on the value of such fare-free zones to induce transit ridership can be made, and the ultimate transferability of such programs can be assessed.

THE PORTLAND CONTEXT

Development patterns and regional growth

Since the early 1970s, the greater Portland area has seen tremendous growth in terms of population and employment. As shown in Table 60, regional population in the Portland CSMA has grown from slightly over one million in 1970 to over 1.5 million in 1990, at a rate of almost 1.9% per year, and is estimated to be over 1.6 million in 1992. Regional employment, likewise, has grown substantially at a rate of about 2.2% between 1980 and 1992. More centrally, the population properly within the city limits contracted slightly during the 1970s, but has grown steadily (at about 1.6% annually) since the early 1980s. The growth in employment in the central city has been somewhat similar between 1980 and 1992, but this hides a sharp decline in the early 1980s (201,500 in 1984) and a relatively strong recovery since then.

Transportation planning and system improvements

The challenge to Tri-Met and the regional transportation planning community has been to manage the transportation system effectively in the midst of such rapid growth. Portland originally began the *Fareless Square* program at a time when air quality problems were most severe in the downtown area. In the early 1970s, the downtown area was in violation of national and statewide air quality standards one out of every three days, and the large number of private vehicles in this area was seen as the primary reason. In response, the region took the initial step of developing a then-somewhat innovative concept—a "transportation control strategy" to meet federal air quality standards. This study, completed in 1972, provided the initial groundwork for a Transportation Control Plan which was ultimately incorporated into the Oregon State Implementation Plan (SIP) in 1977. Elements of the Transportation Control Plan included

- A freeze on additional downtown parking spaces;
- Improved signal timing in the downtown;
- A downtown transit mall;
- A fare-free transit zone in the downtown (called *"Fareless Square"*); and
- Staggered work hours.

Additional transportation programs were instituted in the late 1970s and early 1980s to enhance mobility in the Portland area. These activities began with the enactment in 1978 of the Transit Mall in downtown Portland. The Mall created reserved bus lanes on Fifth and Sixth streets, running north-south, leveraging the fare-free service downtown to improve mobility.[1] Auto traffic on Fifth and Sixth streets was restricted as well, to enhance bus service through this zone.

Specifically, on each street, two out of the three lanes are reserved for buses, and the single general purpose lane disappears after every three blocks to minimize the pass-through private vehicle traffic. In addition, in 1986 Tri-Met initiated service on an east-west light rail line, called MAX, which bisects the transit mall and serves the eastern and western suburbs of Portland. A brief summary of Tri-Met's service is given in Table 61.

HISTORY OF THE *FARELESS SQUARE* PROGRAM

Planning, implementation, and program changes

Planning for the *Fareless Square* program began with the preliminary development of the transportation control strategy in 1972. The elements of this strategy were intended to help Portland reach federal and state air quality requirements. From that time, the mayor of Portland and Tri-Met worked actively to put many of the recommended strategies into practice. First in line was a freeze in 1972 on the number of parking spaces in downtown Portland.

In early 1974, as the energy crisis began, the mayor publicly promoted the *Fareless Square* program. A newly-appointed board of directors at Tri-Met agreed with the mayor to implement the program with funding coming directly out of Tri-Met revenues (that is, with no additional funding from the city or other sources). This was possible in part because of a dedicated 0.61% payroll tax in the city of Portland to fund Tri-Met service. In 1974, revenues and expen-

[1] Dueker, K., Pendleton, P., and Luder, P., "The Portland Mall Impact Study." Prepared for the Urban Mass Transportation Administration, Office of Planning Assistance, Report No. DOT-I-83-7 (1982).

TABLE 60 Population and employment growth in the Portland area

	City of Portland		Portland OR-Vancouver WA CSMA	
Year	Population	Employment	Population	Employment
1970	380,369	n.a.	1,047,343	n.a.
1980	368,148	250,000*	1,333,623	665,000
1990	437,319	n.a.	1,515,452	754,650
1992	445,458	248,724	1,625,034**	863,652

* = Estimated by Colman (1979a)
** = Extrapolated from 1990 and 1991 Census data
Source: US Department of the Census

ditures at Tri-Met were such that the payroll tax was not being used to its fullest extent, and thus could be used to fund the *Fareless Square* program.

A modest downtown circulator service, called the Shop Hop, had been operated by Tri-Met prior to *Fareless Square*. Service ran along Fifth and Sixth streets, with two buses at 10-minute headways providing service between 10 AM and 4 PM on weekdays. A modest $0.10 fare was charged for the Shop Hop service.

By contrast, the *Fareless Square* program eliminated this downtown circulator and instead offered patrons unrestricted, free access to the regular Tri-Met routes running through the downtown area. As originally designed, the *Fareless Square* program involved a rectangular area, running primarily north-south, including approximately 280 square blocks or about one square mile. This area was bordered by the Willamette River to the east, I-405 (the Stadium Freeway) to the west, Hoyt Street to the north, and Market Street to the South. Basically, the bus routes that serve this area were through-routes. In 1975, about 120 buses per hour passed through the fare-free zone during midday periods (9 AM to 4 PM). Also, the *Fareless Square* program operates during all normal Tri-Met service hours, from 5 AM to 1 AM.

Several other policy changes at Tri-Met were instituted simultaneously with the fare-free program in January 1975. These included

- An adjustment in the overall fare structure, from a $0.45/$0.75 zone-based fare system to a $0.45 systemwide flat fare;
- The introduction of a monthly transit pass, providing access to all Tri-Met transit service at substantial savings for frequent riders; *and*
- An adjustment of fare payment methods, from pay-as-you-enter (PAYE) to pay-as-you-leave (PAYL) for buses heading *outbound* from downtown. Inbound buses remained on a PAYE system. Passengers boarding before the Square and exiting after the Square would pay and then ask for a transfer slip. This slip would be presented upon exiting, to avoid paying twice.

Thus, transit patrons boarding within the fare-free zone are not required to pay a fare if they indicate to the driver that they will get off within the Square. However, once having boarded, passengers are on the honor system to alight within the zone. Drivers are generally not responsible for detecting and catching violators; separate fare monitoring agents are employed by Tri-Met to handle fare violations.

Several changes in the *Fareless Square* program have occurred in its 21-year history. The first major change was an expansion of the Square's area to include Portland State University, in July 1977. As originally designed, the southern border of the Square abutted the University; the new border was moved from a normal city street (Market Street) to the Stadium Freeway, a more obvious landmark. The revised Square covered 350 square blocks, a 25% increase in the zone's size.

In addition to this change in the zone size, Tri-Met has made several revisions to the Square's fare payment policy. The original PAYL system for outbound trips caused considerable delays for outbound buses because passengers had to make their way to the front of the bus to exit. This problem was particularly marked in the evening

TABLE 61 Tri-Met service characteristics, 1993

Service area (sq. miles)	592
Service area population	988,284
Annual passenger miles	224,993,022
Annual unlinked trips	60,673,950
Annual vehicle revenue miles	23,444,477
Annual vehicle revenue hours	1,781,604
Total fleet/peak requirement	740 / 579
Operating expenses	$113,894,866
Capital funds expended	$59,823,113

Source: National Transit Database, 1993.

TABLE 62 FY 78/79 costs of the *Fareless Square* program

Item description	Net costs/Funding sources (1978 dollars)
Shop Hop revenue	$12,750
Lost Intra-CBD revenue	$36,400
Additional bus hours in evening peak	$169,000
Total costs	$218,150
Shop Hop operating costs (cost savings)	$67,500
Net Tri-Met support	$150,650

Source: Colman (1979a), pp. 20-21.

peak period. Beginning in 1979, special conditions were added from 3 PM to 6 PM: fare-free privileges were suspended and a PAYE system was instituted. At all other hours, the fare-free program and PAYL on outbound trips were unchanged. As one might guess, the change in policy was considerably more confusing for passengers.

In 1982, systemwide fare payment was switched to PAYE in all directions at all hours. Coupled with new self-service fare machines, passengers were permitted to board through both the front and rear doors. Passengers were required to have proof of payment, and a group of 30 fare inspectors were hired to monitor payment. As a result of this policy, fare evasion increased considerably. The self-service fare program was canceled in April 1984, and drivers again became responsible for fare monitoring. Boarding through the rear doors was eliminated, except in *Fareless Square*.

Fare evasion remained a problem, however. In 1986, a proposal to eliminate the *Fareless Square* program, on the grounds of fare evasion and the costs of fare monitoring, was eventually shelved after considerable public outcry to continue the program. A final revision occurred in 1988, when it was estimated that Tri-Met was losing $250,000 to $300,000 annually from fare evasion. Front door boarding was instituted systemwide (including in *Fareless Square*), and the fare inspectors on the buses were eliminated. A more recent estimate of fare evasion, published in 1990, estimated losses on the order of $310,000 to $350,000 per year (about 1.9% of total revenues) because of buses in *Fareless Square*.

Additional losses may also be attributed to fare evasion on the MAX light rail service. When MAX opened in 1986, the *Fareless Square* program was extended to include that part of MAX that runs through downtown. Since MAX runs entirely on a self-service fare system, there are significant opportunities for fare evasion on MAX, and these are not entirely attributable to *Fareless Square*. Nonetheless, the same study in 1990 estimated fare evasion at about $150,000 for MAX, and part of this cost may be attributable to the *Fareless Square* program.

Additional financial and cost issues

When the *Fareless Square* program was being planned in 1974, the Tri-Met board of directors voted to support the program with part of the revenues from the 0.61% payroll tax of employers in the city of Portland. The authority for such a tax had been granted to Tri-Met in its enabling legislation in 1969. In general, these revenues are used directly to subsidize the fare-free service in *Fareless Square*. This works out to the program's advantage, as it is easy to argue that the primary beneficiaries of the program (downtown workers) are also those who are supporting it financially.

A cost analysis of the *Fareless Square* program was conducted in the late 1970s, as part of a broader evaluation of *Fareless Square* and other fare-free transit programs.[2] An accounting of these costs is given in Table 62. While these data are clearly dated, they do suggest that the most significant new costs of the *Fareless Square* program were those associated with additional service hours required by the program. In particular, Colman's analysis suggests that significant delays associated with the PAYL system during the evening peak resulted in the need for additional service during that time. Lost revenues, on the other hand, accounted for less than 23% of the total annual cost of the program.

Marketing

Initial marketing of the *Fareless Square* program was relatively modest. Perhaps most interesting was a contest that Tri-Met held to name the new fare-free zone. Flyers and other printed materials describing the zone were handed out on bus routes and at various key locations downtown; the local media were also contacted regarding the new program. Finally, additional signs were erected at all bus stops within the Square indicating that the new fare-free policy was in effect at that stop.

Currently, the marketing for *Fareless Square* is handled through Tri-Met's printed route maps and schedules. In addition, other publicity is provided by word-of-mouth of existing transit patrons, and also through kiosks, maps, and other information displays in the downtown transit mall.

RIDERSHIP TRENDS

Fareless Square patronage

The patronage of *Fareless Square* has been relatively constant since Colman's evaluation in 1979.[3] As indicated in Table 63, a ridership survey conducted in November 1977 determined that approximately 8,200 riders per weekday were getting on and off the bus system within the *Fareless Square* area. This total ridership is assumed to comprise primarily trips made by the 68,000 workers in the CBD. Colman's analysis also indicated that many of the *Fare-*

[2] Colman, Steven, "Case Studies in Reduced-Fare Transit: Portland's *Fareless Square*." Prepared for the Urban Mass Transportation Administration, Service and Methods Demonstration Program, Report No. UMTA-MA-06-0049-79-2 (1979a).

Colman, Steven, "Case Studies in Reduced-Fare Transit: Seattle's Magic Carpet." Prepared for the Urban Mass Transportation Administration, Service and Methods Demonstration Program, Report No. UMTA-MA-06-0049-79-3 (1979b).

[3] Colman (1979a), *op. cit.*

TABLE 63 ***Fareless Square* and systemwide ridership**

Year	System average weekday ridership*	*Fareless Square* ridership	Percent *Fareless Square*
1974	78,000	900	1.2%
1975	96,000	N/A	N/A
1976	114,000	N/A	N/A
1977	130,000	8,200	6.3%
...	...	...	...
1988	129,900	4,676**	3.6%
1989	139,400	6,412**	4.6%
1990	148,900	5,360**	3.6%
1991	154,500	6,335**	4.1%
1992	155,000	5,115**	3.3%
1993	154,500	4,481**	2.9%
1994	157,900	3,632**	2.3%
1995	167,900	3,694**	2.2%

* One way, origin-to-destination trips, excluding transfers.
** Based on respondents indicating no fare because they were riding within *Fareless Square*.
Sources: 1974-1977: Colman (1979a), 1988-1995: Annual On-Board Fare Survey, Tri-Met (1996).

less Square riders are frequent users of the program, with 58% using it five days per week, but only 12% using it less than one day per week. These figures indicate that about 20,000 of the 68,000 workers downtown, or about 30%, were using *Fareless Square*.

The following additional characteristics of the ridership in 1977 are noted by Colman:

- Almost half (48%) of the trips in *Fareless Square* were work-related, which were most likely trips to work from shopping, recreation, or other activities. Other major trip purposes included 18% shopping trips, 15% school-related, and 13% social or recreational trips.
- About two-thirds (65%) of all trips in the Square were made during midday (9 AM to 4 PM). Slightly more than 22% were made in the evening peak (4 to 7 PM); about 8% were made in the morning peak (7 to 9 AM); and less than 5% were made in the very early morning or after 7 PM at night.

Colman estimated daily trips within the downtown area at 900 trips prior to the *Fareless Square* program. This included the average daily patronage of the Shop Hop service of 500, and an estimated 400 riders of the normal bus service that both boarded and alighted within the zone. Thus, by his estimate, the introduction of the fare-free zone resulted in over a nine-fold increase in transit ridership within the Square.

While the initial response to the fare-free zone was strongly positive, the net ridership within *Fareless Square* has remained largely constant since the late 1970s. Table 63 indicates that ridership within the Square has stabilized at about 4,000–6,000 passengers each day. The more recent estimates (1988–1995) come from an annual on-board survey conducted by Tri-Met, in which passengers may indicate that they paid no fare because they are traveling within the *Fareless Square*. However, personnel from Tri-Met and the Metropolitan Planning Department believe that there may be some bias against *Fareless Square* riders in the survey. The trips are often of such short duration that the riders do not complete the survey forms. As a result, the actual ridership in *Fareless Square* may be closer to 8,000–10,000 riders per day. This represents about four to five percent of the average weekday ridership on Tri-Met.

Systemwide patronage

One of the key marketing concepts behind *Fareless Square* was that it may help introduce people to transit who may not otherwise try the service. Having used the service downtown, they may be encouraged to use the service for commuting and other purposes. With the considerable proportion of downtown workers using *Fareless Square* (about 30%), one might expect a more considerable secondary effect on Tri-Met patronage as a whole. As indicated in Table 63, systemwide patronage grew considerably in the mid-1970s at an annual rate of about 18–20%. However, ridership did not change considerably between the late 1970s and the late 1980s. More recently, systemwide ridership has grown considerably.

Determining the impacts of *Fareless Square* on system ridership, particularly during the early stages of implementation from 1975 through 1977, is all the more complicated due to the simultaneous introduction in January 1975 of

- The fare-free program;
- A monthly pass program;
- A flat fare system (which was eventually reversed in September 1978); and
- Slight increases in the bus hours of service, particularly in the evening peak.

Hence, isolating the impacts of each of these changes in service is very difficult. In addition, disaggregate ridership data from this period of time do not exist at Tri-Met or at the Metropolitan Planning Department. Thus, it is difficult to infer the types of mode shifts (either from walking, taxi, or private vehicle) that occurred as a result of *Fareless Square*. A similar study of Seattle's "Magic Carpet" downtown fare-free zone,[4] however, found that 25% of users did not make a trip prior to the program; 31% were diverted from walk trips; 34% had used the previous bus service for their trip; 8% were diverted from private vehicle trips; and only 1 percent of users were diverted from taxi trips.

Nonetheless, several studies have explored the question of how *Fareless Square* has impacted long-term systemwide ridership in Portland. Colman's evaluation made use of a May 1975 ridership survey which asked riders whether they had increased their use of Tri-Met service since January, and, if so, what changes caused their increase in use. Approximately 42% of respondents indicated that they had increased their use of Tri-Met. Of these, 35% indicated that the increase in use was related to the monthly pass, while 27% indicated *Fareless Square*, 19% indicated the flat fare, and 18% indicated the increase in service hours. One obvious bias in these survey results, however, is that the survey was distributed only to riders boarding in the CBD. Nonetheless, it suggests that at least some of the considerable growth in Tri-Met ridership in the mid-1970s can be attributed to the *Fareless Square* program. At the same time, the contribution of these other programs that came on line simultaneously cannot be discounted.

Similarly, ambiguous but decidedly positive conclusions can be made from an analysis by Kyte *et al.*[5] These authors conducted a Box-Jenkins time-series analysis of transit ridership in Portland, using aggregate monthly linked trip ridership data between 1971 and 1982. Their model included important transit and private vehicle variables, including gasoline prices, average transit fares, average cash (non-pass) fares, bus platform hours (as a proxy for transit level-of-service), and regional employment. Two sets of models were developed: one using aggregate systemwide ridership, and the other using aggregate ridership by route. Each of these models was used to estimate the elasticities of ridership with respect to the different transit and private vehicle cost and level-of-service variables. Unfortunately, because of the simultaneous changes in January 1975 of fare levels, fare structures, cash and pass fare payment options, and service levels, elasticities for each of these effects could not be isolated. Nonetheless, this combination of factors resulted in a measurable increase of approximately 5,100 riders per weekday (over five percent of the total systemwide ridership). This number is broadly consistent with the growth of systemwide and *Fareless Square* ridership between 1974 and 1977 given in Table 63. In particular, it suggests that early improvements in systemwide ridership from the *Fareless Square* program are likely to have been on the order of one to five percent. However, longer-term implications of *Fareless Square* for Tri-Met's systemwide ridership are not directly estimatable.

EVALUATION OF IMPACTS

Summary of experiences from *Fareless Square*

Several important conclusions regarding the successful implementation of a fare-free zone can be drawn directly from Portland's *Fareless Square*:

- Institutionally, approval of the program was made easier by a very strong link to the city's goals of reducing air pollution and downtown traffic congestion.
- Financially, the *Fareless Square* program was well-endowed with local payroll tax revenue. This made it easier for the management of Tri-Met to accept the financial burden. The downtown payroll tax also was seen as an equitable means of financing; those who use the service are generally seen as those who are paying for it.
- The *Fareless Square* program was one of many strategies working jointly to improve transit mode share, particularly in the downtown area. Other strategies that were employed in the similar timeframe include a parking space freeze, a downtown transit mall with significant private vehicle restrictions, a revised transit fare structure and a monthly pass program, and, on numerous occasions, improvements in service levels (i.e., more bus hours, higher route frequencies). In this way, the positive incentive of fare-free service was seen as offsetting other transportation disincentives, such as the parking and transit mall road-use restrictions.
- The downtown fare-free zone itself can significantly increase transit ridership in the downtown core, but probably less than 10% of the new riders are likely to be diversions from the private vehicle or taxi trips.
- Long-term improvements in systemwide ridership are somewhat difficult to estimate. From other analyses, it appears that the *Fareless Square* program has had a positive impact on the ridership at Tri-Met, and is probably responsible for a systemwide ridership growth of around one to five percent during the mid-1970s.

Comparison with other fare-free programs

The generally positive results of the Portland *Fareless Square* program may be transferable to other areas. The Portland experience was one of several larger urban areas in the United States that experimented with fare-free transit services in the late 1970s as part of the Service and Methods Demonstration (SMD) program at UMTA (now the Federal Transit Administration). Notable experiments in the SMD program, besides Portland, occurred in Denver, Albany, Trenton, and Seattle. To date, the remaining operational fare-free programs are in Seattle and Albany. Seattle's "Magic Carpet" fare-free service in the CBD very closely resembles that of Portland, in the planning, implementation, and evaluation of the fare-free zone.[6]

The Albany case, evaluated by Atherton and Eder,[7] explored fare-free service in the CBD, only during off-peak hours (9 AM to 3 PM) on weekdays and from 9 AM to 5 PM on Saturdays. This project, unlike the Portland, Seattle, and Denver experiences, also allowed significant before-and-after ridership surveys to examine the impacts of the fare-free service on travel behavior and transit ridership. The experiment began in November 1978 and was evaluated one year later as part of the SMD program. Generally, the findings from the Albany test showed marked increases in downtown trips during the fare-free periods (three-fold on weekdays and five-fold on Saturdays). Mode shifts, however, were generally diverted from walk trips rather than from private vehicle trips. Also,

[4] Colman (1979b), *op. cit.*

[5] Kyte, M., Stoner, J., and Cryer, J., "A Time-Series Analysis of Public Transit Ridership in Portland, Oregon, 1971–1982." *Transportation Research A*, Vol. 22A (1988) pp. 345–359.

[6] Colman (1979b), *op. cit.*

[7] Atherton, T. and Eder, E., "CBD Fare-free Transit in Albany, New York." Prepared for the Urban Mass Transportation Administration, Service and Methods Demonstration Program, Report No. UMTA-NY-06-0064-81-1 (1981).

the evaluation suggests that there is no evidence that systemwide transit patronage increased as a result of the fare-free service promotion. Drawbacks noted from the Albany case included problems with fare evasion, revenue losses, and financing difficulties for the fare-free service.

The Denver fare-free transit experiment ran 11 months, from February 1978 to January 1979, with funding provided by UMTA directly. Rather than focusing on a particular geographic area (for example, the CBD), the Denver experiment made *all* transit services fare-free during off-peak hours (before 6 AM, from 8 AM to 4 PM, and after 7 PM). From the interim evaluation,[8] the fare-free service was shown to result in significant increases in off-peak ridership, on the order of a 90% improvement. In addition, about 25% of the new off-peak ridership was attributable to new riders who had not used the transit system before. However, a 20% shift of ridership from the peak to the off-peak period was also observed; the net result was about a 33% increase in total systemwide ridership. Also, less than one-third of the new trips were diversions from the private vehicle. On the negative side, the fare-free service was expensive, service had to be expanded to handle increases in boarding times, and more significant problems with disorderly riders and vandalism were noted.

A similar experiment to that in Denver, in which off-peak fares were eliminated systemwide, was conducted in Mercer County, New Jersey (the greater Trenton area). The evaluation of this demonstration[9] found significant increases in off-peak ridership, on the order of 40 to 50%, during the one-year experiment. The new ridership primarily consisted of diversions from walking and private vehicle trips. However, the absolute number of trips where private vehicle diversion occurred was small. Once the off-peak fare was reinstated, the ridership gains were eliminated. According to the evaluation, only a small number of new transit trips (10,000 per week) were retained. Operating problems noted in the evaluation include bus crowding, delay from bus boarding and alighting, rowdiness and vandalism, and resulting poor driver morale.

In summarizing, it is agreed that the continuing CBD-based programs in Portland, Seattle, and Albany have, in general, been a success at attracting new ridership. With many other programs, such as those in Denver and Trenton, the long-term ridership impacts are largely unknown. Specifically, the short duration of these fare-free experiments, the limited scope of the evaluation effort, and changes in service and management policies during the course of the experiments tend to cloud the picture emerging from these studies. Moreover, the *long-term* ridership impacts of these alternative fare-free service programs are largely unknown.[10] Additional guidance in this area is expected from TCRP Project G-6.

Transferability

In light of the *Fareless Square* experience and the other programs that have been instituted since the mid-1970s, the following suggest conditions for success of fare-free zones as a valuable tool to increase ridership both in the short and the long terms:

- **An obvious transportation problem that requires an innovative solution.** The Portland area had significant air quality problems in the early 1970s, and the *Fareless Square* program was promoted as one of many elements of a solution to that problem.
- **Political support.** *Fareless Square* had strong political support from the mayor and the Tri-Met board of directors. As part of the strategy to bring Portland into line with air quality standards, it also gained support from the Oregon state legislature and the EPA.
- **Dedicated and equitable financial support.** *Fareless Square* benefited tremendously from a dedicated source of funding—the city payroll tax. This long-term revenue source also seems a very equitable source of funds for the program.
- **Long-term planning of both the urban core and the larger region.** Long-term planning, including transportation system expansion and strict zoning and parking limitations have resulted in steady ridership growth for Tri-Met. Downtown zoning and a dedicated transit mall have also helped to keep business activity and employment in the CBD, providing a steady base of transit patronage.
- **Coordination with other transit incentives and disincentives.** *Fareless Square* is only one element of a broad portfolio of transit improvements and private vehicle disincentives that have been implemented in Portland. Such a coordinated approach means that synergy between these other programs and *Fareless Square* can result in more significant ridership gains and mode shift.

[8] Swan, S. and Knight, R., "Denver Off-Peak Free Fare Public Transit Experiment: Interim Report." Prepared for the Urban Mass Transportation Administration, Service and Methods Demonstration Program, Report No. UMTA-CO-06-0010-79-1 (1979).

[9] Connor, D., "Off-Peak Fare-Free Transit: Mercer County, New Jersey." Prepared for the Urban Mass Transportation Administration, Service and Methods Demonstration Program, Report No. UMTA-MA-06-0049-80-3 (1982).

[10] Hodge, D., Orell, J., and Strauss, T., "Fare-Free Policy: Costs, Impacts on Transit Service, and Attainment of Transit System Goals." Prepared for the Washington State Department of Transportation, Technical Report No. WA-RD 277.1 (1994).

APPENDIX N

METROPOLITAN TORONTO LAND USE AND TRANSIT COORDINATION

INTRODUCTION

This case study examines the goal of integrating land use/urban form with the goals of the transit system, in the hope that mutually reinforcing development can help generate a higher transit ridership. The Metropolitan area of Toronto, Ontario has often been cited as a good example of how this integration can greatly benefit transit ridership. The case study provides a brief history of how this relationship developed in Metro Toronto.

No single person, organization, or event can claim sole credit for this transition to a more transit-oriented metropolis. As the case study will show, a number of actions, coalitions, and occasional accidents combined to help the metropolitan area develop as a very transit-oriented community. It will also highlight how Toronto, and the province of Ontario, do not always learn from their own successes.

Lessons from other recent examples of harmonious transit and land use planning are also presented. Ensuring that urban form relates well to transit service provides the most successful long-run policy for ensuring high transit ridership. Unfortunately, it is far from a simple undertaking to achieve this.

BACKGROUND

It has often been argued that it is only through intelligent land use planning that transit has a strong future at all. Continuation of the land development trends of the last thirty years will mean a further entrenchment of the private vehicle as the only viable mode, with large segments of the population excluded from having access to jobs, as well as continuing the environmental impact trends due to urban sprawl.*

The subject of integrating transit and land use planning to ensure a transit-friendly urban form is not a new issue. In the early part of this century, when private vehicle availability was much lower and much larger portions of the urban population were consequently dependent on transit and walking for their mobility, the expansion of the rapid transit system in many large cities (Boston, New York, Chicago, etc.) was naturally integrated with the expansion of the urban envelope. The land development industry had a clear understanding of the benefits that transit access had for their product. With the advancement of the private vehicle into the consciousness and garages of the North American public, the relationship between the road network and development became the predominant relationship. The transit/land use relationship has remained a firm goal of some cities in North America. The dense US cities of the Northeast and Midwest are good examples from the earlier part of this century. Toronto is a good example from the second half of this century, and is highlighted to show how this issue was handled. Other more recent examples are included to show how, by addressing this relationship, significant long-term transit ridership benefits might be achieved.

* In the US, sprawl is generally taken to mean a pattern of discontiguous urban growth, while in Canada it is usually interpreted as continuous, low-density growth, neither of which is conducive to transit usage.

Literature review

Much has been written on the transit/urban form relationship. In the earlier part of this century, it was not a subject that was written about as much, partly because it was the "natural thing to do." The subject became a more popular focus of social scientists starting in the 1960s with Jane Jacobs writing on land use. In the 1970s, a full treatise on the subject was developed by Pushkarev and Zupan.[1] With a splitting up of the planning industry into various specialized disciplines from the 1950s onward, the subject of urban form/transit integration became a difficult subject around which to rally support—that is, until the late 1980s. Simultaneously, a critical mass of land use planners, architects, and transportation engineers have appeared to voice common goals of avoiding the continued sprawl trends by adopting alternative and somewhat neo-traditional forms of development, relating it, in part, to transit services and to the pedestrian. This debate is now continuing, with certain urban areas in North America taking serious steps toward improving the urban form/transportation equation, and as a result, improving transit ridership.

There is now a plethora of "how to" guides, looking at both the smaller picture (individual sites) and the bigger picture of planning land use (urban form) around the transit system. Table 64 highlights some recent examples from various parts of North America.

The nature of the debate

The debate over land use generally can be summarized as two opposing suppositions:

- Developers build the subdivisions at densities that people want, and which happen to require the use of the private vehicle (and people want to own cars), *and*
- People can only make decisions based on what they are offered, and by and large they are not offered land use and lifestyle alternatives at more traditional density levels.

Of course, there is some truth in both of these statements. In order to understand this dichotomy better and to understand how the future does not have to be a continuation of the post-war period of suburban spread, it is necessary to look back and see what have been the chief factors in the creation of our cities. We place a particular emphasis on Toronto, as it has often been held as the prime North American example of a "well planned," transit-friendly city. As we will see, there is both some truth and some mythology in this claim, but nevertheless there are important lessons to be learned in the process of examining the Toronto experience.

[1] Pushkarev, B. S. and Zupan, J. M., *Public Transportation & Land Use Policy*. Bloomington (IN): Indiana University Press (1977).

TABLE 64 Selection of planning/transit documents currently available in North America

Title	Source
Design Guidelines as a Tool to Promote Transit-Supportive Development	Technology Sharing Program, US DoT, 1993
Transit-Oriented Development Guidelines — Review of Literature	Florida DoT, Tallahassee, 1995
Guide for Including Public Transit in Land Use Planning	Alameda-Contra Costa Transit District, Oakland, CA
Encouraging Public Transportation through Effective Land Use Actions	Municipality of Metropolitan Seattle
Access by Design: Transit's Role in Land Development	Maryland DoT
Transit-Oriented Development Design Guidelines	Sacramento County, CA
Guidelines for Transit-Sensitive Suburban Land Use Design	UMTA, Washington 1991
Transit-Supportive Land Use Planning Guidelines	Ontario Ministry of Transportation, 1992
Designing for Transit	MTDB, San Diego, 1993
Planning and Design for Transit	Tri-County Metropolitan Transportation District of Oregon, 1993

TABLE 65 Comparison of several North American and European cities

	Residential density (persons/ha)	Percent of workers using transit	Auto ownership (per 1,000 people)	Per capita gasoline usage (MJ)
Munich	57	42	360	12,372
London	56	39	288	12,426
Paris	48	40	338	14,091
Toronto	40	31	463	34,813
Boston	12	16	465	54,185
Chicago	18	18	445	48,246
Los Angeles	20	8	542	58,474
Phoenix	9	2	499	69,908

Source: Newman, P.W. and Kenworthy, J.R., *Cities and Automobile Dependence: An International Sourcebook*. London, UK, Gower Press (1989).

DETAILS OF THE STRATEGY

Metropolitan Toronto has been successful in integrating rapid transit and land use planning in the past, and this has helped to create the current transit-oriented metropolis that it is today. This has been done despite the most rapid growth taking place in the age of the automobile. Table 65 provides a comparison of a few North American and European cities using key statistics on residential densities, transit usage, auto ownership, and gasoline consumption. The comparison shows that Metropolitan Toronto can be thought of as a "mid-Atlantic" type of a city (that is, intermediate between European and lower-density US development patterns), having both a compactness of urban form and a high transit share.

Toronto governments

It is *Metropolitan Toronto* that is frequently referenced as the main success model for a coordinated land use and transportation model for a city. It is an example of another way of managing urban growth by orienting development towards the transit system as much as the road/highway system. It is important to know what is meant by Metropolitan Toronto, and how it relates to the City of Toronto and the newer outlying regions around Metropolitan Toronto. Three different area definitions will be used in the following discussion. Figure 18 shows the area definitions of

- The City of Toronto, with current population of approximately 600,000;
- Metropolitan Toronto, which has a current population of approximately 2.3 million; *and*
- The Greater Toronto area (GTA), with a current population of about 4.3 million. At this point in time, the GTA has no formal governmental body.†

† A recent study undertaken for the Province of Ontario has recommended the disbanding of the five regional governments (including Metropolitan Toronto) contained in the GTA and replacing them with one super-regional government body. This is the subject of ongoing debate.

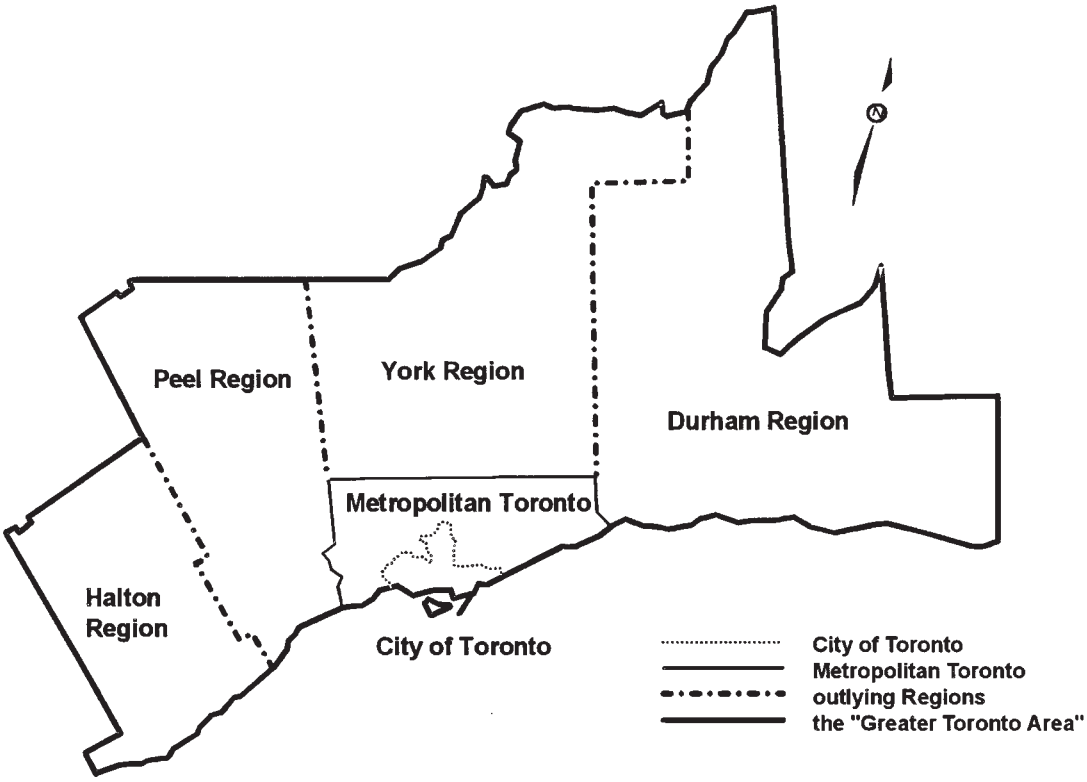


Figure 18. The various "Torontos."

The GTA (excluding Metropolitan Toronto) comprises four other regional municipalities: Peel, York, Durham, and Halton (with a number of towns and cities in each region). The municipalities grew considerably during the 1970s and 1980s, and they will continue to grow; they are projected to double in population over the next thirty years.

For the most part the "transit-friendly city" label refers to *Metropolitan Toronto* as opposed to the Greater Toronto area, which is now as populated as Metro Toronto itself yet a lot more auto-oriented than Metropolitan Toronto. The true success story of a transit-oriented Metro Toronto is illustrated by the fact that half of the office development that took place in the 1960s, 1970s, and 1980s was constructed within a short distance of a rapid transit line, ensuring a high level of transit usage.

The main historical characteristics of land use/transportation planning in *Metropolitan Toronto* are as follows.[2] During a period of rapid residential growth in the 1940s and 1950s, a two-tier form of metropolitan government was introduced. The higher tier municipality of Metropolitan Toronto was born in 1953. This entity was established partly to help the suburbs deal with the expansion of basic services (road, sewers, transit, and so on) with financial aid drawn from the central City of Toronto. Land use planning and public transportation were assigned to regional boards. The planning board was responsible for land use planning throughout the whole of Metropolitan Toronto and an additional 480 square miles of territory outside Metropolitan Toronto. At this time the transit operation was self supporting, as were those in most other North American cities.

Over time, the power base in Metropolitan Toronto has shifted from the City of Toronto to the suburban cities (1.7 million) within Metropolitan Toronto, which now have a combined population almost three times greater than that of the central city.

Evolution of the transportation system

In 1954 the first subway line (north-south) on Yonge Street opened, replacing an overcrowded streetcar line. For the most part, the construction was paid for out of operating profits. In 1957 planners won a battle with the Transit Commission over route alignment for the first east-west subway line. The land use planners had pushed to maximize the *development potential*, rather than to select the alignment that would produce the highest *immediate ridership*.

In 1966 the Metropolitan Toronto Planning Board developed a plan for a "balanced" transportation system comprising 37 miles of subway and 105 miles of expressway (the transit modal share was about 30% at the time).[3] This plan was heavily criticized for being too strongly oriented towards expressway construction. Because of this controversy, the plan was not officially adopted but instead was used as a "guide" for planning development.

In the early 1970s one of the first expressways that was to be constructed was stopped by the provincial government following public protest. The province then promised to increase its financial support for mass transit. Effectively, this decision halted expressway construction within Metro Toronto for two decades, accompanied

[2] This summary borrows heavily from Frisken, F., "The Contributions of Metropolitan Government to the Success of Toronto's Public Transit System." *Urban Affairs Quarterly*, Vol. 27, No. 2 (1991), as well as UMA Engineering Ltd., *Let's Move Overview*. Prepared for the Toronto Transit Commission (1991). A summary of benefits attributed to the expansion of the Toronto Rapid Transit System.

[3] Frisken, *op. cit*.

TABLE 66 Recommended and actual changes in transportation facilities in Metropolitan Toronto, 1959–1980

Type of facility	In place in 1959 (miles)	Recommended in 1966 for 1980 (miles)	Built or under construction by 1980 (miles)
Expressways	42.0	105.0	77.0
Rapid rail transit	4.5	37.0	39.0

Source: Metropolitan Toronto Planning Board (1959, 1964); Metropolitan Toronto Planning Department (1982).

by minor expansions of the subway system and by a heavy increase in expressway construction *outside* Metro Toronto.

At the same time as the "expressway wars" were happening, Metro began a new major planning exercise that now produced a much more transit-oriented plan, requiring high-density employment subcenters in the suburbs (along existing or proposed rapid transit lines) as well as a continued strengthening of the downtown core. As shown in Table 66, by 1980 Metropolitan Toronto had just under 80 miles of expressway (25 miles fewer than originally planned, and with no new expressways built in the heart of the city core).[4]

One of the main differences that had also taken place was that the rapid transit lines built extended out to the suburbs of Metropolitan Toronto and were not confined to the downtown area as the 1966 plan had anticipated. Overall transit service in the Metro area in 1955 was 46.5 million passenger-miles; in 1980 it was 101.4 million passenger-miles, and by 1987 it was 120.3 million passenger-miles. Additions to suburban transit accounted for most of the increase. Despite the large-scale transit service throughout Metro Toronto and a high level of suburban ridership, Metro still experienced the trend away from transit during this time. Figure 19 shows that annual transit trips per capita dropped from nearly 250 in 1955 to less than 170 in the mid-sixties. Transit trips have rebounded some since then, up to about 200 in 1987, such that the current level remains high for North America and puts Toronto somewhere between European and most US cities.

The transportation system that has evolved in Metropolitan Toronto since the 1960s has been characterized by:

- A shift of emphasis away from expressway construction to rapid transit (see Figure 20 for an illustration of the progress of the rapid transit system);
- A substantial increase in rail transit and bus service in the suburbs;
- High per capita ridership in the suburbs and central city;
- A growth in ridership that exceeded the growth in population; and
- Relatively lower operating deficits and higher transit modal share.

These outcomes cannot be realistically regarded as a *direct* outcome of the plan and policies adopted in the early years of metropolitan government in Toronto. However, the Metropolitan Toronto government had a high level of interest (including financial) in the transit system. The metropolitan area authority was interested in providing service to all corners of the area for political reasons. This is illustrated by a doubling of the annual mileage of suburban bus operation between 1955 and 1963. This metropolitan coverage goal diverted

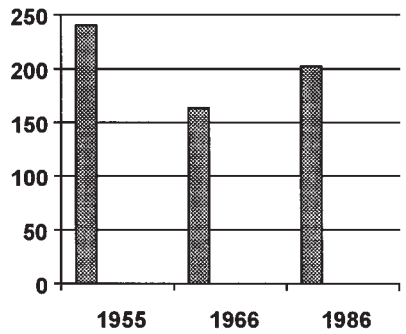


Figure 19. Annual transit trips per capita in Metro Toronto.

the transit system from its previous single goal of financial self-sufficiency. It effectively made Metro a transit community as a whole.

Land use planning policies

During the early years of Metropolitan Toronto, the provincial government contributed to higher density development by maintaining strict controls on septic tank development in areas outside Metro. Ontario also restrained the creation of new municipalities in the surrounding area, and the takeover of arterial roads by the Metro government made it easier to extend continuous roads, suitable for bus routes, into the suburbs. Because Metro was also responsible for sewer and water, it extended these services out in an orderly manner too.

A principal emphasis in the Metro planning documents (from the 1950s on) was that *downtown Toronto* should remain the commercial, cultural, and institutional core of the region. The city supported this by adopting liberal zoning policies to permit or encourage office development at very high densities around the core. Because taxes were based on assessed value and not on population, this was acceptable to the suburbs as they were also benefiting from the increased tax revenues by being part of Metro.

A second urban development principle embraced by Metro called for a mix of suburban housing types and densities,‡ partly in response to the need to have suburban transit serve higher densities. Local municipalities in the suburbs went along with this as they saw the higher tax receipts and lower net cost as advantageous. By the mid-1960s, Metro had to slow down the rate of construction of new

[4] Frisken, *op. cit*.

‡ Jane Jacobs, author of "The Death and Life of Great American Cities," had moved to Toronto in the 1960s and was a player in this movement.

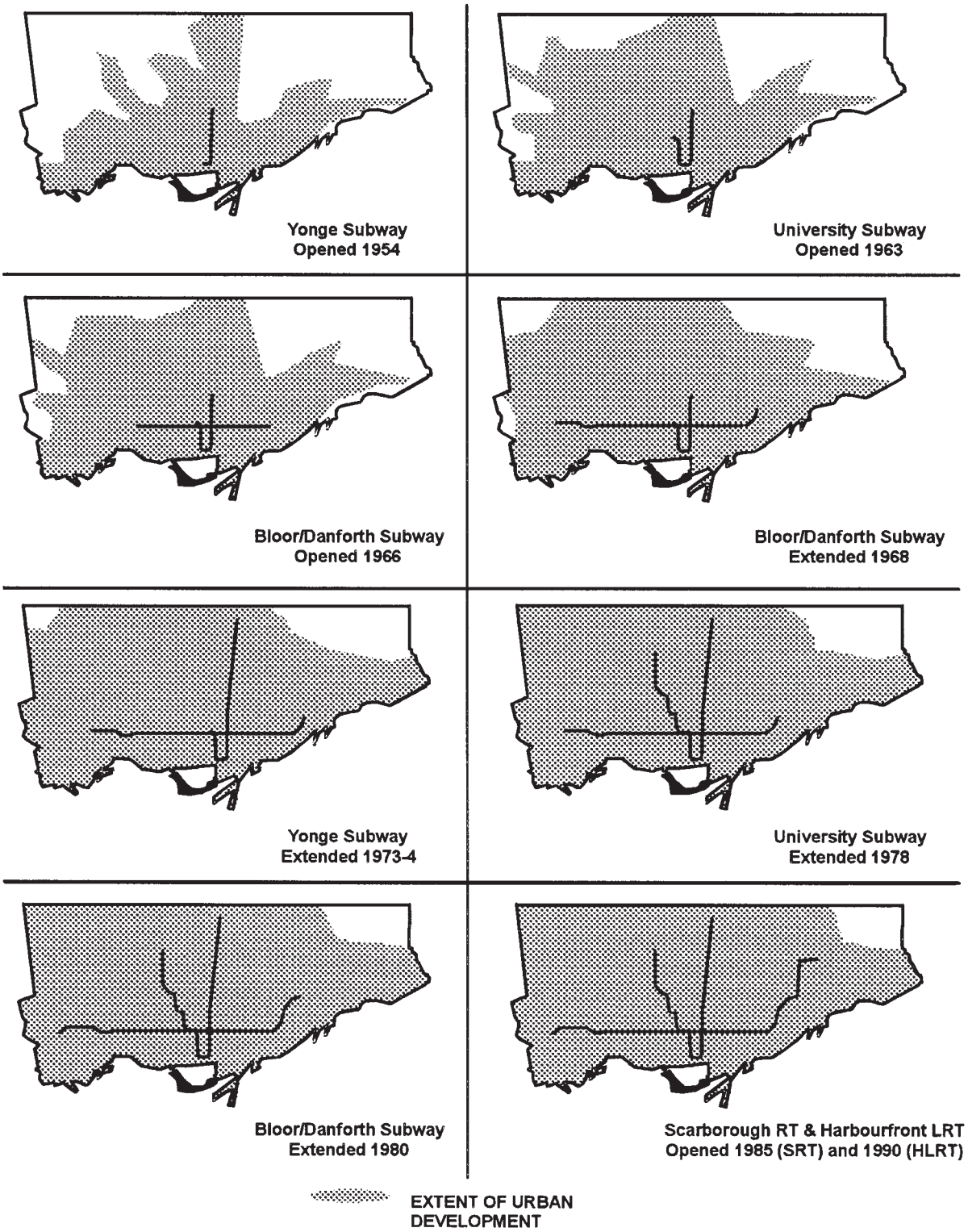


Figure 20. Evolution of TTC rail transit in Metro Toronto.

apartment dwellings by favoring sites near the central area or close to subway stations and main bus routes.

A third urban development principle was the promotion of high-density office development around and above subway stations (a principle that was used to gain support for the first subway). A comprehensive zoning bylaw of the city in 1953 channeled new office development to these transit sites. A rise in property values at subway locations found favor in the development industry also.

Metro took longer than did the central city to promote the use of rapid transit to reinforce urban development patterns. By 1965, planning proposals called for the concentration of intensive land uses at focal points on the transportation system. In 1980, Metro adopted as a "fundamental aim" the creation of a "multi-centered urban structure," to be achieved "through the development of Metropolitan Centers located along rapid transit lines." In the 1990s, the use of rapid transit as shaper of the urban form is still the main focus of planning documents.

EVALUATION OF IMPACTS

From a transit industry viewpoint, the "success" in the Metropolitan Toronto story was the policy of investing more in transit during the 1950s and 1960s than in highways. These successes have paid off for Metropolitan Toronto right through to the 1990s. The "failure" in the last twenty years has been in the areas outside Metropolitan Toronto which did not have the Metro vision: where municipalities built "what the people wanted" as fast as the road and sewers could be laid, and in areas with expressway facilities in place. These municipalities are now including words like "transit focus," "transit-oriented," "nodal development" in their official plans. However, for the most part, it is a case of "too little, too late," as the urban form and density have been mostly set.

The main culprit for this schizophrenia was the provincial government. It is ironic that in the 1970s the province played a pivotal role in stopping expressway construction within Metropolitan Toronto and supporting further transit construction. But at the same time the province began to build and extend expressways in areas just outside the Metropolitan boundary at a fast rate, thereby facilitating the incredible high growth of suburban sprawl that can be seen today in the Regions of Peel, York, Durham, and Halton. It learned the lesson, preached the lesson, and then itself ignored the lesson. The main servicing requirements for the lower-density exurban growth were paid for by the provincial government (whose funds came mostly from the Metropolitan taxpayer). The province provided large subsidies to these outlying areas, allowing a low-density form to develop, mostly at the expense (literally) of the high-density, transit-oriented areas of Metro Toronto.

Ridership and mode share

The success in Toronto has been born out in consistently higher transit usage per capita than in any other major city in North America. The cities of New York, Boston, and Chicago come close; these cities are older than Toronto in having developed their main urban areas during the earlier part of this century. Toronto began developing into a large city at a fast rate from the 1950s onwards. It could have gone the way that many other North American cities were beginning to develop at that time, but the (somewhat accidental) pro-transit coordinated planning initiatives prevented this.

The success for Toronto can be seen in the statistics below[5] (statistics are for 1991 unless otherwise stated):

- Twenty-nine percent (33% in 1986) of home to work trips by Metropolitan Toronto residents between the hours of 6 AM to 9 AM are by transit (another 10% walk or bicycle);
- Thirty percent of all trips to Metropolitan Toronto in the 6 AM to 9 AM period are made by transit;
- Fifty-eight percent of all trips to the Toronto central area in the 6 AM to 9 AM period are made by transit (another 6% either walk or bicycle), and in the peak *hour* the transit modal share entering the downtown is in the 70% to 75% range;
- Forty percent of trips made by Toronto central area residents in the 6 AM to 9 AM period are made by transit and 28% walk or bicycle; and
- In a typical 24-hour weekday, 59% of all trips to the Toronto central area are made using non-auto modes.

In addition to these statistics, it is important to note that ridership on both the Toronto Transit bus and rail system, as well as on the GO Commuter Rail system into Toronto, cuts across class, race, and income lines. The quality of service attracts many choice riders, particularly in the peak periods. Toronto takes great pride in its downtown area; it is considered a "safe and livable city," pleasant for pedestrians, and has a lively downtown feel. Torontonians also take great pride in quoting Peter Ustinov's observation that "Toronto seems like New York run by the Swiss."

What might Toronto have been like without the land use policies?

A comparison of postwar trends in private vehicle and transit use in the United States and Canada has been drawn in a recent TRB paper by Paul Schimek.[6] The paper investigates a number of factors that might contribute to higher transit usage in Canada including income, transit subsidy policies, gasoline prices, private vehicle prices and operating costs, fares, and so on. The author draws several conclusions:

- "Both countries rapidly increased public expenditures on transit during this period (the 1970s), but in the US, transit service only increased modestly."
- "Canadian transit service is not more heavily subsidized,"
- "Residential density is higher in Canada, and more compact development patterns helped to prevent transit use from dropping as low as it did in the US, and made it easier to maintain higher levels of ridership when large amounts of subsidies became available in 1970s."

As it is difficult to say with confidence what would have happened in Toronto with a different strategy, this may be as much as can be concluded. US cities that grew rapidly in the 1950s, '60s, and '70s with an expressway-dependent strategy are examples that

[5] University of Toronto, Joint Program in Transportation, Data Management Group, *1991 Travel Survey Summaries for the Greater Toronto Area*. Toronto, ON, (1994).

[6] Schimek, P., US DOT Volpe Centre and MIT Dept. Of Urban Studies & Planning, *Automobile & Public Transit Use in the USA & Canada: A Comparison of Post-War Trends.* Presented at the TRB 75th Annual Meeting, Washington, DC (1996).

might be considered in a "What if?" scenario. The 1960s Toronto plan for 105 miles of expressway (only 77 miles have been built) might have produced a more typical North American city.

As Marcia D. Lowe noted,[7] tight controls on land use planning can produce negative or positive results. It depends on how they are applied and whether the net market intrusion effect has been considered. Another perspective is provided by Pamela Blais who notes

> True cost-based approach is preferable to a regulatory one that seeks to control costs by controlling the pattern of development, by implementing an urban boundary or limiting lot sizes, for example. Such actions would distort the market, raise land prices by limiting supply, and restrict the ability of the market to respond to consumer demand, reducing competitiveness. This is not to say that land use regulation is not needed for other reasons, only that it should not be used as a primary mechanism to control development costs.[8]

Timeframe for achieving benefits

Investment in rapid transit in Toronto in the 1950s and 1960s has provided benefits from the 1960s through today. An integrated transit investment/land use plan depends, to a great extent, on the marketplace for development. For the last five years the market for office development in Toronto has been severely depressed, and as a consequence the major stride towards transit-oriented development has slowed down appreciably. The effects, therefore, will vary by jurisdiction, and will vary with the marketplace conditions. The areawide effects of pro-transit land use planning are likely to take some years to develop fully, but the benefits will also be sustained for many years. The strategy generally cannot be considered a near-term measure, except in single-site situations.

SUCCESS STORIES FROM OTHER CITIES IN THE HEMISPHERE

Portland (Oregon)

Portland is arguably the best and most recent example of a city taking a positive step in adopting land use policies to support transportation objectives. Portland is a city of approximately 500,000 people, at the core of a metropolitan area of around 1.3 million people. Instead of giving in to ever greater private vehicle dependency and sprawl, Portland has encircled itself with an "urban growth boundary," a perimeter similar to England's greenbelts, beyond which new development is not allowed. Reinforced by zoning reforms, the urban growth boundary allows Portland to grow quickly but compactly. This was done with a commitment to transit, a willingness to innovate, a dedication to integrated land use and transportation planning, and a participatory planning process that involves planners, political leaders, and the public.

In two decades, Portland has increased its housing density by encouraging a blend of multi- and single-family homes in compact patterns. Portland's vibrant downtown boasts such green spaces as Tom McCall Waterfront Park, which was once an expressway (now demolished), and Pioneer Courthouse Square, formerly a parking lot. City officials welcome new office construction and the number of downtown jobs has increased by 50%, but the volume of private vehicles entering the downtown area has remained the same. Transit ridership has consequently grown markedly:

> In 1969, the year Tri-Met was formed, Portland's transit ridership was 18 million passengers annually. By 1991 this had more than tripled to about 58 million, and Tri-Met has set ridership growth goals that should increase even that level by well over half before the end of the decade. Another way to gauge the effectiveness of Portland's return to transit is simply to experience the quality of life in the city. One can quickly conclude that Portland's vision of the livable city deserves examination by urban planners everywhere.[9]

A significant part of the 1972 plan set out a comprehensive vision for building a new downtown area, and it outlined innovative strategies for transit, parking, retail, housing, and open space development. The plan included an overall cap of 44,000 parking spaces for the downtown.§ Similar to Toronto in the 1950s and 1960s, transit became part of the planners' tool-kit. Investment in public transport included a highly controversial (at first) eleven-block transit mall along SW 5th and 6th avenues in the commercial district. Today, 43% of all Portland's commuters to downtown ride buses and a light rail system, a higher ridership rate than those of most other US cities its size (Seattle has a rate of 38%, Denver 29%, and Buffalo 25%). The shift to public transport is believed to be partly responsible for dramatic air quality improvements in Portland.

Again, with similarities to Toronto, Portland had a public revolt against more freeway construction in the mid-1970s (exactly paralleling Toronto's Spadina Expressway battle at that time). The Mount Hood and I-505 freeway proposals were canceled and replaced with investment in light rail (opened in 1986). A second light rail line is currently under construction.

Under a statewide law enacted in 1973, Oregon requires all cities and counties to create local land use plans that adhere to mandatory state goals, which include open space protection and setting of urban growth boundaries. A new state Transportation Planning Rule, adopted in 1991, requires Portland to consider different land use scenarios as alternatives when evaluating transportation improvement options. According to a 1989 estimate, vacant and under-used land within the central city still amounted to nine times the space needed to accommodate Portland's projected growth rate in the next 20 years.

Curitiba (Brazil)

Another successful model is Curitiba, a city with a population of about 1.5 million and the capital of the southeastern state of Paraná;. By the end of the 1960s, Curitiba was going the way of other automobile-dominated cities, with severe traffic congestion, sprawl, and a sorely inadequate bus system. In the 1970s, a city mayor, who had formerly headed the municipal planning commission, initiated a series of transport and land use changes that markedly changed the situation.

Curitiba's transportation system is based on express bus lines that run in reserved lanes, inter-district lines that connect the express routes, and frequent feeder routes linking neighborhoods to the

[7] Lowe, M. D., Worldwatch Paper 105, "Shaping Cities: The Environmental and Human Dimensions." Worldwatch Institute (1991).

[8] Blais, P., "The Economics of Urban Form." Prepared for the Greater Toronto Area Task Force (January 1996).

[9] Middleton, W. D., "Land Use and Transportation Planning, Portland Style." *Transit Connections*, (September 1995).

§ This limit is soon to be lifted, as it is now thought to be unnecessary following a review in the regional plan currently under development.

main system. By closely coordinating land use with the bus system, Curitiba has established strong transport corridors that can be augmented relatively easily to accommodate future growth. For example, the city plans to upgrade some of its more heavily used express bus routes to light rail. As the population and public transport ridership both expand even further, these existing rights-of-way could host a high-capacity rapid rail system if necessary.

One out of five people in Curitiba owns a car—for Brazil, an ownership rate second only to Brasilia's—yet gasoline use per vehicle is 30% lower than the average of eight comparable Brazilian cities.

TRANSFERABILITY

The potential impacts of a pro-transit planning strategy have been known for a long time. If it were easily transferable, it would have been done much more than it has. The difficulties are primarily ones of leadership and of political, business, and public support. There are benefits for many of these stakeholders in pursuing such a strategy, but questions of leadership, jurisdictional boundaries, education about the potential benefits, addressing stakeholder concerns, and so on are the main significant concerns. It is interesting to note that in both Toronto and Portland it took a public revolt and effective political leadership to insist on a transit-first vision.

Jurisdictional issues

In the 1950s and 1960s, the Metropolitan Toronto Planning Board had control over land outside of its geographical area, and the provincial government put strict controls over septic-tank-based development. This was a critical aspect of the Toronto success model. Portland also has declared a boundary around the urban area to control growth around the periphery. In both situations, a *regional* government taking a lead role was essential. Toronto has now lost control over the whole metropolis, and auto-oriented development may be the norm for decades to come. Tight regional control probably becomes more difficult as the urban area becomes larger. The prospect of one level of government having firm planning controls over planning for, say, the counties of Los Angeles, Orange, Riverside, and San Bernadino, seems to be an insurmountable challenge.

Even in the regional government situation, cooperation between the various local municipalities is essential. Within metropolitan Toronto, a lack of cooperation during the 1980s delayed the next major transit expansion plan for the region by at least five years before a consensus based strategy could be developed (which probably led indirectly to one of the lines being indefinitely postponed). By contrast, in previous decades the city of Toronto and metropolitan Toronto were both aligned in promoting the continued strengthening of the Toronto downtown area and in encouraging development around rapid transit stations.

Another jurisdictional issue is the role of higher levels of government involved with transportation infrastructure. In the opinion of the Canadian element of the study team, the province of Ontario** and metropolitan Toronto did all the right things in the 1950s and 1960s, and this bore fruit in the 1960s, '70s, and '80s. According to this viewpoint, the decisions on transportation investment, particularly by the province have mostly been wrong since from the mid-1970s, and the impact of this has been felt since the late 1980s.

** In Canada, the role of the provincial government in transportation investment is more akin to that of the federal government in the United States.

Equity issues

With the support of the city and the metropolitan levels of Toronto governments, the public transit system was developed into the suburbs at a high level of service as development progressed. Each of the rapid transit lines extends from the central area into the suburbs. In addition, local bus service actively feeds the rapid transit stations along the rail lines providing an extensive grid of transit service throughout the region. This is generally considered to be a win-win situation in that the feeder services contribute to a higher frequency of transit in the local areas than would otherwise have been fiscally reasonable.

The relatively higher densities found in metropolitan Toronto make the provision of a good level of service in all areas much easier to justify, and the equity issue is not one that is often heard in the debate on transit in Toronto. Heard more frequently is an argument about which local municipalities will get the next rapid transit investment, in order to help achieve their development goals. More recently, because of the growth outside metropolitan Toronto and because of competition for scarce dollars, the regions outside metropolitan Toronto are now finding their voices and are generally arguing against further rapid transit expansion *within* metropolitan Toronto. This argument is based on the fact that the highest population growth is taking place outside of metropolitan Toronto.

Costs and funding

A recent report examined the economics of land development[10] and concluded, as many had done before, that low density sprawl is more expensive to develop and maintain than higher density contiguous development. It is maintained that the lower density sprawl that has occurred outside metropolitan Toronto in the last twenty years has received a high level of hidden subsidy from the urban taxpayers, particularly in the provision of public water, sanitation, and transportation (expressway, arterial roadways) infrastructure investments. This helps to explain why higher density development has not taken place naturally.

SUMMARY AND CONCLUSIONS

The Toronto metropolitan area has been cited as a good example of transit-oriented land use planning. This case study has shown that while the city does have higher transit market shares, and that development patterns have been more conducive to the success of public transit, these results are not entirely the result of a totally coordinated strategy of transit-oriented development. Rather, the situation in Toronto appears to have developed as a result of political pressures which greatly reduced the amount of investment in highway infrastructure, combined with jurisdictional circumstances which

[10] Blais, P., *op. cit.*

allowed the metropolitan area government to control important aspects of development outside its geographic boundaries.

This lack of a totally coordinated planning effort, has, ironically, made Toronto an even more interesting model for studying the transit-land use connection, as the multijurisdictional character of the city has produced markedly different results in different areas of the metropolis. In metropolitan Toronto, where government cooperation and coordinated planning efforts expanded transit services while limiting additional freeway capacity, transit performs impressively, but the region outside of this area more closely resembles other North American cities where urban sprawl and low density development are prominent features.

It is clear then that jurisdictional issues are very important in this situation. The ability of the Metro Toronto government to affect regionwide development patterns, and the early like-minded policies of the provincial government in restricting freeway expansion, made for a much more transit-friendly environment in the city. However, the lack of continued coordination of transit-oriented policymaking in later years resulted in virtually the opposite effects in the outlying areas of the region.

APPENDIX P

PRICING OF ROAD USE AND OTHER TRAFFIC LIMITATION STRATEGIES

ROAD PRICING IN THE CONTEXT OF OTHER LIMITATION STRATEGIES

In the discussion of transit demand in Chapter 4, we observed that ridership is likely to be significantly more sensitive to policies that make *private vehicle* use *less attractive* in urbanized areas than it is to policies that aim to make *transit more attractive*. However, it is obvious that strategies that deliberately set out to worsen conditions for over 90% of urban commuters are likely to be greeted with less than full enthusiasm by elected government officials. For this reason, proposals to limit private vehicle use, or to make it more expensive, have had a quite checkered political history in the United States.

For the sake of completeness in discussing the major public policy options that influence transit ridership, this appendix briefly surveys details about the policies designed to create disincentives for single-occupant vehicle travel in congested urban areas. Following Thomson,[1] we refer to these policies generically as *traffic limitation*. To view *road pricing* initiatives—the primary focus of our interest—in proper context, it is useful to recognize that traffic limitation, in one form or another, has been a long-standing practice (albeit not necessarily an explicit one) in all cities.*

Within the family of traffic limitation policies, we can draw a useful distinction among three types of limitation methods:

- *Traffic restriction*, which involves the actual prevention of travel by physical or legal means;
- *Traffic restraint*, whereby travel is discouraged rather than prevented entirely; *and*
- *Traffic avoidance*, which attempts to deter people from wanting to travel in the first place.

Traffic restriction

The first category, traffic restriction, typically involves the closing of certain roads at certain times, perhaps to certain kinds of vehicles. In some cases, this may mean a complete prohibition of any motor vehicle traffic within an area, often a city core. Sometimes private passenger vehicles may be banned, with exceptions made (possibly on limited streets or at limited times) for buses, taxis, and commercial vehicles serving local premises.

This type of traffic limitation is rather a blunt instrument, however, as it tends to treat all private passenger vehicles the same, without regard to the value each driver or passenger places on the use of the road facilities, or the costs that they impose on other road users. As such, these restrictions are unlikely to bring about the most *efficient* use of the roadway infrastructure. In addition, while the affected areas should experience enhanced pedestrian mobility, travel times and fuel consumption for the motorists diverted around the restricted area will probably increase, leading to an obvious tradeoff—the net effect of which is not unambiguously positive.

Traffic restraint

By contrast, the second category of traffic limitation, traffic restraint, does not *prohibit* any type of travel directly. Rather, it uses incentives and disincentives in an attempt to encourage the most efficient travel choices. These incentives can take several forms, and differ both in how they are applied and where they are targeted. *Direct* restraints target specifically the choices to be encouraged or discouraged, while *indirect* restraints, as their name implies, target related activities which in turn influence vehicle use. Either type of restraint may use *fiscal* means, which generally involves affecting the prices inherent in travel choices, or *physical* means, whereby the capacity of some part of the infrastructure required for private vehicle travel is limited.

Road pricing policies are a form of direct fiscal restraint. In the United States, people pay for road use in several ways: through tolls on specific facilities, and through governmental taxes on vehicle ownership and fuel purchases. The amounts paid are related only peripherally to the amount that the vehicle is used, and the conditions under which the use occurs. This is, essentially, pricing usage in proportion to the *short-run average variable costs*.

Transportation economists, following Vickrey and Walters,[2] have observed for a long time that the efficiency of roadway use could be improved, at least in theory, by making the prices of road use correspond more closely to the *marginal social costs* of the travel—this idea is often referred to as "congestion pricing."

The theory stems from the notion that drivers choosing to make trips *in congested conditions* do not themselves bear the full social costs inherent in their travel decisions. That is, in the making of a private vehicle trip, there are resources consumed or costs imposed on other people that are not borne by the individual driver. These "externalities" have two main implications. The first, overproduction, is that more than the socially-optimal number of private vehicle trips will be made. The second implication is that the costs not borne by the individual driver are imposed on other members of society, some of whom may not be private vehicle users.

For example, each marginal vehicle added to a traffic jam imposes further delays on all the other drivers, and air and noise pollution produced by high traffic levels is felt throughout the city. The

[1] Thomson, J. M., *Methods of Traffic Limitation in Urban Areas.* Paris, France, Organization for Economic Cooperation and Development (1972).

* "In every city of the world the volume of traffic is limited, intentionally or unintentionally, by measures adopted by governments, both central and local. If these measures were relaxed, there would be more traffic; if they were strengthened, there would be less. In other words, the volume of traffic in a city is not something like the rainfall that has to be accepted; it is amenable to some control or influence by government. Furthermore, depending upon the methods used, control may be exercised selectively over particular classes of vehicle, in particular areas or streets, at particular times, and for particular purposes . . . . Few people, of course, are wholly for, or wholly against, traffic limitation; most people want there to be some traffic but not too much. What constitutes 'too much' is something which every city must decide for itself in the light of its own economic and geographical circumstances, its heritage, aspirations and values." Thomson (1972), *op. cit.*

[2] Vickrey, W. S., "Pricing in Urban and Suburban Public Transport." *American Economic Review*, Vol. 53 (1963) pp. 452–489.

Walters, A. A., "The Theory and Measurement of Private and Social Cost of Highway Congestion." *Econometrica*, Vol. 29 (1961) pp. 676–699.

goal of congestion pricing, then, is to impose a price on each vehicle that reflects all of the marginal external costs, and thereby to encourage socially efficient levels and mixes of traffic.

There are other types of direct fiscal restraint, some of which are designed to accomplish, albeit less precisely, the goals of congestion-sensitive road pricing. For example, *area licenses* (sometimes called *supplementary licenses*) can be used to restrict the number of vehicles allowed to operate in a particular part of the city and/or at particular times of the day.

Other types of traffic restraint can be summarized as follows:

- *Indirect fiscal restraints*. These include parking charges in downtown areas, higher fuel taxes, and disincentives to automobile ownership such as excise taxes or higher registration fees.
- *Direct physical restraints*. The most obvious example of such a limitation may well be the congestion itself. Methods for managing congestion can transfer its harmful effects to less sensitive areas, or off the highway entirely (with techniques such as ramp metering), or provide incentives to increase average vehicle occupancy by providing superior facilities limited to high-occupancy vehicles, at least during congested periods.
- *Indirect physical restraints.* These methods typically involve the limitation of parking facilities in congested areas, or parking management policies that give preference to different vehicles based on occupancy, duration, or time of day.

Traffic avoidance

Finally, the third category of limitation policies, traffic avoidance, seeks to reduce the "need" or desire to make vehicular trips. There are two major potential strategies that can be characterized as traffic avoidance: land use planning initiatives that encourage relatively dense, mixed-use environments where walking or bicycling can be significant modes, and the substitution of telecommunications technologies for part or all of physical travel ("telecommuting" strategies).

HISTORY OF POLICIES CONCERNING THE PRICING OF ROAD USE

The concept of charging for the use of roads is hardly new. Toll roads have existed in what is now the United States at least since the late 17th century, when the earliest "turnpikes" (then used by horse-drawn carriages) required fees for access.[3] More recently, the 1940s and 1950s saw the construction of many toll roads and toll bridges by public agencies, before the interstate highway system ushered in the current era of financing through fuel and other taxes, rather than direct user fees.

Interest in congestion pricing as a means of traffic limitation dates at least to the early 1960s, when the report of the British Government's Smeed Commission[4] became the first government report to support the concept strongly. The report laid the groundwork for the now-accepted principles of successful implementation, and began a debate on the subject in Britain which continues today.

Indeed, the situation in London encapsulates the political fortunes of proposals for congestion-sensitive road pricing. Every 10 years or so, the idea re-emerges with a floating of tentative proposals for London in the media and a detailed study is made. The studies have generally been supportive, but so far no national government has been prepared to "grasp the nettle" and move ahead. Typically, the idea goes into political hibernation for another decade.

Early beginnings in Asia

In the mid-1970s the Urban Mass Transportation Administration (UMTA, now FTA) proposed a series of congestion pricing demonstration projects in several US cities. After much searching a few small cities expressed interest in the program. The level of negative local public reaction, however, was such that none of them proved willing to move even to the next phase, which would have involved no greater commitment than cooperating in a federally-funded detailed *planning study* of the idea in the local context.

At about the same time, however, the government of Singapore was introducing what would be the first congestion-sensitive road pricing system to be implemented anywhere in the world. This program, begun in 1975 and still in use today, uses an area licensing scheme like that described above to price access to the central business district during peak periods. Motorists wishing to enter restricted portions of the "Central Area" must purchase a paper license and display it on the vehicle's windshield. Licenses are sold by the day or month, and are color-coded to facilitate enforcement.

While political resistance remained in the United States throughout the late 1970s and early 1980s, the Asian experiment with congestion pricing continued. The Singapore project quickly proved its value to the government as a *revenue-raising* mechanism, and despite early evidence that the initial prices had been set *too high* to maximize the efficiency of road use, the government could not avoid the temptation to increase them further within the first year of operation. Since then, the area boundaries and fees of the Singapore system have been increased several times.

Between 1983 and 1985, the government in Hong Kong carried out a large-scale evaluation of a proposed program known as the Electronic Road Pricing Pilot Program, encouraged by the World Bank. This study estimated the congestion reduction and travel time savings of a system which would charge motorists for entering the dense commercial areas of Kowloon and the northern portion of Hong Kong Island, and used field tests to demonstrate the reliability of the electronic equipment that would be used to collect the tolls. However, as with the proposed UMTA project in the United States 10 years earlier, public opposition to the scheme eventually prevented its implementation. The aspect of public concern that is said to have killed the proposal, at least formally, was the "invasion of privacy" aspect, that is, nervousness about a government agency being able to monitor the whereabouts of individual vehicles.

The Scandinavian experience

As political and legal concerns derailed the Hong Kong project, the focus of road pricing-related activities shifted to Europe. At about the same time, the first of a series of toll rings was being

[3] Gomez-Ibanez, J. A. and Small, K. A., "Road Pricing for Congestion Management: A Survey of International Practice." *Synthesis of Highway Practice 210*, National Cooperative Highway Research Program (1994).

[4] UK Ministry of Transport, *Road Pricing: The Economic and Technical Possibilities.* London, UK, Her Majesty's Stationery Office, 1964.

implemented in Norway. This first program opened in Bergen in 1986, and charged drivers a fee for entering the central city area at any time before 10 PM or on weekends. It was not a "congestion pricing" scheme *per se*, as the goal was not to reduce traffic or to alter travel behavior so much as to raise needed funds for highway construction. As a result, the tolls charged were quite small (about $0.70), and did not vary much by time of day. Subsequent toll rings were opened in Oslo in 1990, and Trondheim in 1991. At the time of writing, a similar toll ring was expected to open in 1996 in Stockholm, Sweden.

Finally, the most recent congestion-sensitive road pricing project to be implemented fully in Europe involves a French toll road just north of Paris. This project, begun in 1992, represents the first application of congestion pricing to an intercity rather than an urban highway. As such, tolls were made to vary by time of day at the end of the weekend, when congestion is at its worst with the many Parisians returning home from the countryside, rather than during the peak commuting hours.

THE CURRENT STATE OF INTEREST IN THE UNITED STATES

Renewed interest at the federal level

The sine wave of interest in congestion-sensitive road pricing, epitomized by the series of studies for Greater London, is also in evidence in the United States. Following UMTA's lack of success in generating significant local interest in road pricing proposals in the mid-1970s, the idea essentially lay dormant for about 10 years. Then, in the late 1980s, interest revived in at least two important places: in the policy offices of both the Federal Highway Administration and the Federal Transit Administration, and in the Senate Committee on Environment and Public Works, with Senator Daniel Patrick Moynihan, the Chairman of the transportation subcommittee, playing a leading role.

As a result of Senator Moynihan's interest, in particular, the ISTEA legislation included authorization for a "Congestion Pricing Pilot Program" of five demonstration projects, to evaluate the effectiveness of congestion pricing in dealing with congestion problems.

The FHWA held a symposium on congestion pricing in 1992,[5] and Senator Moynihan's subcommittee held congressional hearings. The FHWA and the FTA jointly requested the National Research Council (NRC) to study congestion pricing. The NRC† appointed a blue-ribbon committee that eventually published a two-volume report.[6] The report concluded that

- Congestion pricing would cause some motorists to change their behavior;
- Congestion pricing would result in a net benefit to society;
- Congestion pricing is technically feasible;
- Institutional issues are complex but can be resolved;
- All income groups can come out ahead, given an appropriate distribution of revenues;
- Some motorists would lose;
- Congestion pricing would reduce air pollution and save energy;
- The political feasibility of congestion pricing is uncertain;
- Evaluation of early projects is crucial; *and*
- An incremental approach is appropriate.

The panel made a number of recommendations for federal, state, and local governments, all designed to promote increased interest in, and experimentation with, congestion pricing. Several of the recommendations concerned improvements to (and steps beyond) the ISTEA-authorized pilot program.

On the crucial issue of public acceptance, the reef upon which congestion pricing proposals always seems to founder, the TRB panel had this to say:

> The reasons for rejection of congestion pricing in the past have not changed. Any shift from the current system of financing and using the transportation system toward more marketlike mechanisms can be expected to engender public and political resistance. Concern that the poor would be less able than the middle class or the rich to pay congestion fees is often held up as an important political barrier to the acceptance of congestion pricing. (The unwillingness of some in the middle class to pay higher out-of-pocket expenses may be the more salient political barrier.) New road use charges of any sort are widely viewed as new taxes by a citizenry that holds the government in low esteem. In addition, some commercial interests in congested areas that might be subject to congestion pricing may be more worried about the possible short-term costs than the possible long-term benefits.
>
> The political difficulties of congestion pricing have not gone away, but the forces in favor of congestion pricing have increased. Whereas local political leaders eschewed congestion pricing in the past, support is growing in some areas, particularly in California. Although congestion pricing proposals are proceeding in a small-scale, incremental fashion, that they are proceeding at all is a substantial change from this policy's fate when last seriously considered in the United States.

Spinoff from the federal interest

This level of interest and activity at the federal level, of course, inevitably induced interest among the transportation planning and research communities across the country, if not necessarily among the elected officials of the state and local governments. Sessions and papers devoted to road pricing issues increased markedly in the professional fora in the early 1990s. Among the flurry of relevant publications is one major new book on the topic of congestion pricing.[7]

Not surprisingly, progress on implementing pilot projects under the ISTEA program has been accompanied by the nervousness that caused the 1970s UMTA-sponsored demonstrations to grind to a halt. The most visible of the selected projects concerns pricing across the San Francisco–Oakland Bay Bridge. This bridge is already a tolled facility, and so the demonstration would involve varying the tolls by time of day as an attempt to alleviate congestion. The implementation of the project appears to be still at least two years away, and ultimately will require approval by the state legislature because it will involve changing the existing tolls.

[5] US Department of Transportation, Federal Highway Administration, "Examining Congestion Pricing Implementation Issues." Report 6 in the series *Searching for Solutions—A Policy Discussion Series*, Washington, DC, US Department of Transportation, Federal Highway Administration (1992).

† Two units of the NRC—the Transportation Research Board and the Commission on Behavioral and Social Sciences and Education—were jointly responsible for the study.

[6] Transportation Research Board, "Curbing Gridlock: Peak-Period Fees to Relieve Traffic Congestion." *Special Report 242*, Washington, DC, National Academy Press (1994).

[7] Small, K. A., Winston, C., and Evans, C.A., *Road Work: A New Highway Pricing and Investment Policy*. Washington, DC, The Brookings Institution (1989).

New public and private toll roads

When *new facilities* are opened, there is not an existing pricing precedent that may limit the political willingness to change prices markedly on *existing* facilities. As a result of the federal momentum for transportation privatization in the 1980s, a number of new private and quasi-private toll facilities are currently being constructed, and a few of them have been operating (as of this writing) for several months. Projects in various stages of planning, construction, and operation include

- Three new public toll roads in Orange County, California, developed under the aegis of the Transportation Corridor Agency. According to Fielding, the TCA plans to charge uniform, distance-based tolls that are not sensitive to congestion levels.[8]
- Other privately-developed toll roads in California, authorized under the provisions of the 1989 state law AB680. Some selected projects have been stalled in the courts, but the first AB680 project to become operational—a segment of *State Route 91*, again in Orange County, began service in late 1995. This 10-mile facility, in the median of the existing Riverside Freeway, has adopted a congestion-sensitive toll structure, with tolls varying quite markedly with the time of entry. At the time of this writing, no detailed data about usage levels have been made publicly available, however.
- The *Dulles Greenway* toll road from Dulles International Airport to Leesburg, Virginia, a privately-financed extension of the public Dulles Access toll road, also opened in late 1995. The tolls do not vary by distance or by time-of-day.
- A Washington State program to facilitate private toll road projects, similar in several ways to the California AB680 initiative, has become stalled by legal challenges.

It is encouraging that at least one operational project has used congestion-sensitive tolls, and that two of the remaining AB680 projects are also expected to do so.

THE BARRIERS TO ADOPTION OF CONGESTION PRICING

Several obstacles to the implementation of congestion pricing in the United States have been suggested. At first it seemed that the problem was technological: how to physically charge all individual motorists without making the traffic problem worse? However, the technology to do this with reasonable levels of efficiency has been available for at least twenty years. Until recently, skeptics could argue that the technology was still *unproven*, but experience on the Scandinavian toll rings and even here in the United States (on toll roads in Florida, Louisiana, Oklahoma, and Texas) has demonstrated the efficacy of electronic toll collection (ETC) technology in practice.

Even if the technology does work, critics have responded that it could still be the main stumbling block. The issue becomes one of *personal privacy*—such a system would record the movements of each vehicle and match them with registration information for billing purposes, an attribute many think would doom the idea in the court of public opinion. This problem can also be easily solved with available technology. One current design for ETC uses a read/write debit card (or "electronic purse") system which need neither read nor store any information about the identity of the vehicle or driver. Interestingly, though, experience with ETC in Oklahoma suggests that privacy may not be such a big issue after all, or that if it is, it is only in the initial marketing of the system rather than its actual implementation.‡

The issue, then, is more one of political resistance to charging motorists directly, particularly if the prices necessary to maximize social welfare represent large increases over current payments. The political will directed against the concept comes from several sources, and the main opposing arguments typically use one of the following themes:

- *Taking the "free" out of freeway*. The current system largely funds highway capital and operating costs through user fees rather than tolls. Whether or not this system is well understood by the public—most likely it is not—there is great sensitivity even to the appearance of "taxing" the use of a "free" highway. One version of this argument takes the form, "We've already paid once for these roads. Why should we have to pay again?" This contention confuses the role of prices as a *financing* mechanism with the role of prices as a mechanism by which to ration the consumption of a *scarce* resource—the use of the road space at a time when many other people also want to use it.
- *Congestion pricing would hit the poor disproportionately.* Equity issues are frequently raised as an argument against price increases of any sort; road pricing is no exception. The net incidence of specific road pricing proposals will depend critically on how the substantial toll revenues are to be spent. To be sure, there will be some losers of the proposals no matter how progressively the revenues are spent. What limited analysis has been done on this issue[9] suggests that, under any but the most progressive redistribution schemes, higher-income groups *are* more likely to benefit than lower-income groups.
- *Just another "price increase."* The imposition of variable tolls on existing tolled facilities is perceived as "raising prices," which seems to strike a particular nerve among the public when the increase is the direct responsibility of a government agency. The transit experience shows that, even though prices are less important determinants of demand than various aspects of service quality, public authorities are very nervous about being seen raising prices that are under their direct control.
- *Not with my lane you don't!* If there is one thing worse than adding tolls to a non-tolled facility it may be adding tolls to an existing lane, and in the process "taking" the lane from general use. The idea that travelers will be left worse off if they don't pay the toll doesn't sit well with most people, and this resistance was amply demonstrated in the late 1970s when a lane of the Santa Monica Freeway in Los Angeles was converted to an exclusive HOV facility in the peak period. Local public outcry was so severe that the HOV restriction was removed after several months.

[8] Fielding, G. J., "Private Toll Roads—Acceptability of Congestion Pricing in Southern California." *in* Transportation Research Board (1994), *op. cit.*, Vol. 2, pp. 381–404.

[9] For a recent review, see Guiliano, G., "Equity and Fairness Considerations of Congestion Pricing." *in* Transportation Research Board (1994), *op. cit.*, Vol. 2, pp. 250–279.

‡ Purportedly, when users of the Oklahoma Turnpike were offered "anonymous" options very few users chose this method of payment.

There is also a less well-defined resistance to road pricing which stems from the perception that the traveling public will be the big losers, or alternatively, that only those collecting the tolls will benefit. This may be because it is hard for most people to see, in practice, how toll revenues will be redistributed to their benefit. On the other hand, they may not benefit. If they continue to use the roadway, they will either pay more or be forced to travel at a less desirable time. If they are "tolled off," they will have to choose a less desirable mode of transportation, which may be made worse by the addition of all of the other former drivers.

What makes *new* private or public toll roads promising as a congestion pricing test case is their potential to bypass most (if not all) of these problems. Because they are new facilities which begin life as toll roads, they avoid the notion of "taxing" a "free" road. Variable tolls should be easier to implement, since many of the roads are owned by private companies and thus don't face the same public pressure about prices. If consumers value the time savings at least as much as the toll, they will choose the toll road alternative; if not, they won't. Finally, these new facilities, by definition, represent additions to existing capacity, and offer *alternatives* to existing public facilities, thus avoiding the "take a lane" problem.

THE CURRENT STATE OF RESEARCH

This section describes the most recent research into congestion pricing, including both empirical models that attempt to estimate traveler reaction to new hypothetical projects, as well as studies of existing travel patterns in the most recent applications of road pricing in Scandinavia and elsewhere. It is intended that this information serve both as a reference for the interested reader wishing to find more information about the concept of road pricing, as well as a synthesis of recent research results.

General references

Perhaps the best source for a comprehensive look at congestion pricing is found in the NCHRP Synthesis "Road Pricing for Congestion Management: A Survey of International Practice," co-authored by Jose Gomez-Ibañez of Harvard and Kenneth Small of the University of California at Irvine. As the title suggests, the report examines both the theoretical side, and the practical implementation of congestion pricing projects.

Although out of print, another excellent general reference is Johansson and Mattsons's *Road Pricing: Theory, Empirical Assessment and Policy*, which is the result of a 1992 conference held in Sweden to discuss road pricing issues.[10] The first section has four chapters on the *theory* of road pricing, the second part has three chapters on *empirical* evidence, and the third section has five chapters on the *policy* issues of road pricing. The first chapter in the policy section provides a thorough discussion of road pricing in the larger context of the planning tools available to influence traffic demand, while Chapter 12 provides a more detailed discussion and classification of the types of charging methods. These chapters are a good complement to the material on traffic limitation policies presented above. Some of the other chapters are discussed in more detail below.

Finally, the National Research Council report, *Curbing Gridlock*, described above, also provides a good characterization of the theory and concept of road pricing as it relates to the transportation planning problems faced by American cities. The report also presents substantive conclusions about the impacts of implementing road pricing in the United States, and addresses each of the issues involved. A second volume contains the series of technical papers which were prepared as part of the project.

Evaluation of European road pricing projects

In Chapter 6 of Johansson and Mattson, Farideh Ramjerdi describes the results of a panel study, carried out in 1989 and 1990, of residents of the Oslo region.[11] The Oslo toll cordon was introduced in February 1990. The panel study captures the response to the imposition of the tolls. However, there are indications that the panel suffered from attrition, and from underreporting of trips in the second wave (1990).

The report includes a good deal of information on direct and cross-elasticity of volume by cost of mode. It examines walking, bicycle, private vehicle, and transit modes. In general, the cordon toll had very little impact on travel, although the impact was in the "right" direction. The direct and cross-elasticities of demand with respect to the cordon toll are shown in Table 67.

The low elasticities are expected. The Oslo toll cordon was designed to minimize its impact on travel as much as possible, since the primary purpose of the toll was to raise revenue, not reduce traffic or congestion. In addition, the toll authority sold seasonal passes (in varying denominations) that allowed unlimited travel across the cordon for the duration of the pass period. Thus, auto travelers who anticipated a high number of cordon crossings were able to pay up front for a seasonal pass, thereby reducing the marginal cost of each cordon crossing to zero, which further decreased the net impact of the toll cordon.

A 1992 paper by Terje Tretvik presents the public response to the implementation of the Trondheim toll ring.[12] The first half of the paper describes the Trondheim toll arrangement, while the second half discusses public opinion towards the toll. The paper reports results of surveys conducted before and after the opening of the Trondheim toll ring, which reveal that the number of people with negative attitudes towards the toll declined once it was in place. While most residents were opposed to the tolls alone before the opening, the entire package of policies—which included the new tolls—was judged favorably by most people once they were in place.

Tretvik also authored Chapter 5 of Johansson and Mattson, which is entitled "Willingness to Pay for Time Savings: The Trondheim Toll Road Experience."[13] This chapter describes a study of a toll

[10] Johansson, B. and Mattson, L. G. (eds.), *Road Pricing: Theory, Empirical Assessment and Policy.* Norwell , MA, Kluwer Academic Publishers (1995).

[11] Ramjerdi, F., "An Evaluation of the Impact of the Oslo Toll Scheme on Travel Behaviour," Chapter 6 of Johansson, B. and Mattson, L. G. (eds.), *Road Pricing: Theory, Empirical Assessment and Policy.* Norwell, MA, Kluwer Academic Publishers (1995).

[12] Tretvik, T., "The Trondheim Toll Ring: Applied Technology and Public Opinion" *IWWZ-Report No. 37: The Use of Economic Instruments in Urban Travel Management, 1992*. Trondheim, Norway, Selskapet for Industriell og Teknisk Forskning, Division of Transportation Engineering (1992) pp. 69–87.

[13] Tretvik, T., "Willingness to Pay for Time Savings: The Trondheim Toll Road Experience." Chapter 5 of Johansson, B. and Mattson, L. G. (eds.), *Road Pricing: Theory, Empirical Assessment and Policy.* Norwell, MA, Kluwer Academic Publishers (1995).

TABLE 67 Estimates of mode-specific elasticities for Oslo, 1990

Elasticity of demand with respect to tolls:	Travel purpose work		Other travel purposes	
	All tours	Tours crossing cordon toll	All tours	Tours crossing cordon toll
Car/driver	-0.04	-0.14	-0.014	-0.06
Car/passenger	0.04	0.09	0.015	0.05
Public transport	0.03	0.04	0.018	0.05
Walk/bike	0.01	0.06	0.013	0.06

Source: Ramjerdi (1995).

road just outside Trondheim rather than the Trondheim toll ring itself. This toll road goes from Ranheim towards Værnes, the Trondheim airport, currently extending about two-thirds of the distance to the airport. The paper reports on the revealed impact of the extension of the road in 1990, combined with a corresponding increase in the toll charged.

It was found that explanatory models of traveler behavior fit better when *perceived* time savings (from using the toll road) were used instead of engineering estimates. This may be due to the impact of quality of service differences between the facilities. Also, as the toll went up relative to the actual time saved, the perceptions of time saved became more accurate, but *the perceptions still overestimated the actual time saved* by between 23% and 57%. The users of this toll facility exhibited the following values of time, based on an analysis of the perceived time savings:

- For commute trips, 57% of the wage rate;
- For business trips, 99% of the wage rate; and
- For all other trips, 59% of the wage rate.

A 1992 paper by Ramjerdi[14] delivered to the World Conference on Transport Research in Lyon compares the current cordon tolling scheme in Oslo, Norway, to two other systems—an "optimal" cordon toll, and a "socially optimal" road pricing toll. The optimal cordon toll would reflect the marginal cost to traffic imposed by users of the road, whereas socially optimal tolls would replace the cordon with a price charged to each link in the network model, computed to equal the marginal social cost of each additional driver on that link. The author finds that the optimal cordon toll would eliminate the social cost of collecting the tolls, but would reduce the revenue collected, and the socially optimal tolling scheme would further reduce the gross revenues collected, but would result in even greater net benefits to the traffic flow in Oslo.

Johannson and Mattson also authored a chapter in their book (Chapter 10), which deals with the politics behind the agreement to create a road pricing system in Stockholm.[15] They use the so-called Dennis Agreement as a case study of how a "package approach" can win approval for congestion pricing measures. The agreement, signed by the three largest political parties in Stockholm, consists of a package of transportation improvements including both a public transport component and a road component. The authors discuss the impacts of the agreement on revenue, traffic volumes, travel behavior, vehicle emissions, destination choices, and land use patterns, and conclude that the inclusion of congestion pricing in a *package* of transportation improvements made the pricing element politically acceptable. The Dennis Negotiation Game is also described.

There has also been study of the demonstration project conducted in Cambridge, UK, in 1993. Chapter 7 of Johansson and Mattson, written by Brian Oldridge, presents some of the background about traffic conditions in the city, and the local politics involved in potentially establishing a congestion pricing system.[16] He concludes that zone pricing schemes face too much political difficulty to give them serious consideration, but that congestion metering schemes will be "dynamic and immediately responsive to actual conditions." The paper closes with a discussion of the demonstration project, and the fact that the technical system has been proven in operational tests. The application of the project to Cambridge and other cities is also discussed.

Blythe, Clark, and Rourke analyzed the more technical aspects of the Cambridge demonstration, evaluating the ADEPT system used for toll collection.[17] The Cambridge implementation of the ADEPT system included in-vehicle transponders and smartcards, which were triggered by microwave beacons placed in a cordon around the city center. Users were charged on the basis of vehicle speed. The on-board unit determined if the vehicle was traveling slowly, and, if so, assumed that the vehicle was on a congested stretch of road and tolled the smartcard accordingly. If the vehicle moved at free-flow speeds, then the card was not charged. The trial seems to have been strictly an engineering trial, with no "real users" and hence no behavioral findings or implications, but did demonstrate the efficacy of this technology for toll collection.

Finally, a recent paper by Hayes and Ramón provides a description of the "zone access control" system being developed in Barcelona, Spain.[18] The system has not yet been implemented, but

[14] Ramjerdi, F., "Road Pricing in Urban Areas: A Means of Financing Investment in Transport Infrastructure or of Improving Resource Allocation, the Case of Olso." *Transport Policies: Selected Proceedings of the Sixth World Conference on Transport Research*, Vol. III., Lyon (1992).

[15] Johansson, B. and Mattson, L. G., "From Theory and Policy Analysis to the Implementation of Road Pricing: The Stockholm Region in the 1990s," Chapter 10 of Johansson, B. and Mattson, L. G. (eds.), *Road Pricing: Theory, Empirical Assessment and Policy*. Norwell, MA, Kluwer Academic Publishers (1995).

[16] Oldridge, B., "Congestion Metering in Cambridge City, United Kingdom." Chapter 7 of Johansson, B. and Mattson, L. G. (eds.), *Road Pricing: Theory, Empirical Assessment and Policy*. Norwell, MA, Kluwer Academic Publishers (1995).

[17] Blythe, P. T., Clark, D. J., and Rourke, A., "Results of the Cambridge Experiment in Congestion Management." *Seventh International Conference on Road Traffic Monitoring and Control*, London, UK, The Institution of Electrical Engineers (1994).

[18] Hayes, S. J. and García Ramón, J., "Zone Access Control in Central Barcelona Using ATT Technologies." *Seventh International Conference on Road Traffic Monitoring and Control*, London, UK, The Institution of Electrical Engineers (1994) pp. 38–41.

the first stage has been designed with the input of residents and merchants who would be affected. It would restrict automobile access to zones in the city based on the time of day or week, the vehicle type, the user type, the number of previous entries, the origin/destination, and the duration of stay; as such, it is most closely analogous to the area license used in Singapore. However, it will use electronic vehicle identification systems, based initially on read-only, in-vehicle devices, rather than paper licenses, and it is intended that the system will eventually be used to charge variable prices.

Other econometric modeling of impacts

We are aware of two recent European studies to model the impacts of proposed road pricing schemes. These analyses go beyond the traditional travel demand analyses, which are typically limited to the direct effects of time and cost changes on travel behavior.

A 1994 paper by May *et al*. reports on the *network* impacts one would expect to see from various methods of toll collection, using network models to analyze Cambridge and York, in the United Kingdom.[19] In addition to forecasting aggregate impacts on travel demand that will result from road pricing measures, this paper posits that the *method of collection* will also have an impact on travel patterns and demand. For example, a cordon scheme may cause congestion on the routes just outside of the cordon boundary, as drivers switch to these routes to avoid the charges. Four types of toll collection systems are examined in the paper: point or cordon charging; charges related to the time spent in an area; charges related to distance traveled in an area; and charges related to time spent in congestion.

The time-based and congestion-based schemes were the only two charging schemes that were found to have a beneficial impact on average network speed in the absence of demand effects. When the demand effects were included, all of the charging schemes improved network travel times, but the time and congestion charging schemes were still the most successful. The authors conclude by noting that these findings are contrary to earlier findings indicating that cordon and distance tolls were likely to perform better than time or congestion charges.

Haag developed a dynamic systems model (cybernetic model) to evaluate the general effects of road pricing on aspects of *regional development* in Frankfurt, Germany.[20] The study showed that a road pricing scheme would significantly benefit the economy of the Rhein–Main region, and would have an insignificant ecological effect in the region. The effect on equity and the financial effects of road pricing could not be determined with the cybernetic model, because both of these effects are intertwined and dependent upon how the money collected from a road pricing scheme is reinvested in the region.

However, the study suggests that implementing road pricing in a limited area, such as in the urban core, will result in higher price differences between urban and suburban areas, which in turn could lead to greater separation of land uses. Unless these unintended secondary effects can be controlled, it is argued, they may imply that road pricing could be a bad policy for an area in the long run.

IMPLICATIONS FOR US POLICY

Whether or not we are any closer to congestion-sensitive road pricing in the United States, the question remains, what would it mean for our cities in practice? We know in theory that congestion could be reduced, and as a result, perhaps the single-occupant vehicle's share of urban commute trips could decline in favor of increased use of public transit. We also have the benefit of foreign experience (some very recent), as well as a great deal of research on the subject. What then, can we say specifically about the implications of these types of pricing schemes for US transportation policies?

The NRC panel's 1994 findings probably capture the most that can currently be concluded about the applicability of congestion pricing in a North American context. In brief, the idea is very attractive primarily for the *potential* it shows for generating large net social benefits by using highway facilities more efficiently. The theory is persuasive, and congestion pricing has long been viewed by the majority of transportation analysts as the most promising strategy for improving urban travel conditions.[21] There are considerable (and justifiable) uncertainties about such aspects as public acceptance, the net distributional implications, and such macroscopic issues as effects on the larger network and on longer-run adjustments such as property values, urban form, and the regional economy.

There are strong limitations to the applicability of the overseas experience to North America:

- The *Singapore* experience illustrates the efficacy of prices as a road rationing device (peak traffic has fallen by about 75%), even though an area-licensing scheme is a very blunt form of congestion-sensitive pricing. However, Singapore is a very autocratic society, and this experience probably demonstrates little about political feasibility and sensitivities in a more democratic, pluralistic environment.
- The *Scandinavian* projects, by and large, have been less concerned with pricing as a device to encourage efficient use than with pricing as a means of financing infrastructure costs. The Stockholm experience reinforces a lesson drawn long ago from attempts to interest US cities in road pricing: that to be palatable, price initiatives need to be packaged with a number of other, more popular measures, probably including a commitment for the use of the pricing revenues to create relatively near-term amelioration of other travel-related problems (for example, significant proposals to improve transit service quality).
- Of the overseas projects, the *French* one is probably the most relevant. The pricing was truly congestion-sensitive (at least it varied by time of day), with the avowed purpose of reducing congestion. It was priced to be revenue-neutral, it had a big impact on traffic flow, with few (if any) adverse impacts. Apparently, it has a high level of public acceptance. However, the setting was more an intercity route, not an urban one, catering more to discretionary travel than to daily commutes. Relatively high tolls are normal on the French Autoroutes.

[19] May, A. D., Milne, D. S., van Vliet, D., Smith, M. J., and Wisten, M., "The Network Effects of Alternative Road Pricing Systems." *Seventh International Conference on Road Traffic Monitoring and Control*, London, UK, The Institution of Electrical Engineers (1994) pp. 46–49.

[20] Haag, M., "Effects of Road Pricing in the Rhein-Main Region—Study Based on a Cybernetic Evaluation Model." *Transportation Planning Methods*, Proceedings of Seminar G held at the PTRC European Transport Forum, University of Warwick, England, Volume P379 (1994) pp. 69–80.

[21] Beesley, M. and Kemp, M. A., (1987), *op. cit.*

In the United States, we do have some toll facilities in a number of metropolitan areas, particularly the older, more dense cities of the Northeast and the Midwest. Moreover, electronic toll collection methods are being introduced with increasing momentum, and by now we have accrued enough domestic experience with ETC that technological feasibility questions are no longer much of an issue.

The California SR91 experience, currently operational for less than a year, is the development that comes closest to providing a relevant data point on US soil. It appears that it will be some time before any data or analysis of that experience will find its way into the public domain, however.

So what happens next?

As of this writing, in late 1996, the immediate prospects for congestion pricing initiatives in US cities look as checkered as ever. The USDOT interest has moderated slightly, and the California Bay Bridge experiment, selected for funding under the ISTEA program, appears to be stalled. On the other hand, environmental pressure groups in a variety of cities have rallied to the cause. In large part because of pressures exerted through neighboring local governments, congestion-sensitive pricing is now being discussed and studied for an increasing range of existing toll facilities, including the Tappan Zee Bridge and the New York City bridges and tunnels operated by the MTA's Triborough Bridge and Tunnel Authority. Various new euphemisms are appearing: "incentive pricing," "market-based pricing," and so on. And even *US News and World Reports* and the *New York Daily News* have had recent editorials supporting the case for congestion pricing. It would be a foolish prognosticator who either discounts the groundswell of current interest or minimizes the political barriers to significant adoption.

The **Transportation Research Board** is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results. The Board's varied activities annually draw on approximately 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purpose of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S. DOT	U.S. Department of Transportation