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Ridesharing— Transportation Demand Management

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Transportation Research Record 1212

Contents

Foreword

Transportation demand management, transportation system management, and vanpooling/ridesharing are the subjects covered in this Record.

The papers that cover transportation demand management (TDM) consist of a set of case studies for 10 U.S. cities; the planning, development, and implementation of TDM in three suburban activity centers; and a public/private approach in packaging programs tailored to meet individual commuting needs.

The papers on vanpooling/ridesharing and HOV usage are varied. One discussion focuses on cost recapture for standard van leases, and a comparison is made between the traditional approach linked to the length of standard van lease and using a cost recapture formula based on the actual useful life of a van in mileage.

Various operational aspects of HOV lanes are discussed. Travel behavior is compared before and after the opening of HOV lanes in a suburban travel corridor. Discussions in other papers include the operational aspects of a bus/carpool lane in a dense urban corridor and the results of a guaranteed ride home program that reimburses eligible HOV users for a fixed number of miles of travel to or from work using taxis. Also, the phenomenon of "instant" carpooling is described and evaluated whereby ad-hoc carpools are formed each morning in order to use HOV express lanes.

A series of papers focuses on joint public/private sector efforts in ridesharing/paratransit. These papers include an assessment of the costs and benefits available to private sector employees through the operation of employer ridesharing programs, joint private sector evaluation of a transportation and parking information service in a central business district, assessment of transportation system management programs developed through a consensus between the public and private sectors, and a discussion of the privately operated government regulated "público" system of Puerto Rico.

Comparison of Transportation Demand Management Market Research Study Results and Transportation Management Association Development in Three Suburban Activity Centers

ROBERTA VALDEZ AND JUDY WANG

A focus of transportation demand management (TDM) planning and implementation efforts in suburban Orange County, California, has been at the activity center level. The efforts have entailed organizing activity center employers to participate in TDM planning through transportation management associations (TMAs) or other related groups and then establishing and implementing TDM programs at the centers. Market research studies are conducted to assist in planning and implementation at each center. A comparison of TDM planning, TMA development, and program implementation efforts in three activity centers is presented in this paper. The activity centers represent each section of the county: Newport Center in the south, South Coast Metro in the center, and Brea in the north. A brief description of each area is provided, followed by the study methodology, survey results, and, finally, the status of TMA and program implementation efforts. The activity centers not only represent different regions, employment compositions, and levels of involvement and commitment from the cities and business communities, but also different stages in program development. Therefore, comparisons between the centers are provided throughout the paper and similarities and differences are reviewed in the conclusion.

Typical of other suburban areas throughout the country, Orange County, California, has experienced unprecedented growth in jobs and population. In fact, during the 1970 to 1980 decade, Orange County was the third fastest growing county in the nation. The urbanization trend in Orange County has resulted in the emergence of at least 11 major activity centers. These centers cumulatively accounted for over 300,000 jobs in 1985 and are expected to contain more than 425,000 jobs (a 42 percent increase) by the year 2000.

The county's current transportation infrastructure has already been overburdened by existing travel demand associated with these centers. Even with planned and programmed improvements to the transportation network, commute times will continue to lengthen and commuter stress will become more pervasive during peak hours. Public agencies are attacking the problem with a complexity of programs and actions aimed at enlarging the local transportation system, but the initiation of transportation demand management (TDM) actions within the activity centers is the additional ingredient needed to enhance commuter mobility in Orange County.

TDM entails a variety of techniques that lower the demand placed on the transportation system, thereby maximizing its ability to carry traffic. Examples of TDM strategies include carpooling, vanpooling, transit, alternative work hour programs, telecommuting, on-site services, and parking management. Experiences such as the 1984 Olympics have demonstrated that these techniques can be useful in reducing congestion and that they can be effectively implemented through localized transportation planning. This paper describes the efforts of the Orange County Transit District (OCTD) in conducting such localized demand management planning in three suburban activity centers in Orange County.

OVERVIEW

The OCTD has worked extensively with a number of different activity centers in Orange County that have been identified for localized demand management planning and program implementation. The goals of these efforts are to

- Organize activity center employers to participate in TDM planning through transportation management associations (TMAs) or other related groups;
- Plan, develop, and implement TDM strategies at each activity center;
- Work with city and county planning agencies to include them in the TDM planning effort and to implement municipal TDM measures; and
- Coordinate TDM plans with transportation strategies planned by city, county, and state agencies along major transportation corridors in Orange County.

DESCRIPTION OF THREE ACTIVITY CENTERS

The three activity centers discussed in this paper represent different geographic regions in the county, different employ-

Orange County Transit District, 11222 Acacia Parkway, Garden Grove, Calif. 92642.

ment compositions, different levels of involvement from the local cities and business communities, and different stages of program development. The location of the three activity centers, Newport Center, South Coast Metro, and Brea, relative to each other, is depicted in Figure 1. A brief background description of each of these areas follows.

South Coast Metro

South Coast Metro lies within the cities of Costa Mesa and Santa Ana covering an area of 3.5 sq mi (see Figure 2). South Coast Plaza, one of Orange County's largest retail shopping centers, is a core area offering a variety of retail shops and restaurants. In addition to the Plaza, South Coast Metro contains over 5.2 million sq ft of office space, over 5,000 residential units, and a performing arts center.

Almost three-fourths of the firms in the Metro represent the retail trade and service industries (42 percent and 32 percent of the firms, respectively). The area contains approximately 1,114 employers with a total of about 25,545 employees. The employment composition by employer size is shown in Table 1.

Newport Center

Newport Center consists of a shopping center surrounded by a series of professional office buildings, a library, and an art museum. The geographic boundaries are shown in Figure 3.

Services and retail trade are the major industries in Newport Center (44 percent and 27 percent of the firms, respectively). There are about 745 employers with approximately 10,500 employees in the center (see Table 2).

Brea

The Brea activity center is centered around the Brea Mall and the business development along the Orange Freeway (Freeway 57). The financial center and Brea's civic and cultural center are also located within the activity center. The geographic boundaries are shown in Figure 4.

Manufacturing and retail trade are the two most common industries, accounting for almost two-thirds of all firms (29 percent each). There are an estimated 57 employers within the activity center with 50 or more employees, and these firms employ an estimated 15,150 people. The employment composition is shown in Table 3.

TDM MARKET RESEARCH STUDY

The TDM Market Research Study consisted of a separate study in each of the activity centers. These market research studies were conducted to assist in planning and implementing TDM programs. The studies were valuable for a number of reasons. First, before TDM actions could be planned and implemented at an activity center, it was necessary to obtain information about the appropriateness of strategies for that area. In addition, potential members of the TMA or other planning organization were identified in the course of the studies. Finally, the results of the studies demonstrated area-wide support within the business community for TDM planning and implementation efforts, which facilitates employer involvement in programs.

Objectives

All three TDM market research studies had the following objectives:

- Provide reliable estimates of current employee commuting behavior at the center;
- Provide information on current employer initiatives and support concerning employee transportation; and
- Assess the employee and employer market potential for various TDM techniques, including carpooling, vanpooling, alternative work hours, telecommuting, and parking management.

Sampling Methods

The sample selection varied slightly from one area to another. In South Coast Metro, a representative sample was obtained from a listing of all employers with six or more employees derived from a countywide data base. Data collection was conducted during October and November 1986. Data were collected from 2,600 employees, which represented an overall response rate of 56 percent. One hundred and forty-four employer surveys were completed, which represented a 49 percent response rate; the response rate for large organizations (more than 100 employees) was substantially higher (80 percent). Interviews were completed with members of senior management of 24 of the 37 largest firms in the area, for a 65 percent response rate.

In Newport Center, the sample was derived from a listing, by size, of all firms in the area. The listing, which was updated 1 month before survey administration, was obtained from Newport Center's transportation coordinator. Of the 341 companies approached, a total of 134 participated in the study, for a 56 percent response rate; the response rate for large companies (more than 100 employees) was high (93 percent). Data were collected from 2,333 employees, which represented a 30 percent response rate.

In Brea, a representative sample was derived from a list of all firms in the area with 50 or more employees. Of the 51 firms approached, a total of 39 participated in the study, for a 76 percent response rate. Data were collected from 2,164 employees, which represented a 34 percent response rate.

Instruments

In the South Coast Metro and Brea studies, three survey instruments were developed: an employee questionnaire, an employer questionnaire, and a survey designed to be administered in a face-to-face interview with company executives.

In Newport Center, a senior management survey was not used, but employee and employer questionnaires similar to

FIGURE 1 South Coast Metro, Newport Center, and Brea activity centers.

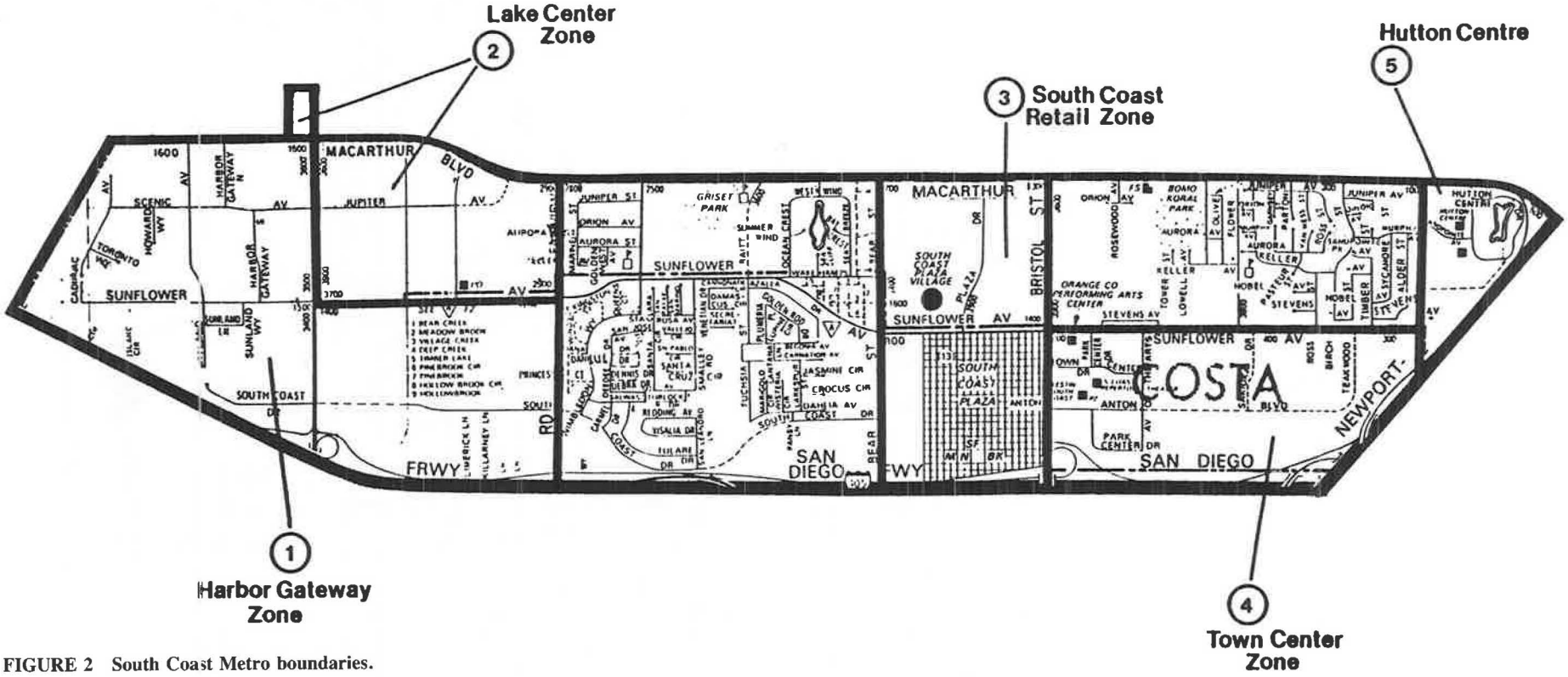

FIGURE 2 South Coast Metro boundaries.

TABLE 1 SOUTH COAST METRO EMPLOYMENT COMPOSITION BY EMPLOYER SIZE

Size (Employees)	No. of Employers	Percentage of Employers	No. of Employees	Percentage of Employees
1–5	617	55	1,851	7
6–25	376	33	4,498	17
26–50	53	5	2,014	8
51–100	29	3	2,204	9
100+	39	4	14,978	59
	1,114	100	25,545	100

TABLE 2 NEWPORT CENTER EMPLOYMENT COMPOSITION BY EMPLOYER SIZE

Size (Employees)	No. of Employers	Percentage of Employers	No. of Employees	Percentage of Employees
1–4	300	40	799	8
5–19	345	46	2,793	27
20–99	86	12	2,575	24
100+	14	2	4,333	41
	745	100	10,500	100

those used in the other two areas were developed. The objectives of the employee survey were to assess

- Commuter travel characteristics including current mode and willingness to consider alternatives, trip distance, travel time, and origin and destination of work trip;
- Employee work schedule characteristics; and
- Employee need for a car before, during, and after work.

The objectives of the employer survey were to obtain a descriptive profile of employers including

- Parking costs and availability;
- Availability of on-site services;
- Ridesharing incentives offered; and
- Work schedule policy.

The objectives of the senior management survey were to

- Obtain senior management's perception of traffic conditions;
- Obtain the perception of the effects of traffic on the organization; and
- Assess the willingness to participate in a cooperative effort to help solve traffic problems.

STUDY RESULTS

Perception of Congestion and Stress

As shown in Figure 5, employees perceived significant and similar levels of congestion in all three areas. In Brea, 16 percent felt that commuting to work was more stressful than their other daily activities; whereas in South Coast Metro, about a fourth (28 percent) reported this level of stress.

Given a list of social issues, senior management executives in both Brea and South Coast Metro indicated that traffic congestion affected their company more than any other issue (see Table 4). The table also shows that traffic congestion is perceived as a problem by more executives in South Coast Metro than in Brea.

In both South Coast Metro and Brea, about one-fourth (21 percent) of the executives would consider relocating if traffic conditions got worse. Executives in both areas believed that employers not only have a responsibility to help reduce traffic problems, but that it is in the long-term self-interest of business to get directly involved in reducing traffic congestion (see Table 5).

Executives in both Brea and South Coast Metro noted that traffic conditions affected company operations in many ways. The questions were presented in different ways (i.e., open-ended in South Coast Metro, but with effects listed in Brea), so responses cannot be compared. In Brea where respondents were asked about each effect, more executives indicated that traffic had an effect on employee tardiness (53 percent), client/customer access (39 percent), and productivity (36 percent) than on other areas. In the South Coast Metro study where the question was open-ended, the executives cited delivery of products (29 percent), as well as employee tardiness (29 percent) and client/customer access (21 percent), as the major effects of traffic conditions on company operations.

Commute Mode

As shown in Figure 6, driving alone was the predominate commute mode in all three areas.

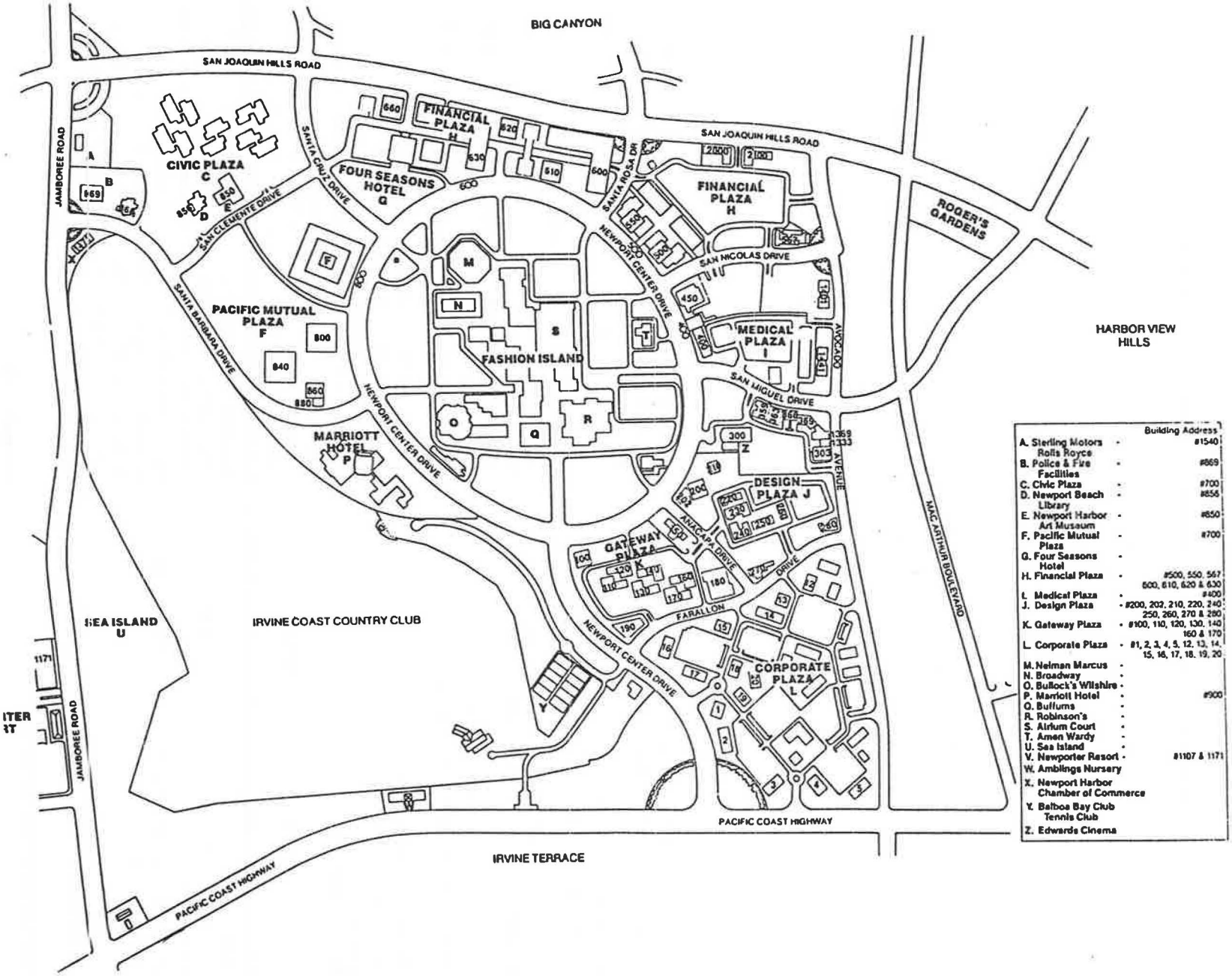

FIGURE 3 Newport Center boundaries.

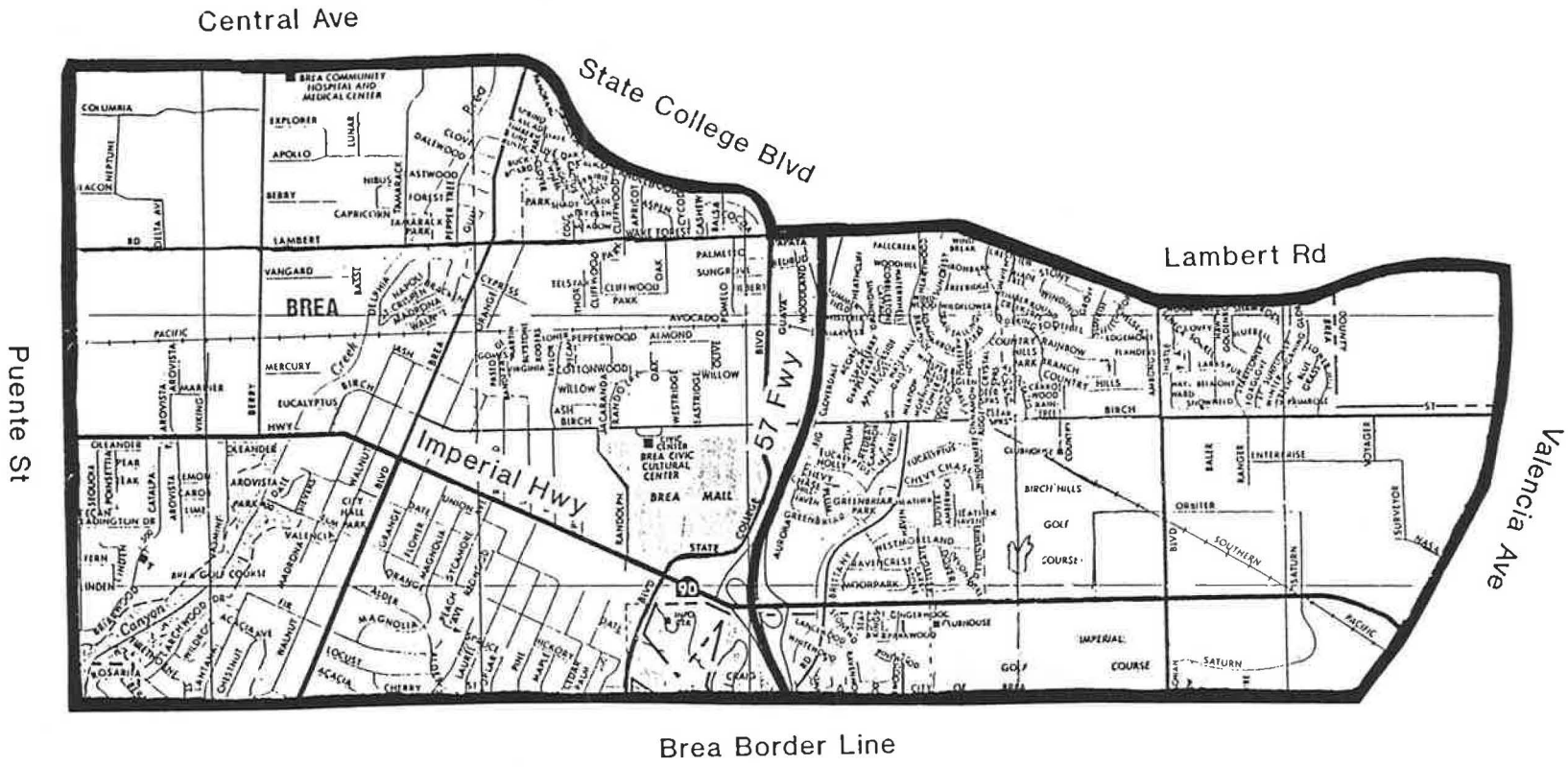

FIGURE 4 Brea boundaries.

TABLE 3 BREA EMPLOYMENT COMPOSITION BY EMPLOYER SIZE (50+)

Size (Employees)	No. of Employers	Percentage of Employers	No. of Employees	Percentage of Employees
50–100	16	28	1,200	8
101–250	24	42	4,200	28
251–500	8	14	3,000	20
500+	9	16	6,750	44
	57	100	15,150	100

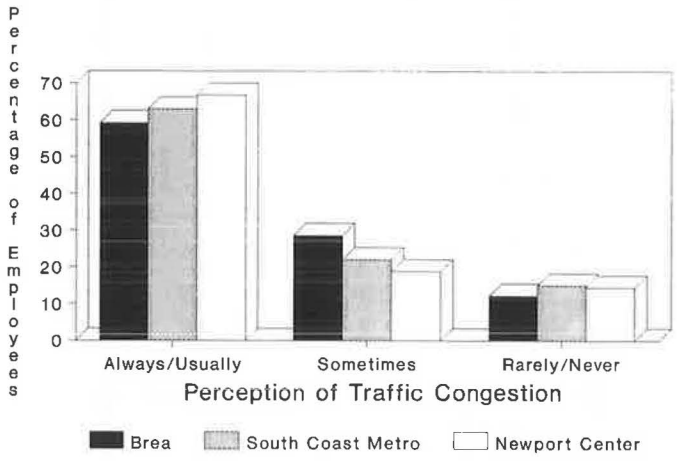

FIGURE 5 Comparison of employee perception of traffic congestion for the three activity centers.

TABLE 4 SENIOR MANAGEMENTS' PERCEPTIONS OF THE EFFECTS OF SOCIAL ISSUES ON THEIR ORGANIZATION

	Percent Indicating Issue Affects Company[a]	
Social Issue	South Coast Metro	Brea
Traffic congestion	88	55
Affordable housing	54	46
Parking	33	36
Quality of schools	25	31
Crime	17	32

[a]Does not total 100% due to multiple response.

Levels of Employer Support

In Brea and South Coast Metro, large employers (i.e., 100 or more employees) were more likely to provide support for ridesharing than small employers. In all three areas, employers were more likely to provide information than to offer any active assistance or operational support (see Table 6). As also shown in Table 6, Newport Center employers were more active in providing information to employees. This finding is probably the result of the efforts of "Centeride," a TDM program supported by OCTD and The Irvine Company, a major developer. Several advertising and promotional campaigns were conducted in Newport Center as part of the program in a 6-month period preceding the survey.

TMA DEVELOPMENT

As mentioned previously, each of the three activity centers represents a different stage in the development of areawide TDM programs. Part of areawide program planning and implementation includes the establishment of TMAs. The term TMA has been used to describe a wide range of different organizational arrangements that have in common a major goal to coordinate a private sector response to local traffic problems. A TMA can be a committee of a local chamber of commerce or a separate nonprofit organization. Generally, these organizations focus on TDM techniques to accomplish their goals. The status of each of the activity centers with regard to TMA and TDM program development will be described in the next sections.

Newport Center

On May 18, 1986, a major developer, The Irvine Company, contracted with OCTD to establish a field office and TDM program called "Centeride" in Newport Center. The agreement provided funding for a full-time staff member (OCTD) and for promotional materials. The first-year objectives of this program were to conduct a ridesharing campaign and to investigate the potential for other demand management strategies. The TDM Market Research Study presented in the previous sections fulfilled the second objective.

TABLE 5 SENIOR MANAGEMENT PERCEPTION OF THE RESPONSIBILITY OF EMPLOYERS

Statement	Percent in Agreement	
	South Coast Metro	Brea
Employers have a responsibility to help reduce traffic problems in area	83	82
Attempting to solve transportation problems does *not* interfere with main purpose of business	76	64
It is in long-run self-interest of business to get directly involved in reducing congestion	92	86

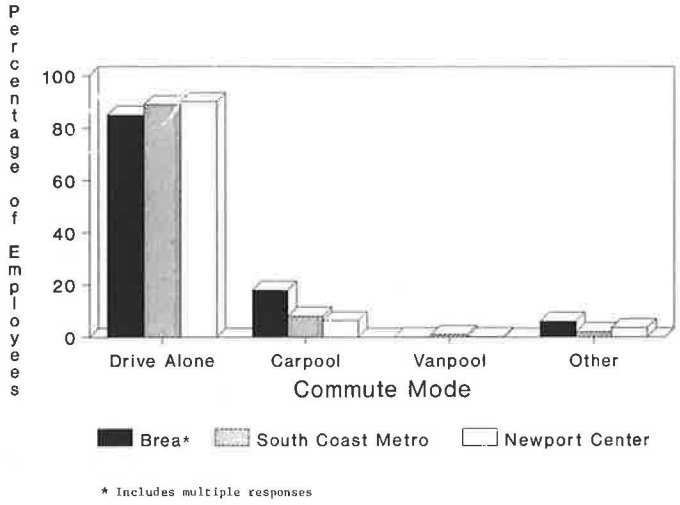

FIGURE 6 Comparison of commute modes for the three activity centers.

The results of the study were presented to the Newport Center Association (NCA) on June 25, 1987. The presentation was attended by area employers, NCA members, the Mayor, and members of the Newport Beach City Council, city staff, and planning commissioners.

At a second meeting, held on July 23, 1987, decisions were made to establish an executive task force (ETF) representing the city and large employers in Newport Center. The task force members volunteered their own organizations to be pilot companies in cooperation with the Centeride program staff to set an example for how other organizations might take part in the future.

The contract between OCTD and The Irvine Company for the Centeride program has been extended through January 2, 1989. Efforts are currently directed toward obtaining private-sector funding from Newport Center companies to continue the program because OCTD will discontinue funding participation at that time.

South Coast Metro

The South Coast Metro Alliance was founded in 1985 to market the area and also in response to a study sponsored by the Orange County Transportation Commission (OCTC), which concluded that there was potential for a TMA to be effective in alleviating travel demand in the center. The focus of the first 2 years' activities were on advertising campaigns designed to promote South Coast Metro.

In 1986, OCTD initiated the TDM Market Research Study described previously. A presentation was made to an ETF composed of business leaders in September 1986, which described the proposed study and introduced the TMA concept. The study was completed in April 1987, and the results were presented to the ETF, developers, and city and county officials in the area (27 in attendance). An action plan was subsequently developed and approved that addressed both transportation system and demand management strategies.

A joint privately (South Coast Metro Alliance and ETF) and publicly (OCTD) funded field office has been established in the center to implement the plan. The South Coast Metro Alliance is contributing 50 percent through a 1 cent per sq ft assessment of each of its members, and OCTD is providing matching funds. The ETF is presently filing for nonprofit status and will become an equal funding partner when that is accomplished.

In addition to providing information for development of the Action Plan, the study results have and will continue to

TABLE 6 COMPARISON OF LEVELS OF EMPLOYER SUPPORT FOR RIDESHARING

Support	Percent of Employers[a]		
	South Coast	Newport	Brea
Information			
Display bus schedules/maps	20	58	15
Distribute ridesharing information	23	59	26
Distribute lists of carpool partners	20	11	21
Prepare (AQMD)[b] Traffic Abatement Plan	17	–	24
Publish articles in newsletter	–	–	5
Active assistance			
Employee transportation coordinator	7	–	26
Conduct meetings—potential riders	0	–	10
Identify riders for car/vanpools	3	–	21
Onsite bus promotions	–	–	0
Operational support			
Operate vanpools	7	–	3
Subsidize car/vanpools	0	–	8
Preferential parking for carpools	10	3	10
Sell monthly bus passes	10	4	5

[a]Represents employers 100+ in Brea and SCM; all 134 in Newport.
[b]South Coast Air Quality Management District.

be used in planning new programs and services. An OCTD express bus service serving South Coast Metro from two locations in the county has been established based on the employee trip origin information obtained in the study. Plans are also under way for several new projects including on-site services, parking management, a guaranteed return trip program, and intercompany vanpooling, based on study results.

Brea

In March 1988, the city of Brea through its Economic Development Committee (EDC) organized a Traffic Management Program (TMP) Steering Committee. The TMP Steering Committee was composed of representatives from the EDC, the city of Brea, the Brea Chamber of Commerce, OCTD, and several employers. Under the leadership of the steering committee, OCTD conducted the TDM Market Research Study described previously.

The results of the study will be presented to the TMP Steering Committee in September 1988, and a task force will be established to review the study in more detail and recommend an action plan by January 1989.

CONCLUSIONS

In spite of the fact that the three activity centers described in this paper represent different regions and employment composition, there were similarities in perception of congestion, role of business, and commute modes. In all three areas, a majority of employees reported that the freeways used during their commutes were usually or always congested. In both areas where management was interviewed, executives felt that employers not only have a responsibility to help reduce traffic problems in their area but that it is in the long-term self-interest of business to get directly involved in such efforts. In all three areas, about the same level of solo commuting exists.

The major difference in the study results from the three centers illustrates the impact that an areawide TDM program can have. In Newport Center, employers—even those with fewer than 100 employees—were much more active in providing information to their employees than in the other two areas. Centeride, a TDM program for Newport Center, had been in operation for 6 months preceding the study and the focus of the efforts had been on dispersal of ridesharing information.

The three areas represented different levels of involvement from the cities and business community and different stages of TDM program and TMA development. One of the most salient observations is that in Brea, where there has been much support from all of the key parties—the city, developers, and the business community—for a cooperative private- and public-sector effort, progress toward TMA and TDM program development is moving more swiftly than in the other areas. It is possible that within 1 year of establishing a TMP Steering Committee, there will be a Traffic Management Action Plan and a mechanism established for program implementation. In contrast, in both South Coast Metro and Newport Center, the process was more lengthy.

Publication of this paper sponsored by Committee on Ridesharing.

Ten Cities' Strategies for Transportation Demand Management

CAROLYN P. FLYNN AND LAWRENCE JESSE GLAZER

This paper documents research into the strategies used by several cities to accomplish transportation demand management (TDM) objectives. Distinct categories of TDM strategies (regionwide rideshare agencies, developer requirements, transportation fees, incentive ordinances, transportation management organizations (TMOs), rideshare ordinances, and comprehensive TDM ordinances) are documented. The paper is comprised of a set of case studies organized by community. For each case study, the strategy (or strategies) used is identified; background information on the community and its transportation problems is presented; along with descriptive information including land use, population, number of employees, land-use intensity, recent growth, spread of peak period, and availability of public transit; the TDM strategy is described at length, including its institutional location; and the community's experience to date is assessed. The 10 cities included in the inquiry are Irvine; Pleasanton; Los Angeles; and Sacramento (all in California); Bellevue and Seattle, Washington; Portland, Oregon; Dallas, Texas; Orlando, Florida; and Montgomery County, Maryland. Regionwide rideshare agencies, developer requirements, TMOs, and employer and developer rideshare ordinances were used most often with success.

Transportation Demand Management (TDM) activity can be organized along a spectrum from "actions" on one extreme to "strategies" on the other. A TDM action is a measure that affects commuters directly. These include, for example, carpool matching, vanpool programs, subsidized transit passes, flextime policies, ridesharing coordinators, information centers, bicycle facilities, shuttle services, and others. TDM actions are usually implemented directly by employers or by areawide ridesharing agencies, such as San Diego Commuter Computer. At the other end of the TDM spectrum are "strategies." A TDM strategy refers to a higher-level government policy or program consisting of ways to encourage or require intermediaries—such as employers, developers, transportation management organizations (TMOs), or governmental entities—to carry out TDM actions. This paper describes the TDM strategies used in 10 U.S. cities or counties: Irvine, Pleasanton, Los Angeles, and Sacramento (all in California); Bellevue and Seattle, Washington; Portland, Oregon; Dallas, Texas; Orlando, Florida; and Montgomery County, Maryland. The approaches used by these jurisdictions vary widely, ranging from an emphasis on voluntary participation in established areawide ridesharing programs to strict requirements on developers and employers. The strategies can be classified into seven distinct strategies, with many communities using several of these approaches:

- *Regionwide rideshare agencies*—voluntary rideshare programs that are instituted for entire regions, without a supporting ordinance requiring developer or employer cooperation.
- *Developer requirements*—conditions placed in the use permit of a development (or sometimes expansion of an existing development) that require specified TDM actions or results.
- *Transportation fees*—fees exacted from developers, usually X dollars per square foot of space, to cover the costs of transportation improvements or services.
- *Incentive ordinances*—policies wherein developers are offered reduced on-site parking requirements in return for agreement to adopt specified traffic-mitigation actions.
- *TMOs*—groups of employers or developers who form nonprofit corporations or other structures to promote joint efforts to reduce traffic and provide ridesharing services.
- *Employer rideshare ordinances*—local regulations requiring employers to attempt/achieve reduction in vehicular use by employees (commuters).
- *Comprehensive TDM ordinances*—comprehensive regulations requiring TDM efforts by employers, developers, and property managers, which include technical assistance, penalties for noncompliance, and monitoring and reporting procedures to ensure compliance.

The highest-level city policy decisions are made at the strategy level, not the action level. We have therefore organized the case studies to highlight examples of the different TDM strategies that have been used. Each case includes a description of the strategy used, descriptive information on the area (i.e., population or land-use intensity), the institutional location of the program, and experience to date. The research was conducted by assembling written reports and published literature, conducting 12 in-depth interviews with appropriate staff, and acquiring up-to-date documents from the interviewees.

CASE STUDIES

Case Study 1: SEATTLE, WASHINGTON

STRATEGY: Developer requirements.
STRATEGY DESCRIPTION: The city of Seattle uses authority from the State Environmental Protection Agency (SEPA) and the Seattle Municipal Code to put forth uniform TDM requirements for all new development (including residential).

Crain & Associates, 2007 Sawtelle Boulevard, Suite 4, Los Angeles, Calif. 90025

Requirements vary depending on the size and type of development.

BACKGROUND: The city of Seattle has experienced rapid growth in the past decade, with 1 million sq ft of office space added in 1986 and 3.5 million more planned for 1988. Traffic problems, both in the downtown and suburban employment centers has become "terrible . . . the biggest issue in the city," according to one city planner. The process of having many buildings under construction at once also contributes to congestion. The city responded by implementing a policy, beginning 6 years ago, to require developers to offer extensive TDM programs.

DESCRIPTIVE INFORMATION:

Land use: The Seattle downtown area has densely developed office and retail. The suburban employment centers have light industrial, office, and retail uses.

Land-use intensity: In downtown, the tallest building is 76 stories, and the average number of stories is 50.

Population: 500,000 residents.

Number of employees: 193,000 in downtown.

Growth environment: 5.2 million sq ft of office space has been built or approved since 1986; 422,000 sq ft of retail has been built or approved since 1986.

Spread of peak period: 6:00 to 9:00 a.m., and 3:00 to 6:00 p.m. (subjective evaluation of planner).

PROGRAM INSTITUTIONAL LOCATION: Developer requirements are negotiated by METRO, the areawide transportation agency, and the Seattle Planning Department. When a developer files, a notice is sent to METRO planners, who comment on the transportation strategy. METRO then works with the city to prepare necessary environmental documents and to negotiate a memorandum of understanding or the Transportation Management Plan (TMP) with the developer. The METRO staff person with responsibility for the city of Seattle has 4 years of TDM experience. METRO also has a commuter services representative for each district of the city, who helps developers and employers with TDM programs. These representatives' experience ranges from 1½ years to over 10 years.

DESCRIPTION OF TDM STRATEGY: The city began developer requirements 6 years ago and in the past 2 to 3 years has established a set of requirements that were recently written up in a Director's Rule, describing code interpretation. It is hoped that the Director's Rule will lay out the requirements for each commercial or office developer to include in his or her TMP. This TMP would take the place of a single memorandum of agreement. Regardless of the planned development size, the TMP is required to contain the following elements: (a) a building transportation coordinator, (b) periodic promotional events, (c) a commuter information center, (d) required building tenant participation (put in the lease agreement), (e) rideshare matching, (f) a guaranteed ride home program, (g) biennial employee or tenant surveys, (h) quarterly reports, and (i) ridesharing incentives. All projects with over 25 employees are to conduct surveys. Adverse traffic or parking impacts associated either with a single development or cumulatively with prior, simultaneous, or planned future development are identified by city staff in the course of environmental review of a new developmental proposal. Depending on this review the city may also require one or more of the following ridesharing incentives: higher parking fees for single occupant vehicles, parking management techniques, high occupancy vehicle (HOV) cost subsidies, carpool bonuses, transit pass subsidies, vanpool sponsorship, reduced parking costs for HOVs, street and site improvements, subscription bus service, and flextime work schedules. In addition, larger projects may be required to dedicate land for transit facility, to build a bus shelter, to provide a paved pedestrian walkway connecting bus stop and facility, or to construct a bus pullout, if required for safety or layover reasons.

EXPERIENCE TO DATE: The city of Seattle and METRO were the key players in creating the developer requirements program. Planners report that developers complained at first, but with consistent application of the requirements over several years they have now become used to the process. Since 1986 or so, the program has become standardized, with developers knowing what to expect. METRO believes that the developer requirements program is working well. There is 44 percent transit ridership in downtown Seattle and a lot of developer activity in preparing and implementing TMPs. The city is currently reviewing the program, although the results of the review are not yet available to the public.

Case Study 2: PORTLAND, OREGON

STRATEGY: Regionwide rideshare agency.

STRATEGY DESCRIPTION: Rideshare, Portland's regionwide rideshare agency, is operated within a department of Tri-Met, the regional public transportation agency serving three counties in the Portland area. The agency encourages use of alternatives to the single occupant vehicle, including carpooling, vanpooling, and taking the bus. The purpose of the program is to decrease the number of vehicles on the streets and highways, thereby decreasing air pollution, traffic congestion, road repairs, and the need for new streets and highways.

BACKGROUND: Rideshare became the region's ridesharing agency in 1975. The genesis of Tri-Met's efforts to promote voluntary ridesharing efforts was the gas crisis of the 1970s. The city of Portland participated with several counties in the effort to establish Rideshare. This agency is the focal point of TDM program efforts in the Portland region, with commitment ebbing and flowing with changing demand factors, such as gas prices and employment levels. The commitment level is slowly increasing after a low as a result of a recession in the early 1980s. There are growing concerns over traffic congestion; whereas most of the existing congestion is on radial freeways to downtown Portland, recent modeling efforts have indicated pervasive suburban congestion throughout the region by the year 2005.

REGIONWIDE DESCRIPTIVE INFORMATION:

Population: The combined population of the three counties in the Portland region is 1,050,000 residents.

Land-use intensity: Density ranges from 9.8 persons per acre

in downtown Portland to 1.3 in the southern portion of the Portland metropolitan area. Average population density is 2.5 persons per acre throughout the region.

Growth environment: The region's population grew rapidly during the 1970s, but recession conditions abruptly altered population growth trends, with the population for the entire region increasing by only 30,000 persons in the past 6 years.

Data on traffic congestion: Employee work trips are projected to increase by 25 percent between 1983 and 1992. The market with the largest growth will be the intrasuburban work trips, with a 34 percent growth rate.

PROGRAM INSTITUTIONAL LOCATION: Rideshare is housed in the Paratransit Department of Tri-Met. The Paratransit Department is responsible for both specialized transportation for the elderly and handicapped and for ridesharing. The staff of three includes a program manager, an employer outreach assistant, and a carpool matcher. Before the creation of the Paratransit Department 1 year ago, the Rideshare program was housed in several other Tri-Met departments including Service Planning, Transportation Development, and Marketing.

DESCRIPTION OF TDM STRATEGY: Rideshare provides a computerized matching service for members of the public who request help finding carpool members. At present, there are 850 ridesharing applicants in the data base. Rideshare is currently working with a software programmer to enable private employers to link directly with Tri-Met's data base. This software will also enable employers to provide their own in-house matching program.

Tri-Met's discounted carpool parking program provides incentives to rideshare. The agency administers approximately 800 parking spaces in parking garages, surface lots, and long-term meters. All spaces require at least three members per carpool. Their innovative long-term-meter discount-carpool-parking program allows 580 carpools to park for $25/month and exempts the carpools from paying the normal meter rate.

Employer outreach is also an important component of Rideshare. Recently, staff received approximately 250 employer responses for some level of ridesharing assistance from a mailing to 700 employers. Rideshare staff will provide technical assistance to these employers for such things as surveys, but the employers themselves are responsible for ongoing duties such as in-house carpool matching or selling transit passes.

A $15 transit pass coupon program is currently being planned. The program would enable employers to purchase blocks of $15 coupons for their employees. With these coupons, employees can purchase a transit pass for $25/month compared to the regular price of $40/month. Rideshare staff are also responsible for administering 7 Tri-Met and 60 park-and-ride lots in the region to encourage vanpools and transit use. The private lots, usually belonging to churches or shopping centers, are located on transit lines and cost Tri-Met little to use.

EXPERIENCE TO DATE: Rideshare has been particularly successful in providing incentives such as discounted carpool parking and park-and-ride lots. Although they have been successful in promoting carpools and facilitating transit use, efforts to promote vanpools have not produced results. The Rideshare program received an excellent response from employers for assistance. At present, most of the employers who have sustained employer-based TDM programs have been local hospitals. Located in residential areas with constrained parking limits, these employers have been most active and successful with a comprehensive TDM effort.

Case Study 3: MONTGOMERY COUNTY, MARYLAND

STRATEGIES: Developer requirements, transportation fees, incentive ordinance, TMO, and comprehensive TDM ordinance.

STRATEGY DESCRIPTION: Montgomery County's primary approach is to require new developers (both commercial and residential) to provide extensive on- and off-site TDM programs. The county has also recently enacted a measure creating a special Transportation Management District where all existing and new employers are required to file TDM plans with the goal to meet an average auto occupancy of 1.3 persons per vehicle and 25 to 30 percent transit ridership.

BACKGROUND: Montgomery County is a large suburban area bordering Washington, D.C. The county has experienced rapid growth in both commercial and residential development in the past decade. It has a low unemployment rate (approximately 2 to 3 percent). Although growth has been concentrated in two suburban employment centers, planners note that there has been significant building throughout the county. Traffic has become the "number one" problem in the county, and there are moratoriums on residential or commercial building, or both, in many county subareas. In this context, TDM is seen as an important strategy to allow the area to accommodate growth and maintain acceptable traffic levels.

DESCRIPTIVE INFORMATION:

Land use: Montgomery County land uses include office, commercial, industrial parks, low-density residential, and townhouses. The employment centers have higher-density office (primarily 20-story buildings) and small-business retail.

Population: 700,000 residents.

Number of employees: 400,000.

Spread of peak period: 7 to 9 a.m. and 4 to 6 p.m. (subjective evaluation).

Data on traffic congestion: Data are collected for major roadways and used to monitor growth and TDM impacts. When traffic has reached too high a level in a county subarea, building moratoriums are imposed.

Transit availability: Montgomery County is served by the extensive Washington, D.C., METRO subway, Metrobus regional bus service, Ride-On neighborhood bus service, and MARC commuter rail service.

PROGRAM INSTITUTIONAL LOCATION: The county's TDM programs are provided by the Maryland National Capital Park and Planning Commission (M-NCPPC), a bicounty areawide planning agency. The transportation coordinator, with 10 years of TDM experience, has responsibility for TDM activities.

DESCRIPTION OF TDM STRATEGIES:

Developer Requirements: Requirements are negotiated under the Adequate Public Facilities Act (APFA), a 1973 ordinance requiring that new development be approved only when adequate public facilities have been established to accommodate it. This act was interpreted to include transportation demand management in 1982, and for the past 6 years the county has been requiring developers to implement certain TDM programs. The M-NCPPC typically requires that a 10-year plan for a TDM program be prepared and that the developer achieve certain trip reduction goals and give the county an irrevocable letter of credit equal to the cost of implementing the program for 10 years. Each year the TDM program is successfully implemented, the value of the letter of credit is reduced by 10 percent.

Transportation Fees: The Montgomery County Council enacted impact fee legislation in 1986. The fee is meant to defray a portion of the road construction costs necessitated by the additional traffic generated by the development. The amount of the fees varies to account for the relative trip impacts of different land uses and the relative needs and costs of supporting roads.

Incentive Ordinance: Developers are allowed a 15 percent reduction in required parking if they participate in the county's Share-A-Ride program and also submit a written agreement with the following conditions: (a) the owner or lessees (employers) with more than 25 employees will designate a transportation coordinator to promote TDM activities at the site, (b) the owner or lessees will provide preferential parking for carpools and vanpools, (c) the owner will make an annual payment to a public fund that provides Share-A-Ride services, (d) the owner will report semiannually on progress and, (e) the owner will pay a penalty in the event of noncompliance. Smaller reductions are available for private incentives such as in-house carpool matching, private shuttles, and so on. However, if the developer does this instead of participating in the county's Share-A-Ride program, he or she must set aside a land bank sufficient to provide additional parking spaces equal in number to the reduction granted.

Transportation Management Organization: The county has recently embarked on an effort to establish TMOs in certain county subareas with dense development. A major emphasis is to reduce the demand for trips and to produce enough trip reductions to allow additional land development. The county's first TMO was incorporated in February 1989 in the North Bethesda area. Its goals are to (a) serve as a public forum for the discussion of transportation issues, (b) generate measures to reduce traffic and facilitate orderly growth, (c) coordinate an areawide program, (d) organize and manage a bus or van transit service, (e) develop common parking policies, (f) aid members in developing TDM programs, and (g) initiate a cooperative planning process between public and private sectors. County government has taken the lead role in forming the organization. Most of the interest from the private sector has come from those developers who cannot get their projects approved unless something is done to ease the traffic situation.

Comprehensive TDM Ordinance: A recently enacted 1987 ordinance established a Transportation Management District in one of Montgomery County's busiest employment centers, Silver Spring. Within this district, all existing and new employers are required to implement TDM programs. Requirements for new employers include executing a traffic mitigation agreement, achieving a 1.3 vehicle occupancy for all employees, and achieving a level of transit use equal to 30 percent for all employees. These requirements will be strictly monitored and penalties will be exacted if goals are not met. Existing employers are also required to achieve an average vehicle occupancy of 1.3, with a requirement that transit use equal 25 percent of employees. Enforcement for existing employers will not be as strict as for new developments: fees will be exacted for failing to file a TDM plan but not for failing to meet the goals.

EXPERIENCE TO DATE:

Developer Requirements: The transportation coordinator notes that the APFA has been a successful tool. Over 20 developers have used the program to implement TDM actions as a result of their development agreements. The requirements are generally accepted by developers as a "necessary evil" and important for the county to be able to accommodate more growth. The incentive ordinance and the transportation fees work well in tandem with the case-by-case developer requirements.

Transportation Management Organization: The TMO in North Bethesda was adopted too recently to have any significant experience yet.

Comprehensive TDM Ordinance: No experience yet. The county has sent out notices to affected employers, who will be filing plans over the next several months.

Case Study 4: SACRAMENTO, CALIFORNIA

STRATEGIES: Developer requirements, incentive ordinance, and rideshare ordinance.

STRATEGY DESCRIPTION: Sacramento's primary strategy has been to adopt ordinances to standardize TDM requirements for both developers and employers. The city also passed an incentive ordinance, whereby parking reductions are offered as an incentive to the developer to carry out TDM actions.

BACKGROUND: Sacramento, like other California cities, has undergone rapid growth in the past decade. Projections for future growth suggest that the population is likely to increase from 275,000 residents in 1980 to 403,000 in 1995. Recognizing that financial constraints made it impossible to match this growth with additional freeways and roadways, the city decided to aggressively adopt TDM for new growth. The city wanted to mitigate air quality impacts of new development as well.

DESCRIPTIVE INFORMATION:

Land use: Sacramento's downtown land use is primarily high-rise office and retail.

Population: 325,000 residents.

Number of employers: There are 200 employers with more than 100 employees.

Growth environment: The population is expected to increase to 403,000 residents by 1995.

Data on traffic congestion: Auto use is projected to increase 48 percent between 1980 and 1995, from 740,000 trips per day to 1.1 million trips per day.

Transit availability: Sacramento has an adequate bus transit system, with a new light-rail system. There are plans to expand both to accommodate new growth.

PROGRAM INSTITUTIONAL LOCATION: The developer requirements are carried out within the Sacramento Department of Public Works. Three staff members, including the associate engineer and the senior engineer, have responsibilities for TDM. A team of engineers and planners has the responsibility to review employer and developer plans.

DESCRIPTION OF TDM STRATEGIES:

Developer Requirements: In December 1988 the city of Sacramento revised its 1983 developer requirements ordinance. The 1983 ordinance required that developers and employers include in a transportation management plan between 2 and 5 of 14 designated "trip reduction measures." Each of these measures was assigned an associated "trip reduction percentage." The goal was for each developer to include in his or her plan sufficient measures to effect a 15 percent reduction in total single occupant vehicle trips to be generated by the development. The vague definition of "trip reduction" and the associated trip reduction percentages made monitoring difficult and resulted in what was essentially an activity requirements ordinance with no true performance measure. Therefore, the city revised the performance measure to be percent of employees ridesharing.

The new ordinance establishes the goal that 35 percent of employees who commute during the peak periods to the site be encouraged to travel by some means other than single occupant vehicles. Requirements for "minor projects" (primary place of business for 25 to 99 employees) are simply that the owner provide facilities to post rideshare and transit information. Requirements for "major projects" (primary place of business for 100 or more employees) are that they obtain an annual Transportation Management Certificate from the city engineer by (a) providing facilities to post rideshare and transit information, (b) designating a transportation coordinator for the project, and (c) agreeing to file an annual TMP. The plan must document the commute modes of all employees currently occupying the project, progress toward attainment of the 35 percent goal, and, if the goal has not been met, the implementation of additional TDM measures. TDM measures that developers may use include participation in a transportation management association (TMA), preferential parking, parking fees, transit passenger shelter, bus or light-rail transit station subsidy (if located within 1,320 ft of an existing or proposed transit center), transit operating subsidy (if located within 1,320 ft of an existing or designated bus route or light rail transit station), transit pass subsidy, buspool or shuttle bus program, vanpool program, bicycle lockers and showers, land dedication for transit facilities (if need is determined), and subsidy for transportation systems management (TSM) capital improvements (if need is determined).

Rideshare Ordinance: In December 1988 the city also passed a rideshare ordinance to require employees to establish TDM policies so that "35 percent of their employees who commute during the peak periods are encouraged to arrive at their work site by means other than single occupant vehicles." The rideshare ordinance requirements are similar to those in the developer ordinance. Minor employers (employing 25 to 99 persons) are required to post rideshare and transit information, to designate a transportation coordinator who will coordinate with local transit agencies on the distribution of information, and to provide newly hired employees with alternate commute mode information. Major employers (employing over 100 persons) are required to obtain an annual Transportation Management Certificate by filing a TMP, with the goal of implementing TDM measures that will meet the 35 percent participation goal. At a minimum, the plan must document compliance with all requirements on minor employers, provide a status report on the current commute modes of employees, document TDM measures planned to increase alternative mode use, and provide an implementation plan. Annual plan updates must provide current data on employee commute modes and a summary of the previous year's TSM program. Employers who meet the 35 percent alternative mode trip goal for two consecutive years can apply for a Transportation Management Certificate valid for 2 years.

Incentive Ordinance: A parking reduction ordinance was also adopted in 1983. It allows substitution of required off-street parking spaces for the provision of incentives to use alternative transportation rather than single occupant vehicles. The substitute measures are assigned a particular "parking reduction level"; for example, offering employees a 50 percent transit bus pass subsidy allows for a 5 percent reduction or 20 spaces, whichever is less.

EXPERIENCE TO DATE:

Developer Requirements and Rideshare Ordinance: No experience yet. The city is currently preparing developer and employer TSM handbooks.

Incentive Ordinance: City staff report that the parking incentive ordinance has been used only once, and they plan to revise the ordinance. The primary problem is that the ordinance is complicated, and developers are reluctant to build below traditional levels of parking.

Case Study 5: BELLEVUE, WASHINGTON

STRATEGIES: Developer requirements and TMO.
STRATEGY DESCRIPTION: The basic approach used by the city of Bellevue has been to (a) pass an ordinance requiring new developers to provide TDM programs and (b) provide TDM services to existing employers through a TMA in the downtown area and an aggressive city-funded ridesharing program called EASY RIDE in two employment centers outside downtown (defined as noncentral business district, or non-CBD).

BACKGROUND: In 1980 the city of Bellevue adopted the Central Business District Sub-Area Plan, an ambitious rezoning effort aimed at focusing development in a strictly defined 90-acre new "downtown." Development outside this area was

limited to a floor-to-area ratio (FAR) of 0.5, whereas inside the line it could go as high as 10.1. Since the plan went into effect, downtown Bellevue has "shot skyward." Although overbuilding during the early 1980s gave Bellevue one of the country's highest office vacancy rates, rapid growth is fast eating into the surplus. Many Bellevue buildings now command higher rents than their Seattle counterparts (10 mi to the west). This intensive growth has led to a strong citizens' effort to slow growth, including collecting 8,000 petitions to find traffic solutions to citywide congestion. Planners say growth, with its resulting transportation problems, is the single most important issue in Bellevue. The city of Bellevue has committed to a strong TDM policy to maintain acceptable traffic levels.

DESCRIPTIVE INFORMATION:

Land use: Within the Bellevue CBD, there are approximately six office buildings with over 20 stories, mixed with predominantly one-story retail and smaller office uses. Outside the CBD, land use is primarily low-density residential. There are two suburban employment centers with mixed-use office parks of light industrial and office space.

Population: 85,000 residents.

Number of employees: 65,000.

Land-use intensity: There are 50 employees per acre in the CBD.

Growth environment: The CBD now has 5.5 million sq ft of office space, half of which has been built since 1980. All office buildings over 15 stories were built in a 3-year period.

Pressure for future growth: Projections to the year 2000 are to double the 5.5 million sq ft of downtown office space and to increase the current 3 million sq ft of retail to 4 million with a major (1 million sq ft) shopping center in downtown.

Spread of peak period: Surveys show that 60 percent of employees fall into 1-hour peaks: 7:30–8:30 a.m. and 4:30–5:30 p.m.

PROGRAM INSTITUTIONAL LOCATION: The city of Bellevue locates its TDM planning within the Department of Planning. One full-time associate planner has responsibility for TDM activities, particularly the EASY RIDE program funded by the city for suburban employment centers. The Bellevue TMA is a formalized public-private partnership between the Bellevue Downtown Association; the city of Bellevue; and METRO, the regional transit agency. The TMA itself, however, is privately implemented by the Bellevue Downtown Association. There are six staff members and a policy board that manages the association.

DESCRIPTION OF TDM STRATEGIES:

Developer Requirements: In the CBD, recent revisions to developer requirements include a new performance standard based on maximum p.m. exiting trips from the building. For the non-CBD, an ordinance requiring developers to provide a TDM program was adopted in the Land Use Code in early 1987. Depending on the size and type of the development, developers are required to post rideshare and transit information; distribute information; and provide a transportation coordinator, preferential parking, financial employee incentives, and a guaranteed ride home. The code requires that property owners submit a report 6 months after Certificate of Occupancy and every year thereafter. The report must describe each of the required TDM components that were in effect for the previous year, the total number of employees, the expenditures for financial incentives and guaranteed ride home, the number of bus passes sold, and the number of registered carpools and vanpools. A reporting form is provided by the city. It should be noted that this is perhaps the only example in the country of guaranteed ride home program requirements being codified in a city's land-use code.

Transportation Management Association: The Bellevue TMA provides TDM services within downtown Bellevue. The services are available to employers whether or not they are members of the TMA or the Bellevue Downtown Association. The TMA contracts with METRO (the regional transit and ridesharing agency) to provide carpool and vanpool matching. It provides parking and transportation management services to developers, employers, and employees; provides personalized assistance from a transportation coordinator; and promotes ridesharing in downtown with marketing brochures. In order to provide parking management services, the TMA enters into service contracts with property owners whereby the TMA is given, without cost, employee parking spaces that are currently provided free. The TMA then charges for the parking and uses the revenues to provide parking enforcement and other transportation services. The TMA also manages adopted transportation management programs for various building owners.

EASY RIDE: As a follow-up to passing the developer requirements ordinance, the Bellevue City Council funded a 2-year demonstration project for the city to provide aggressive ridesharing promotion and services for existing employers in two employment districts outside the CBD. This direct service provision approach was explicitly chosen over requiring existing employers to implement TDM actions. The new program is called EASY RIDE. It is administered by the Bellevue Department of Planning, which contracts with METRO to provide specific service. EASY RIDE has two transportation coordinators to assist commuters, discounted vanpool fares, and a guaranteed ride home program (by taxi) for pooler or bus riders who miss their ride home because of overtime or home emergency. Performance is monitored by annual employee surveys and driveway counts of auto occupancy.

EXPERIENCE TO DATE: Planners report that there is a reasonable level of employer and developer support for the downtown TMA, particularly because it is administered by the downtown business association. Developer response to the recent developer requirement ordinance, so far, is limited, although planners report that a good deal of developer input was solicited during the 1½ year approval process and that developers are supportive of the final product. EASY RIDE has met with significant employer involvement, with employers forming 10 vanpools in the first year and reporting that the guaranteed ride home program is a successful and important ingredient.

Case Study 6: ORLANDO, FLORIDA

STRATEGIES: Incentive ordinance and transportation fees.
STRATEGY DESCRIPTION: Orlando passed a 1982 ordinance that lowered off-street parking requirements for office (and retail in conjunction with office) development in exchange for contributions to a transportation management trust fund. When no developers took advantage of the ordinance, the city passed an impact fee ordinance, which required new developments to pay for road and related infrastructure capacity needs. These fees are targeted primarily toward continuing to build roads and widen freeways, and there is little focus on TDM.
BACKGROUND: Orlando is located in east central Florida and is experiencing rapid growth. Most growth is taking place in suburban regions, with the major work sites being Disney World, Martin Marietta, and several industrial parks. Downtown employment is primarily city and county government, lawyers, and banks. Projections for even more growth led the city, which, along with the state, does not collect income taxes, to search for ways to fund infrastructure improvements to support new development.

DESCRIPTIVE INFORMATION:

Land use: Land uses in Orlando include low-density office, light industrial, and residential.

Population: There are 159,000 residents in the city of Orlando, and 1 million residents in the Orlando urbanized area.

Growth environment: The city grew from 99,000 to 159,000 residents between 1970 and 1988.

Transit availability: Bus service is provided by Tri-County Authority, and there are only 72 peak-hour buses for the entire Orlando metropolitan area. There is general recognition of the need to expand transit service, and current plans call for an increase in bus service. There was a well-publicized move in 1987 to build private-sector-funded light rail, but the project did not succeed.

PROGRAM INSTITUTIONAL LOCATION: The impact fee ordinance is administered by the city of Orlando Transportation Planning Bureau. One transportation planner has primary responsibility.

DESCRIPTION OF TDM STRATEGIES:

Incentive Ordinance: Under the 1982 Downtown Parking District Overlay Ordinance, a developer could avoid the construction of up to 20 percent of required parking in exchange for contributions to a transportation management trust fund. Contributions would be based on 80 percent of construction cost for each space avoided, with the "cost" of a space set periodically by the city council. For example, the cost of a space in 1986 was set at $5,600, resulting in a proposed contribution per space avoided of $4,480 (at 80 percent).

Transportation Fee: The recently enacted 1986 Impact Fee Ordinance requires new developments to pay for the road and related infrastructure capacity needed to accommodate the vehicular trips to be generated. Capacity needs would be calculated based on trip generation rates from the Institute of Transportation Engineers, and fees would be derived from cost projections of improvements needed annually for the city's transportation system. Some downtown developments can receive "discounts" for land uses that offer the potential of shared parking among different uses during the day and evening or on weekends. In this sense, this strategy is similar to an incentive ordinance strategy.

EXPERIENCE TO DATE:

Incentive Ordinance: Between 1982 and 1986, the city received no payments for the trust fund because project lenders were leery of proposals to design less than "adequate" parking into office and mixed buildings. In suburban markets, planners point out that developers and lenders believe that below-standard parking facilities detract from a project's appeal to office employers. Additionally, although parking facilities are an expensive investment both in terms of construction costs and the valuable land consumed, they are also considered to be a permanent fixture to the property that represents an asset with a quantifiable value under traditional appraisal methods.

Case Study 7: IRVINE, CALIFORNIA

STRATEGY: TMO.
STRATEGY DESCRIPTION: The major TDM effort in Irvine is the Irvine Spectrum TMA ("Spectrumotion"), with mandatory membership for new companies moving into the Irvine Spectrum development.
BACKGROUND: The City of Irvine is a master-planned community in Orange County, California, which has made TDM a planning priority. Irvine Spectrum is one of the city's main developments—a 2,600 acre premier master-planned center for research, technology, and business. Irvine Spectrum has developed quickly; a company a week moved into the center in FY 1986–1987. The city of Irvine placed trip restrictions on certain land segments through the entitlement and zoning process to ensure that traffic would not become a problem. Partly because of these restrictions, the developer of this center began the planning and implementation of a transportation management organization in 1985.

DESCRIPTIVE INFORMATION:

Land use: Land uses in the Irvine development include office and light industrial.

Number of employees: There were 14,000 employees in 1987, with approximately 50,000 expected at build-out.

Number of employers: There are 340 employers in Irvine Spectrum.

Transit availability: There is minimal bus service at present because the area is still developing; but bus service may be increased in the future.

PROGRAM INSTITUTIONAL LOCATION: The TMA was formed as a nonprofit corporation with a formal board of directors in July 1986. Membership is mandatory for all com-

panies moving into Irvine Spectrum, and companies previously located there are offered associate membership for a nominal fee. The mechanism for required membership and collection of assessments is the "Codes, Covenants, and Restrictions," a document which must be signed as part of any land sale or agreement.

DESCRIPTION OF TDM STRATEGY: The TMA offers a wide variety of services to the employers and employees of Irvine Spectrum. The TMA surveys employees of new companies moving into the development for matching purposes on the in-house poolmatch computer. The data base is updated annually during Share-A-Ride week in October. There are approximately 3,700 employees in the data base. The information is used to develop carpools and vanpools and to assess work shifts and major new public transit routes for the area. Bicycle commuting is encouraged through Spectrumotion Wheelers Club. Regular newsletters and flyers keep employees informed and at least two major promotions are held annually to encourage participation.

EXPERIENCE TO DATE: The association won two awards from the Orange County Transportation Commission along with several other companies in Irvine Spectrum participating in association programs. The TMA had formed 13 vanpools within the first year and had 1,000 employees participating in carpools. 160 Irvine Spectrum employees signed up as members of the bicycle club. Further data are being collected for evaluation.

Case Study 8: DALLAS, TEXAS

STRATEGIES: TMO and developer requirements.

STRATEGY DESCRIPTION: The major TDM effort in Dallas is the Parkway Center TMA, developed partly because of conditions of development of the Parkway Center, as well as city council actions providing monetary support for a TMA and, in some cases, mandatory membership in the TMA for new developers. Dallas also has an aggressive bicycle program.

BACKGROUND: Parkway Center, encompassing approximately 2,000 acres, is situated about 10 mi north of downtown Dallas. Between 1981 and 1986, the area was the scene of intense development, with 12.8 million sq ft of office, 14 hotels, and 3 major shopping malls built. A consultant study of land use and transportation in the area indicated that the development (with over 50 million sq ft of office space projected at build-out) would require a coordinated program of infrastructure improvements, increased transit use and other traffic mitigation measures, including formation of a TMA. Although initial planning for the TMA was aggressive, a severe economic downturn in Dallas has slowed the association's development indefinitely. A core group continues to stay active and interested.

DESCRIPTIVE INFORMATION:

Land use: Land uses in Dallas include prestige high-rise office buildings, 14 hotels, and major shopping centers.

Size of area: 2,000 acres.

Number of employees: 125,000 employees expected at build-out.

Data on traffic congestion: Parkway Center will generate an estimated 75,000 automobile trips in the afternoon peak.

Growth environment: There were 12.8 million sq ft added to Parkway Center between 1981 and 1986. Future development would exceed 50 million sq ft of office space.

Transit availability: The bus system in Dallas currently has a significant number of empty buses; the Dallas Area Rapid Transit has decided to cut 13 percent of its route structure.

PROGRAM INSTITUTIONAL LOCATION: Although officials of the city of Dallas and two suburban jurisdictions negotiated the creation of the TMA with property owners and are full members of the TMA, the organization itself is a private one. The association has a 12-member board of directors (both private and public representatives) and is to operate under an executive director, with one urban and transportation planner on staff, with clerical support.

The bicycle program is operated out of the city's Department of Transportation and is the primary responsibility of one transportation planner.

DESCRIPTION OF TDM STRATEGIES:

Developer Requirements: The city of Dallas and two suburban jurisdictions negotiated a series of transportation-related commitments from Parkway Center property owners, including dedicated rights-of-way for public use; financing of offsite road improvements through a 50-cent-per-square-foot development impact fee; reduced maximum parking limits; special provisions for transit (such as easements for a bus transfer station and erection of bus shelters) in return for FAR bonuses; and participation in a TMA, including paying 5 cents per square foot toward its operating costs.

Transportation Management Association: The TMA will work with major employers to encourage ridesharing and coordinate employee arrival and departure times to ease peak-hour congestion. It will conduct transportation surveys for its members and evaluate trip patterns and parking availability at employment sites. Based on these data, the TMA will help employers decide which commuter services best suit their employees' needs. The TMA will also monitor local traffic conditions, assist employers with parking management strategies, organize an internal shuttle bus service, and work with public and private transportation providers to provide commute alternatives.

Bicycle Program: The city of Dallas has an aggressive bicycle program, stressing bicycle safety, parking, and adequate bicycle routes within the city. The planner responsible for the program is working on a bicycle program ordinance, which would require new developments to install bicycle parking based on a percentage of parking requirements. Large employment centers would also be required to install safe and secure bicycle lockers, and retail developments would be required to install bicycle racks. The ordinance is now being reviewed by employers and developers and will probably be adopted in 4 to 5 months.

EXPERIENCE TO DATE: Planners with the Dallas Department of Transportation report that urgency for the TMA has completely dissolved with the economic downturn. A core group is still active and in 1987 negotiated a new shuttle service

with Dallas Area Rapid Transit connecting office concentration with restaurants to reduce lunch time congestion. However, an executive director was never hired and there has been very little activity in the past year. Planners point out that developers are having trouble leasing space.

Case Study 9: PLEASANTON, CALIFORNIA

STRATEGY: Comprehensive TDM ordinance.
STRATEGY DESCRIPTION: Pleasanton has adopted a comprehensive TDM ordinance, covering both developers and existing employers, aimed at reducing peak-hour commuting to 55 percent of what would occur if all employees drove alone during the peak hour.
BACKGROUND: Pleasanton is a small but rapidly developing community located at the eastern fringe of the San Francisco Bay Area. In the past decade, the city started to pursue commercial development. By the early 1980s, millions of square feet had been approved, and still more millions had been announced. When it became clear that the new commercial development would transform Pleasanton into a major employment center, with resulting traffic congestion and difficulties, citizens, employers, and developers all became involved in an effort to alleviate future problems. The TMO was organized beginning in 1982, and the subsequent TDM ordinance was adopted in October 1984.

DESCRIPTIVE INFORMATION:

Land use: Land uses in Pleasanton include office, commercial, industrial parks, and low-density residential.

Population: 46,800 residents are projected by 1990.

Number of employees: 17,500 (1980).

Growth environment: Population grew from 18,300 in 1970 to 35,000 in 1980. The number of jobs in Pleasanton is expected to increase 305 percent from 1980 to 2,000, and 14 million sq ft in new commercial development has been proposed for Pleasanton.

Spread of peak period: The ordinance defines the peak period as 7:30 to 8:30 a.m. and 4:30 to 5:30 p.m.

Data on traffic congestion: Pleasanton has an ongoing system to monitor traffic congestion at major intersections. The ordinance calls for stricter TDM measures if traffic congestion goes below level of service (LOS) D.

Transit availability: There is a sparsity of bus service in the area.

PROGRAM INSTITUTIONAL LOCATION: The ordinance created a transportation systems manager position in the city's Department of Planning and Community Development. This coordinator collects intersection performance data, assists employers, reviews survey reports, and reviews and evaluates all employers' and complexes' TDM programs. Annual reports on results to date are made to the city council. Major responsibility for oversight, however, rests with a TSM task force, composed of executive level representatives of each large employer and complex, plus a coordinator appointed by the downtown businesses, the Pleasanton transportation systems manager, and representatives from transit operators.

DESCRIPTION OF TDM STRATEGY: The goal of the ordinance is to reduce peak-hour commuting traffic volume to 55 percent of what it would be if all commuters drove alone in their vehicles during the peak hour. The ordinance provides that any reasonable combination of TDM measures, including transit-related programs, ridesharing, nonvehicular commute modes, and alternative-work-hour programs can be used to achieve the trip reduction goal. The ordinance requires all employers to conduct an annual survey of employee commute patterns. For employers of 50 or more employees, or employers within multitenant complexes, a work place or complex ridesharing coordinator must be appointed. The 55 percent goal can be phased in over a period of years: 15 percent reduction in the first year and an additional 10 percent in each of the next 3 years.

For the first 2 years, fines could be collected from any employer or complex for failing to provide the required survey data, but not for failing to reach the specified ridesharing goals. After 2 years, the coordinator could recommend to the city council that ordinance provisions on mandatory TDM actions be activated. Under these provisions, the coordinator can reject a TDM plan and require additions or revisions. The success of the ordinance will be monitored through strict traffic monitoring of major roads and intersections. The ordinance goal is to maintain an LOS C or better on city streets and intersections for as long as possible; to exceed LOS D only after TDM measures have achieved the 45 percent reduction goal; and to preclude street operations from reaching LOS E. The TSM task force has the authority to mandate additional TDM elements if a particular employer or complex is found to be the primary contributor to traffic at a congested city street or intersection.

EXPERIENCE TO DATE: Experience in Pleasanton has been positive so far. The Pleasanton transportation system manager was hired in the first year and baseline data on employee travel patterns were collected. Formats for TDM plans were developed, along with guidelines for monitoring procedures and the design of preferential parking. All but one employer initially complied with the ordinance; the remaining employer was fined and subsequently did comply. All but two employers were able to meet the first-year goal of 15 percent commuting by some means other than drive alone during the peak period. By the second year, all large employers and complexes had implemented TSM programs. Twelve companies even exceeded the fourth year goal of 45 percent of employees commuting by some means other than drive alone during peak period in the second year, and only three failed to meet the second-year goal of 25 percent. The annual surveys have had high response rates: 75 percent in 1985 and 77 percent in 1986.

Much of this success is because employers and developers were deeply involved in the development of the ordinance, which has been called a grass-roots effort. A task force representing all major employers shares responsibility for compliance with the city's transportation coordinator.

Case Study 10: LOS ANGELES, CALIFORNIA

STRATEGIES: Incentive ordinance, transportation fees, and rideshare ordinance.
STRATEGIES DESCRIPTION: The city of Los Angeles has used three TDM strategies. In 1983, the city adopted an incen-

tive ordinance, offering developers reduced parking requirements in exchange for successful encouragement of commute alternatives. The Coastal Transportation Corridor Specific Plan was passed in 1985. It requires developers in the Venice and Marina areas to pay transportation fees for road and traffic mitigation improvements. And in 1987, the city passed an employer ridesharing ordinance, requiring that all large employers and large multitenant buildings prepare and implement TMPs to encourage their employees to reduce their driving. The rideshare ordinance was subsequently rescinded in light of the South Coast Air Quality Management District's (AQMD's) Regulation XV (see next case study).

BACKGROUND: Los Angeles has led the country in experiencing a tremendous growth in suburban employment centers. Along with new jobs and economic prosperity have also come extreme traffic congestion and concerns over environmental quality. Citizen pressure to curb growth and alleviate transportation problems and public concern over maintaining quality of life in Los Angeles have led the city to adopt a variety of TDM-related measures to reduce the number of single occupant commuters.

DESCRIPTIVE INFORMATION:

Size of area: 470 sq mi.

Land use: Los Angeles' huge land area encompasses varied land uses, including several high-rise office districts and increasing amounts of suburban employment to the north in the San Fernando Valley, to the southwest in the Venice/Marina coastal area, and to the south in the city's industrial sections, as well as to the east.

Population: 3.3 million city residents.

Transit availability: Bus service varies within the city. Areas such as downtown Los Angeles and some suburban employment and residential areas are well served. Other suburban areas have limited service.

PROGRAM INSTITUTIONAL LOCATION: Most TDM activities within the city of Los Angeles are implemented by the Transportation Planning Division of the city's Department of Transportation, although several other city agencies and departments, including Planning, Zoning, and the Community Redevelopment Agency, also have significant input. Several planning associates have various responsibilities for different rideshare ordinances, actions, and developer negotiations.

DESCRIPTION OF STRATEGIES:

Incentive Ordinance: The Los Angeles parking management ordinance grants developers reduced parking requirements in exchange for successful encouragement of commute alternatives that would lessen parking demand on site. Reductions in parking requirements of up to 40 percent for on-site or 25 percent for remote parking are authorized if supported by a parking management plan submitted with the application for a conditional use permit. To protect against the possibility that projected reductions in parking demand at the site are not achieved, the land owner must either set aside a land bank or enough open space to accommodate the full amount of parking required by the code, or he or she must gain approval from the zoning administrator of an alternative plan. The owner must also record a covenant running with the land that if specified levels of compliance are not achieved, the owner at that time will develop the additional parking spaces or other measures required by the zoning administrator.

Transportation Fees: Within the area specified under the Coastal Transportation Corridor Specific Plan (parts of Venice, Mar Vista, Westchester, Marina del Rey, and Playa del Rey), developers of land uses that will generate over 100 peak-hour p.m. trips are required to develop and implement a TDM program that will reduce peak-hour trip generation by at least 15 percent. Developers are also required to pay a transportation impact assessment fee of $2,010 per peak-hour p.m. trip projected using Institute of Transportation Engineers trip generation rates. The funds from the fee are to be paid into the Coastal Transportation Corridor Trust Fund and used for a variety of purposes including the development of a city-sponsored TDM program, traffic signal improvements, transit improvements, construction of new streets, and the widening of existing streets and intersections.

Developers may reduce their assessed fees by prescribing measures and programs that will reduce the number of vehicle trips to be generated by the proposed development. A reduction of up to 25 percent of their assessed fee is allowed. Developers may also receive a reduction in their transportation fee for any improvements that they make or propose to make to the regional or subregional transportation system. Developers can obtain an additional 25 percent reduction on the assessed fee by transferring credit for trip reduction achieved through a mitigation program for another employer within the same employment center. Developers who do not follow through with their TDM programs and subsequently fail to achieve targets will be assessed a nonconformance fee of up to $6,030 per trip.

Rideshare Ordinance: Before it was rescinded, the rideshare ordinance covered all employers with over 700 employees at one work site and all multitenant buildings with more than 700 employers and more than 550,000 sq ft of floor space. The objective was for each employer to achieve an average vehicle employer ridership (AVER) of 1.5 persons per vehicle (1.75 in downtown Los Angeles). The AVER was calculated as the number of commuters arriving at work between 6:00 and 10:00 a.m., divided by the number of vehicles arriving at the work site between 7:00 and 9:00 a.m. The two different time periods gave credit for shifting commuter travel outside the peak period. There was also a "reasonable efforts" clause for those who could not achieve the 1.5 (or 1.75) for good reasons.

EXPERIENCE TO DATE:

Incentive Ordinance: Since its adoption in 1983, the parking management ordinance has been used by only one developer, who was allowed to build at a rate of one space per 1,000 sq ft after developing an aggressive TDM and parking management plan. Planners at the Los Angeles Department of Transportation stress that the agreement was strongly influenced by the fact that the new subway will be near the downtown site. Primary reasons for the ordinance's lack of use are

(a) the low level of minimum parking currently required by city code; (b) the lack of specified evaluation criteria for permit approval; (c) the fear of local lenders that overreducing parking will lessen marketability; and (d) restrictive provisions of the ordinance protecting the city, specifically the requirements for land set-asides and a covenant running with the land to bind future property owners. Other reasons for lack of use relate more to implementation than to the ordinance itself: (a) most developers do not know that the ordinance exists because of a lack of any city budget, staff, or materials set aside for publicizing the ordinance; (b) unwillingness of developers to tolerate the delay of 3 to 9 months typically required for approval; and (c) confusion from the diffusion of responsibility for the ordinance among three city departments concerned with transportation, planning, and zoning.

Transportation Fees: Four developments, including the large Howard Hughes Center, have been fully or partially completed to date under the transportation fee requirements of the Los Angeles Coastal Transportation Corridor Specific Plan. Five more projects are currently planned for the area. Analysts have raised several problems with the ordinance: (a) trip reduction goals are based on nationwide Institute of Transportation Engineers (ITE) trip generation rates, which have a high degree of variance depending on local conditions; (b) developers are asked to submit yearly reports including monitoring the extent to which they have achieved their own goals; and (c) lack of clarity in definition of "reasonable progress" toward TDM goals, which can be used to waive penalties for nonachievement of goals. Since most of the new developments covered by the Coastal Transportation Corridor Specific Plan are still under way or only recently completed, it is still too early to judge the impact of this ordinance on local traffic conditions.

Rideshare Ordinance: The ordinance was officially rescinded in June 1988, to be subsumed under AQMD's Regulation XV. The key differences between the two are that the Los Angeles rideshare ordinance gave credit for flex-time and covered multitenant property owners, neither of which are included in AQMD's Regulation XV.

Case Study 11: LOS ANGELES REGION: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (LOS ANGELES AQMD)

STRATEGY: Rideshare ordinance.
STRATEGY DESCRIPTION: AQMD's Regulation XV requires that all existing employers of 100 or more people develop and implement a plan that encourages employees who report to work between 6:00 a.m. and 10 a.m. to reduce their driving.
BACKGROUND: The AQMD points out that the Los Angeles area remains among the worst in the country in terms of air quality. Mobile sources are responsible for most of the pollution that helps form smog. In order to deal with current traffic and air quality concerns and to prepare for future growth, the AQMD took strong action to require all large employers to create programs encouraging their employees to rideshare.

DESCRIPTIVE INFORMATION:

Land use: The AQMD covers a four-county area: Los Angeles, Orange and Riverside Counties, plus the nondesert portion of San Bernardino County. Land uses encompass downtown Los Angeles and all suburban employment growth centers surrounding it.

Population: 11 million (South Coast Basin) residents.

Spread of peak period: 6:00 to 10:00 a.m. (according to Regulation XV).

Growth environment: Population expected to grow by almost 50 percent by the year 2010.

Data on traffic congestion: 7 million work trips made per day, expected to increase by 42 percent by the year 2010.

Transit availability: Bus service varies significantly throughout the region, with downtown Los Angeles and certain suburban employment centers well served and other areas receiving limited service.

PROGRAM INSTITUTIONAL LOCATION: The AQMD was created by state health laws. The district monitors air quality 24 hours a day and sets maximum emission levels for commercial and industrial sources of pollution.

DESCRIPTION OF TDM STRATEGY:

Employers of 100 or more people at a single site within the AQMD must develop and implement a plan that encourages employees who report to work between 6:00 and 10:00 a.m. to reduce their driving. The plan must include (a) a verifiable estimate of the current average vehicle ridership (AVR) among employees, (b) a current list of measures being taken to increase the AVR, (c) commitment to offer specific incentives that could reasonably be expected to reach AQMD's specified goal (1.5 for most areas in the district, 1.75 for downtown Los Angeles, and 1.3 for extreme outlying areas), and (d) the name of a trained transportation coordinator who will develop and manage the trip reduction plan. The role of the transportation coordinator need not be full-time; however, the coordinator must complete a district-approved training program. Employers are required to renew their plan annually and to conduct annual vehicle counts or employee surveys to track their AVR.
EXPERIENCE TO DATE: Regulation XV was approved in the Fall of 1987, with plans to phase employers into the program over a period of 30 months, depending on the number of people they employ. The district began sending official Regulation XV notices to employers of 500 or more people beginning July 1, 1988. Employers of 200 to 499 people will begin receiving official notices after January 1, 1989. Finally, employers of 100 to 199 people will begin to receive official notices after January 1, 1990.

SUMMARY AND ANALYSIS OF TDM STRATEGIES

Figure 1 reflects city staff evaluations of the success of various TDM strategies. Regionwide rideshare agencies and devel-

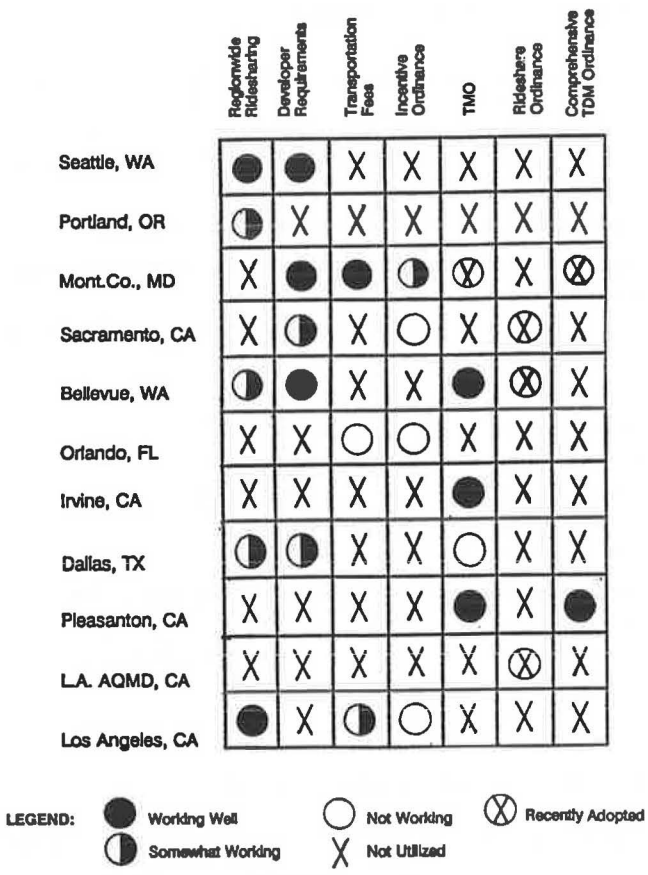

FIGURE 1 Summary of TDM case studies.

oper requirements are the most commonly used strategies. Only one of the case-study cities, Portland, relies on a regionwide rideshare agency as its primary TDM strategy. Such agencies exist in virtually every large metropolitan area and are usually reported to be successful, with the recognition that they are limited in that the use of their services is voluntary. A rideshare agency combined with a regulatory environment can be most effective.

Developer requirements—conditions placed in the use permit of a development that require specified TDM activity—are used by 5 of the 10 case study cities and in all instances were reported to be working well or somewhat working. Difficulties with case-by-case developer requirements were reported to be in their ad hoc nature. Developers want to know what the city will require in advance. Most cities have developed some way to codify or standardize the requirements through an ordinance or handbook, in the interests of equity and to lessen uncertainty.

Transportation fees, which are exacted from developers to cover the costs of transportation improvements or services, are used by three case study cities (Orlando, Los Angeles, and Montgomery County). Los Angeles found that its initial fees were set too low. In general, transportation fees are justified by the need to build new transportation capacity to accommodate additional traffic, not to develop TDM actions. However, these fees are increasingly being used for demand management.

Incentive ordinances, in which developers are offered reduced on-site parking requirements in return for agreement to adopt TDM actions, were used by four cities (Sacramento, Orlando, Montgomery County, and Los Angeles). In most cases incentive ordinances did not work because developers did not take advantage of them. Developers reportedly perceive building below traditional parking levels as a threat to the marketability of the development. In cities where parking code requirements are perceived to be above market requirements, such ordinances can be effective.

TMOs—groups of employers or developers who form an organization to implement TDM measures in a specific geographic area—are used in 5 of the 10 case study cities. They were reported by city staff in most cases to be working well. There is often close coordination between city staff and the TMO. For example, in Bellevue, the Downtown Bellevue Association acts as the TMO and is responsible for providing ridesharing services in the downtown area to members and nonmembers. The city then provides services in outlying areas where there are no TMOs. TMOs generally work best when members of the private sector identify a problem that they are committed to working together to solve.

One interviewee commented on potential problems when the public sector is too closely involved in the planning and formation of TMOs. He pointed out that citizens and community groups concerned with growth may perceive the TMO to be an alliance between government and developers meant to facilitate more development. In addition, many citizens view TMOs as experimental in nature. They argue that the county should require that the TMO implement trip reduction measures—and provide proof that they work—before allowing additional development in the TMO area.

Employer rideshare ordinances—local regulations that require existing employers to attempt to achieve reduction in vehicular use by employees—have much potential to be effective at increasing ridesharing and flextime. However, the two examples of this strategy in these case studies (Sacramento and Los Angeles-AQMD) were adopted too recently to predict their eventual success.

Comprehensive rideshare ordinances are comprehensive regulations requiring TDM efforts by employers, developers, and property managers, which by definition include employer rideshare ordinances. Two of the case study communities had adopted such ordinances, Montgomery County and Pleasanton, and although the former was adopted too recently to evaluate, we have much information on the latter. The Pleasanton ordinance experience is well known; it is reported to be quite successful, with high acceptance among employers who must meet increasing annual participation rate goals.

One issue that the cities with ordinances have faced is whether to require the developer or employer to implement specific TDM actions (i.e., an on-site TDM coordinator or carpool matching) or to require that they meet specified performance measures (i.e., 25 percent of all employees ridesharing, accomplished with whatever TDM actions the employer or developer deems appropriate). The four cities with either an employer rideshare ordinance or a comprehensive TDM ordinance appear to be moving toward a reliance on verifiable performance requirements, either "percent ridesharing" or "commuter vehicle occupancy." In addition, all four require three specific activities: annual reports, annual surveys (or

counts), and the designation of transportation coordinators to implement ridesharing programs at the development or employment site.

Specific activity requirements have been used extensively. Most programs include and sometimes require particular types of ridesharing actions. Company-supported vanpools were encouraged by policies or programs in 7 of the 10 cities and, in cases where there was experience, were reported to be working well or moderately well. Ridesharing coordinators were encouraged or required by six communities and, in most cases, were working well. Transit and ridesharing information centers were encouraged by six cities, again with good success. Eight of the 10 cities used some TDM strategy to encourage employers to provide employee ridesharing incentives such as preferential parking for rideshare or carpool and vanpool subsidies. This worked well or was somewhat working in all cases except one (Los Angeles-AQMD), where it is too early to tell.

Three cities encourage bicycle use through specific programs or ordinances (Irvine, Sacramento, and Montgomery County), which worked well or moderately well. Four cities tended through their programs or policies to encourage work-hour modifications, which were also judged to be working well or moderately well. Fringe parking with shuttle services was offered by one city (Portland), with good success. Annual transportation surveys were required by six of the cities. These were working well in all cases where there had been enough experience to judge.

Publication of this paper sponsored by Committee on Ridesharing.

Key Considerations for Developing Local Government Transportation System Management Programs

SUSAN PULTZ

This report is intended to be a reference to clarify the decision making process that leads to selection of (a) an approach for a transportation system management (TSM) program (voluntary or regulatory), (b) whom to include in the program, (c) program goals, (d) mitigation measure requirements, and (e) an administrative structure for the program. TSM programs can be a cost-effective way to increase vehicle occupancy and thus improve efficiency of the street and highway systems. However, in most cases, TSM programs alone will not solve the traffic problems, so they should be considered just one part of a broader strategy. A city should develop its TSM program through a consensus between the public and private sectors. Employers prefer voluntary programs, but they tolerate mandatory programs that are inexpensive, allow flexibility in meeting requirements, and allow private-sector control. The combined voluntary/mandatory TSM approach, a program type that starts as voluntary and becomes mandatory only if and when preselected targets are not reached, appears especially promising. The programs that are most effective at increasing the commute-alternatives-use rate are characterized by a long-term funding source that can maintain sufficient professional staff time for fairly intensive work with targeted employers and developers. Various factors, including the transportation environment, employer characteristics, employee characteristics, and the development environment, should be assessed in developing the TSM program. A program's goal should not be too high; credibility will be enhanced by selecting an ambitious but achievable goal. According to a 1985 Metropolitan Transportation Commission study, a good employer program can result in 5 to 8 percent of employees switching to nonsolo driving. Much higher changes have been achieved, but rarely. Compliance is usually judged based on implementing program requirements rather than meeting specific numerical goals. Implementation of a program's requirements by no means guarantees that the goal will be met.

Urban and suburban traffic snarls have become pervasive, and local governments have begun to design their own traffic mitigation strategies—some voluntary and some mandatory—to cope with escalating traffic. This paper is intended as a reference to help local governments develop traffic mitigation approaches suitable to their local needs. It does not provide a model ordinance; rather, it provides an inventory of key issues that must be addressed before a specific approach can be recommended. As such, it will be more useful to the staff person charged with the task of designing an effective program than to the policy maker or general reader.

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Questions addressed in this paper include the following:

- How does the commute environment affect program results?
- How do the attitudes of employers, developers, and elected officials affect what is possible to accomplish within these programs?
- What are the major differences between voluntary, mandatory, and other types of transportation system management (TSM) approaches, in terms of effectiveness and acceptability?
- How does the commute environment affect program results?
- Who should be included in a TSM program?
- What types of goals are appropriate and how should they be quantified?
- What kinds of traffic-mitigation activities should be required of employers and developers?
- How can a city TSM program be administered?

ESTIMATING TSM PROGRAM EFFECTS

City traffic-mitigation programs for employers and developers are designed to shift employees out of single occupant vehicles and into a "commute-alternatives" mode, such as carpools, vanpools, transit, bicycling, and walking. Some programs also encourage employees to travel outside of the peak traffic hour. When employees shift from solo driving to commute-alternatives use or from peak-hour to off-peak-hour driving, peak-hour vehicle trips on the highway and local street systems are reduced. Thus, these programs can affect traffic conditions. This section discusses how to estimate the effect of a traffic-mitigation program on traffic conditions.

To estimate the program's effect on traffic we must know the following information:

- How much the commute-alternatives participation rate increased because of the program;
- How many vehicle trips were eliminated because of the participation rate increase; and
- What percentage of all trips on a roadway the eliminated vehicle trips represent.

Measuring how much the participation rate changed as a result of the program can be accomplished by comparing employee survey results from before and after the start of the program.

Vehicle Trip Reductions

Estimating the vehicle trip reduction is more involved. It requires data about the particular modes now used by the employees who changed from solo driving. If all of these employees switched to transit or walking to work, all of these employees' vehicle trips would be eliminated. If all of these employees switched to two-person carpools, half of the vehicle trips would be eliminated. In reality, employees will probably switch to several different modes, so somewhere between half and all of the vehicle trips generated by those who previously drove alone to work will be eliminated.

Measuring the vehicle trip reduction for commuters switching to off-peak-hour travel is straightforward. Traffic peak hours are typically defined as 7:30 to 8:30 a.m. and 4:30 to 5:30 p.m., although many freeways are experiencing extended periods of heavy congestion. Each solo driver or carpool moving from the peak hour to the off peak eliminates one peak-hour vehicle trip. The total peak-hour vehicle trip reduction is determined by the number of employees commuting during this period and the commute modes used by these employees.

Effects of Vehicle Trip Reductions on Traffic Conditions

To estimate the effect of the vehicle trip reduction on traffic conditions, we must know the traffic volumes on the streets and highways of concern. If traffic volumes are close to capacity, even a small percent reduction in vehicles could have a significant effect on traffic conditions. This is because travel delay increases rapidly as volumes approach and then exceed street capacity.

At the same time, if a program results in eliminating a sizeable percentage of peak-hour vehicle trips generated by a city's employers, traffic may not decrease proportionately. Usually, there are many other types of traffic on a city's streets besides work traffic, such as "through" traffic going to and from other cities and the city's own shopping, school, and recreational traffic. The percentage of through traffic, in particular, will be much higher on freeways and major arterials compared to local streets. Therefore, reductions in peak-hour vehicle trips generated by a city's commuters will be far less noticeable on freeways and arterials than on local streets. The combined effort of several adjacent cities is probably necessary to affect traffic significantly on a long stretch of freeway. Also, there can be latent demand for travel during the peak hour—other vehicle trips may switch over to traveling during the peak hour and erode the TSM program's benefits.

This latter phenomenon calls into question the purpose of a TSM program. However, even if traffic conditions are not improved, TSM programs will increase the number of people traveling per vehicle and result in more efficient use of existing capacity.

Evidence of TSM Programs Affecting Traffic Conditions

Some evidence of TSM program effects on areawide traffic conditions is provided by the Golden Triangle Task Force study that used a traffic model to predict the effects of the task force's proposed program in Santa Clara County (*1*). The model results showed that if the commute-alternatives participation rate among major employers increased from the current 15 to 17 percent, to 35 percent, traffic on both local streets and freeways would decrease by up to 10 percent—a substantial change. This is an important finding because such large changes in commute-alternatives use areawide have not occurred in the past and, therefore, observation of such traffic condition changes has not been possible. However, it is not yet clear whether all the measures needed to reach this goal can realistically be implemented.

UNDERSTANDING LOCAL ATTITUDES

To be effective, a TSM program must be understood and supported by all responsible for program implementation. The program development process should entail assessing local expectations and attitudes toward the TSM program, then developing an appropriate approach for reaching a widespread consensus.

The Community

Much of the groundwork for setting up a TSM program has been laid if policies and programs that support commute alternatives already exist in the community. As a first step in TSM development, city staff should note if the following programs and policies exist:

- Voluntary employer commute-alternatives programs;
- Good communitywide information programs about the local rideshare agency and transit service;
- Sidewalks and bike paths for walking and bicycling to work;
- Project development standards that include bus turnouts and shelters, sidewalks to transit stops, preferential parking for carpools, bicycle storage, and so on; and
- Transportation planning programs that consider commute alternatives (e.g., high occupancy vehicle (HOV) lanes are supported for freeway widening projects).

Employers

Understanding employer attitudes is especially important because employers will be largely responsible for implementing the program. Outlined here are some of the key findings from a 1987 Bay Area Council study that focused on what the region's major employers think of TSM programs and why (*2*).

The following factors motivate employers to adopt TSM programs:

- Employers are receptive to instituting transportation programs when they are relocating. Easing commutes during the transition is valued as a way to minimize employee disruption and turnover.
- Recruitment, retention, and morale problems have been linked to commuting problems. The commuting problems are seen to stem from the problem that housing is scarce and expensive near many work places, forcing lengthy commutes on already crowded freeways.
- A sense of responsibility for traffic and commuting problems has been a motivating factor among major employers with a long-term stake in their communities.
- Employer location can be a motivating factor, especially for suburban employers. Downtown employers, who are located near good transit service, are less likely than suburban employers to think easing employee commutes is their responsibility.

What do employers think about regulatory TSM programs? Most of the surveyed employers oppose TSM regulations. They think that city programs should be voluntary because employers cannot actually force employees to change their commute behavior. They also think that TSM programs will require money and impose a burdensome reporting requirement without any guarantee that they will actually change commute behavior and relieve traffic.

Some employers think that it is really government's job to control traffic and that government should not pass its responsibilities off onto the private sector. They think that government should shoulder some of the burden by providing other inducements for changing commute behavior, such as convenient transit service and HOV lanes for carpoolers. They also think that government should set a good example by starting TSM programs for its own employees.

Employers are more tolerant of certain types of programs. They are most tolerant of programs that are inexpensive, allow the employer flexibility in meeting requirements, and allow private sector control over citywide program implementation.

Developers

Developers are generally more amenable to TSM program requirements than employers because they recognize that they are bringing new traffic into an area and should participate in mitigating it. They ask mainly that the requirements be flexible because, at the time of building construction, they may not know who their tenants will be and what the employee commute patterns and needs will be. The ordinance should allow them to develop their program after tenants are known. It should also allow for special cases, such as exemptions for tenants who do not contribute to peak-hour traffic.

Elected Officials

City officials often have conflicting concerns about TSM programs. They may support TSM programs as an approach to addressing traffic problems but be uncertain about the impact on business development. Some officials are concerned about stringent voter initiatives to control traffic and development. Because elected officials may have little say over the type of voter initiative developed, a TSM program may appear as the "lesser of two evils" and a step in the right direction to addressing the concerns of their constituency.

COMPARING PROGRAM APPROACHES

Types of Approaches

The major TSM program approaches can be described as voluntary, mandatory or regulatory, a combination of voluntary and regulatory, and incentive.

Voluntary

In the voluntary approach, the employer's or developer's decision to start a program and the level of effort are purely voluntary. An example is the Santa Clara County Manufacturing Group, a business association that allocates one full-time professional to promote TSM programs among member companies and to provide technical assistance. Another example is Berkeley TRiP, which is sponsored by the city of Berkeley and the University of California at Berkeley and provides commute-alternatives assistance to downtown employers.

Mandatory

There are several kinds of mandatory, or regulatory, programs:

- *Developer conditions*. Local officials specify conditions of approval for development permits. The cities of San Mateo and San Francisco both require TSM programs as conditions of approval for new development.
- *Commute-alternatives ordinances*. Employers are required to meet specified criteria to implement TSM programs to achieve a desired level of commute-alternatives use among employees. Placer County and Contra Costa County have this type of ordinance.
- *Vehicle-trip-reduction ordinances*. TSM programs are required to reduce vehicle trips by a certain percentage as compared to a specified baseline. Both ridesharing and shifting to off-peak commuting are used. The Los Angeles Coastal Corridor ordinance requires these programs of new developers and new employers. The city of Pleasanton requires vehicle trip reductions of all large employers.
- *Incentive ordinances*. Rather than requiring developers or employers to implement TSM programs, these ordinances offer benefits to encourage TSM program implementation. The cities of Palo Alto and Los Angeles allow developers to reduce parking in return for commitments to implement TSM programs.

Voluntary/Mandatory

A new concept that appears promising is called the voluntary/mandatory approach. The program starts as voluntary and

becomes mandatory if the agreed-upon rate of progress (as measured by specified standards) does not take place. The ordinance is adopted at the start of the voluntary phase and can be triggered into effect by the ordinance's own language about the required progress rate. This approach is being considered by the Marin County TSM Task Force and the Golden Triangle Task Force in Santa Clara County. It could be quite effective because employers will be motivated by both the active involvement of professional staff and the desire to avoid a regulatory program. Because the voluntary program is given time to prove effective, the approach should be acceptable to the business community.

Informal Agreement

Local governments could request major employers to sign letters of agreement outlining local governments' expectations about activities to be conducted and the services local governments will provide to assist employers. The letters could also state that, at certain intervals, transportation audits (survey information) would be solicited from the employer to determine current program implementation status. Like the voluntary/mandatory approach, this approach would be a precursor to a more mandatory approach, in that it relies on good faith commitments.

Comparison Criteria

The program development team should compare the various approaches according to several criteria, including effectiveness, acceptability to the private sector, flexibility, potential for cooperation or compliance, and potential for longevity. They should then decide which approach meets local needs.

Effectiveness

Usually, effectiveness is measured by the size of the increase in commute-alternatives use or the size of the peak-hour vehicle trip reduction achieved by the program. Contrary to the common perception, mandatory programs are not necessarily more effective than voluntary programs. Some voluntary programs by individual employers or developers have been quite effective. However, mandatory programs appear more effective at getting all employers or developers in an area to participate in the program.

The most effective programs of all types have sufficient staff time to work with employers or developers targeted by the program. Staff time is needed mainly for assisting employers to develop programs, monitoring program results, and notifying employers about ways to improve their programs.

The effectiveness of TSM conditions on developers can be improved if TSM program requirements are passed on to tenants (employers) in lease agreements. Thus, employers are also held responsible for meeting conditions once the developer is gone. When the conditions do not have to be specified in lease agreements, it has been found that some developers have not informed tenants about them.

Parking incentive ordinances have not been effective because they have generated little developer interest. The reason appears to be that investing in ongoing TSM programs is perceived to be risky compared to providing parking. Providing ample parking is a one-time expense and is known to be an attractive feature to prospective tenants.

Acceptability to Private Sector

Voluntary and incentive programs are generally more acceptable to the private sector than mandatory ones.

Flexibility

Because employers within a city have varying constraints and needs depending on their size, sector, and site characteristics, programs must offer employers flexibility in how they meet requirements. Of course, voluntary and incentive programs are completely flexible. The mandatory approaches must balance equity considerations—the need to require the same things of similar developers or employers—against flexibility needs.

Potential for Cooperation or Compliance

Full compliance with a mandatory program appears to result from perceptions that the city is committed to the program and that enforcement penalties are possible. However, imposing enforcement penalties does not appear to be necessary for compliance. Evidence of this exists in Pleasanton, where the city transportation manager and the employer task force are able to bring the rare noncompliance cases around by sending mild letters suggesting action.

Program Longevity

Sustaining the TSM program for the long term is critical to its effectiveness. TSM programs rarely show immediate results nor will they necessarily remain effective over the long term. First, getting commuters to change habits can take time. Second, the commuters who agree to switch to nonsolo driving may switch back again in a year or two unless commute assistance is ongoing. Finally, constant employee turnover means that the program will have to keep active to maintain a certain rideshare level.

Program longevity will depend largely on maintaining stable funding for staff time. Public sources of money, such as municipal general funds, county sales tax revenues, assessments from special districts, and impact fees, are usually more stable than counting on voluntary funding from the private sector. Fees for voluntary private-sector programs generally come from transportation management association dues.

Ensuring that conditions of approval for developers will continue means "tying them to the land" through language in the deed. This allows conditions to be passed on if the property is sold. Otherwise, a second owner will have no obligation to meet the conditions.

Table 1 compares the program approaches using a rating

TABLE 1 COMPARISON OF PROGRAM APPROACHES

Criteria	Program Approach				
	Voluntary	Conditions of Approval	Rideshare and Trip-Reduction Ordinances	Incentive Ordinances	Voluntary/ Mandatory
Effectiveness	2	3	3	1	3
Acceptability	3	2	2	3	3
Flexibility	3	2	2	3	2
Potential for compliance	1	3	3	1	3
Potential for longevity	1	3	3	1	3
Total	10	13	13	9	14

NOTE: High = 3, medium = 2, low = 1; maximum points = 15.

scale (3 = high, 1 = low) for each criterion. The scores for each program for each criterion are shown, as well as a total score for each approach. The mandatory program types—the conditions of approval and the rideshare and trip-reduction ordinances—rated higher overall than the voluntary and incentive approaches because of higher ratings on effectiveness, potential to maintain cooperation or compliance, and potential for program longevity. However, the voluntary/mandatory approach rated highest of all—it had the same scores as the regulatory approaches on all criteria, except that it had a higher acceptability rating.

Choice of Approach

Although the combined voluntary/mandatory TSM program approach is strongest according to the selected criteria, the other approaches may be more suited to local needs and conditions. The choice of approach should be based on both program objectives (traffic problems targeted) and the level of political and financial commitment to the TSM program. Determining which approach to use may be the most difficult and time-consuming task of the program development team.

Conditions of approval should be used if the city is not concerned about areawide traffic conditions but wants to target new development effects at nearby intersections or streets. A voluntary program should be used when the city has areawide traffic problems and wants to explore a TSM program's potential. It is also appropriate if funding is limited and the private sector is opposed to an ordinance and believes it can accomplish a lot on its own. Ordinances should be considered if there appears to be a strong commitment to a TSM program and the city wants to affect areawide traffic conditions through requirements on new and existing employers.

IDENTIFYING TSM OPPORTUNITIES

Various factors, including employer characteristics, employee characteristics, transportation environment, and the development environment, should be assessed in developing the TSM program. These factors will determine which program measures should be implemented in the particular jurisdiction, and they will influence program results. It is impossible to say how much a factor or unique combination of factors will affect results. However, the city can probably determine whether results are likely to be moderate or high.

In the following subsections are described some distinct commute environments, program measures that are most appropriate for each, and the effects their characteristics will have on results:

New Suburban Office Parks

New suburban office parks generally have ample parking and are most accessible by car. Transit service to office parks is often poor because of the low density. However, the centralized administrative structure can promote ridesharing and match carpoolers and vanpoolers efficiently. Congested freeways near business parks may lead commuters to avoid the aggravation of driving. If traffic is concentrated over short peaks, flextime should be beneficial. Data for new suburban office parks often show long average commute distances during the first couple of years after they open because employees have not yet moved their residences closer to work or found new jobs closer to their residences. Carpooling and vanpooling are attractive for long-distance commuters. Parking management techniques, such as preferential parking for carpools, may provide an added incentive to use commute alternatives. Without TSM programs, the limited commute-mode options result in low rates of commute-alternatives use and shifts to off-peak travel. However, there is potential for relatively large increases to these rates.

Congested Travel Corridors

Transit, flextime, and carpooling are key solutions where capacity is constrained and roadways are crowded. Corridors with preferential bus and carpool treatment will offer incentives to commuters to switch to nonsolo driving. Flextime will improve use of freeways and enlarge the market for transit service and carpool formation. However, flextime may not greatly improve overall traffic conditions if heavy traffic is already spread over long periods of the day.

Areas with Large Employers

Like business parks, large employers have the resources to become involved in TSM programs if they so choose. They

can staff transportation coordinator positions, a key ingredient to effective programs, and will have a good sized pool of employees from which to organize carpools and vanpools.

Areas with Small Employers

TSM programs for areas consisting predominately of small employers are problematic unless some organizational structure can be superimposed to make transit and carpool services available to these employers. Individual companies lack resources to sustain a commitment to TSM programs. Often small employers are geographically dispersed, which creates further problems for transit and carpool initiatives. Counties that have explored TSM ordinances for small employers generally adopt lower expectations concerning possible solutions.

Downtown Central Business Districts (CBDs)

Downtown areas generally provide factors conducive to transit, such as expensive parking and multiple transit services. However, substantial increases in transit use may be possible only if transit service improvements are implemented, such as improved service coordination, frequency, hours of operation, and ticket availability.

TARGETING THE PROGRAM

The project development team must decide whether to target the program at new developers, new employers moving into new developments, existing employers, residences, or a combination of these. Sometimes just particular geographic areas are targeted. Equity considerations will figure prominently in deciding whom to include in the program. In addition, program objectives, which identify the desired effects of the program on the transportation system, will determine in part who should be included in the program. If the objective is either to maintain existing traffic conditions or to improve them, the city will have to reduce all vehicle trips sufficiently to more than offset the traffic effects of any new development. Therefore, both new and existing employers should be included. If a city's existing traffic conditions are acceptable, but congestion is expected from new development, only new employers may be targeted.

Employers and Developers

TSM programs usually target developers and employers because employee commute trips make up the major share of peak-period traffic, and developers and employers have many possible ways of influencing employee commute habits. Developers can install preferential parking for rideshares and provide subsidized shuttle service through financial arrangements that carry over beyond the developers participation in the project. Employers can establish company policies conducive to ridesharing, appoint a transportation coordinator, institute flextime, and provide financial and other incentives to their employees.

Residences

TSM programs are appropriate for high-density residential development, where efficient carpool matching and transit operations are possible. Complexes with common areas have potential for efficiently reaching all residents with promotional materials and services. Promotional activities can also be conducted by homeowners' associations.

A concern with requirements on residential development is that because there are housing shortages in many areas, especially for low- and moderate-income levels, cities often do not want to place restrictions that may discourage residential development. In fact, encouraging residential development near job sites is a strategy for reducing traffic. Residents who live near work may be able to walk or bicycle to work, or they may be able to commute via arterials rather than the congested freeway system.

Equity Considerations

The issue of who should be targeted often raises equity concerns. Existing employers may think that new developers and employers should be held more responsible for controlling traffic because the new development has pushed traffic conditions from acceptable to congested levels. At the same time, new employers argue that all employers should be included to the same extent because they are all contributing traffic to the problem areas. The geographic areas targeted for the program may have the most traffic congestion and also the most economic prosperity. The areas not targeted may argue that both development and government resources need to be distributed more evenly.

SETTING GOALS

Program goals numerically describe the expected program result. A primary purpose of goals is to measure progress. To maintain the program's credibility, the city should measure progress toward achieving the goals. If measurements show that progress is not occurring at the expected rate, this may signal that the program should be adjusted, the timetable should be altered, or the goal itself should be changed.

Goals are also used to budget resources. Realistic goals will help a city decide how much resources to expend on a program. A city that expects only minimal results will want to allocate less money than a city that expects substantial results.

Types of Goals

Goals are usually expressed in one of the following ways:

- *Percentage of nonsolo drivers*. Sometimes called the participation rate, this goal states the percentage of the employ-

- *Percentage of nonsolo drivers.* Sometimes called the participation rate, this goal states the percentage of the employer's work force that is expected to commute by an alternative to solo driving. It is used when the program is emphasizing mode change rather than a travel-time or peak shift. The advantage of using this goal is that it can be calculated easily from employee surveys. However, it does not relate the program's effects to traffic conditions.
- *Percentage of solo drivers.* This goal is the percentage of an employer's work force expected to drive alone to work. It has the same strengths and weaknesses as the percentage-of-nonsolo-drivers goal.
- *Overall reduction in vehicle trips.* This goal is to reduce vehicle trips by a certain percentage by increasing nonsolo driving. With this goal, the program's results can be easily translated into an effect on traffic conditions. The vehicle trips reduced by the program can be expressed as a percentage change in traffic volumes on streets or freeways. With this goal type, the "baseline"—the number of vehicle trips against which the reduction is measured—must be specified. It is either (a) the number of vehicle trips that would occur if all commuters drove alone or (b) the existing number of vehicle trips that occurred before the program was implemented for a specific employer or geographic area. Some percentage of the work force uses commute alternatives when no TSM program is in effect, so the existing vehicle trip rate is lower than the rate that would exist if all commuters drove alone.
- *Percentage reduction in peak-hour vehicle trips.* This goal is concerned only with the peak hour, so vehicle trips can be eliminated by both increases in commute-alternatives use and shifts to off-peak-hour travel. Therefore, the percentage reduction will be greater than for the overall vehicle trip-reduction goal. Usually, the goal is measured by considering the number of employees who start work between 7:30 and 8:30 a.m. or leave work between 4:30 and 5:30 p.m. The baseline must be specified.
- *Level of Service (LOS).* This goal is a measure of traffic conditions. It should express what the conditions should be and on which road facilities. The LOS usually selected is "D," characterized by a high-traffic-volume-to-road-capacity ratio, but no congestion. Definitions of LOS are found in *TRB Special Report 87: Highway Capacity Manual* (*3*). Measuring goal attainment requires a traffic monitoring program.

Selecting a Goal

The goal should represent a decrease in the solo driving rate or in the p.m. peak-hour vehicle trip rate as compared to the preprogram level and one which the city has a fairly high likelihood of attaining. The preprogram rate should be identified by means of an employee survey. Then, the external factors likely to affect the program's potential should be assessed to decide if the solo commuter decrease is likely to be on the moderate or high side.

Cities should probably select slightly ambitious goals. An ambitious goal may push employers to do all they can, whereas a more conservative one may be too easily reached. However, the city should be wary of overselling the program to the public.

Using Data To Gauge Results

Recent data on results of various Bay Area TSM programs can be used to gauge expected results. A 1985 Metropolitan Transportation Commission (MTC) assessment of six good employer TSM programs found that about 5 to 8 percent of employees switched from solo to nonsolo driving. A 1986 Santa Clara County Manufacturing Group survey showed that member companies with TSM programs had caused 6 percent of their employees to start using commute alternatives. These rates of switching correspond to about a 3 to 7 percent vehicle trip reduction. Changes much greater than this have been reported, but they are rare. One example is the Bishop Ranch Business Park in San Ramon, which reports (in a 1986 survey provided to MTC as part of the MTC/RIDES funding agreement for FY 1986–1987) a 45 percent nonsolo driver rate (*4*). This rate probably indicates that approximately 25 percent of the business park's employees have switched to ridesharing as a result of the program.

Less information is available about peak-hour vehicle-trip reductions as a result of shifts to off-peak-hour commuting. The best example is Pleasanton's TSM program, which, as of 1987, had resulted in 10 percent of employees shifting to off-peak-hour commuting. The rate of commute-alternatives use has actually decreased slightly in Pleasanton since the program started, so the net peak-hour trip reduction has resulted from changes in travel time. Bishop Ranch Business Park results also indicate that 5 to 10 percent of employees have shifted to off-peak travel.

Thus, a reasonable goal for a program with moderate potential would be to cause 5 to 8 percent of employees to switch to nonsolo driving. An ambitious program could aim for a change of a few percentage points higher. Changes as high as Bishop Ranch's are unlikely as a citywide average. A moderate peak-hour vehicle-trip-reduction goal would probably be a 13 to 17 percent reduction, as compared to the existing or ambient (areawide) rate. About 3 to 7 percent would be from ridesharing and 10 percent from travel-time shifts. Information is not available to indicate a reasonable goal for a program with high potential.

Review of Existing Programs' Goals

The 35 percent nonsolo driver goal selected for both the Contra Costa County model ordinance and the Santa Clara County Golden Triangle program, now being developed, shows that the programs are expected to result in 15 to 25 percent of employees switching to nonsolo driving. This goal is ambitious. In comparison, the goals of the proposed San Mateo County model ordinance—15 percent peak-hour trip reduction in 10 years and 25 percent in 20 years, as compared to all commuters driving alone during the peak hour—are probably already being attained.

It is interesting to note that although some goals may appear very different, they may actually be striving for similar changes in commute behavior. The Los Angeles Coastal Corridor ordinance and the Pleasanton ordinance goals are examples of this. The Los Angeles Coastal Corridor ordinance seeks to

achieve a 15 percent reduction in vehicle trips based on trip generation factors (obtained from the Institute of Transportation Engineers) that already include some commute alternatives use. The Pleasanton ordinance's trip reduction goal is 45 percent, as compared to a baseline of all commuters driving alone. Although highly reliable data are not available, indications are that before Pleasanton's ordinance was implemented, there was about a 25 percent reduction in peak-hour vehicle trips through either mode change or shift to off-peak-hour travel, as compared to the number of vehicle trips that would be made if all commuters drove alone during the peak hour. Therefore, Pleasanton's ordinance expects to eliminate an additional 20 percent of peak-hour vehicle trips. This is fairly close to Los Angeles's 15 percent peak-hour vehicle-trip-reduction goal (*5*).

Adjustments to Program Goals

A program may have more than one goal. Goals are sometimes varied for geographic areas within a jurisdiction. For example, the Contra Costa County ordinance specifies higher goals for the I-680/CA-24 and I-80 corridor than for the rest of the county.

Goals are also sometimes varied by employer size. Large employers will have higher goals because they have more resources to devote to the TSM program and because a large concentration of employees offers more opportunities for rideshare matching. Although many programs use size cutoffs of 100 employees for setting goals, cutoffs as high as 300 to 500 employees may be necessary to achieve economies of scale in TSM programs. Programs that vary goals by employer size also tend to vary the program requirements (measures to encourage ridesharing or travel-time shift) accordingly.

Finally, goals are often varied over time to account for the fact that programs require start-up time and employees need time to change their commute habits. Also lower goals and "easy" measures such as flextime may need to be replaced by higher goals and tougher measures as traffic increases as a result of new development.

MEETING PROGRAM REQUIREMENTS

Program requirements are the traffic mitigation activities that employers or developers must undertake according to an ordinance action. Voluntary programs also recommend certain activities sometimes. Requirements ensure some equity—that similar efforts are required of similar employers. They also allow the city to guide employers or developers to undertake measures that are appropriate to local conditions and have proven effective. Compliance is usually judged based on meeting requirements rather than on meeting specific numerical goals, because implementation of a program's requirements does not guarantee certain results. Some employers may implement the program more meticulously than others. In addition, factors external to the program will affect results, as described earlier.

Programs vary in terms of the specificity of their requirements. One approach is for each employer to set annual vehicle-trip-reduction goals for itself and decide how to achieve these goals.

A less flexible approach is exemplified by Pleasanton's ordinance. It requires appointment of a transportation coordinator to implement the program, participation on an employer task force, and implementation of some measures from a particular list. Measures on the list include preferential parking, carpool subsidies, and others. If the employer's program does not meet the city's annual goals, the employer must implement more measures from the list. Another method is to list measures from which the employer must pick and to identify specific vehicle-trip-reduction percentages expected from each. The employer can choose any combination of measures expected to result in the stated vehicle-trip-reduction goal. The weakness of this option is that it is difficult to predict whether measures will reduce vehicle trips by a certain percentage.

Some cities have identified "performance standards" that provide specific guidance about implementing each measure. San Francisco requires new office buildings to promote public transit and sell passes. The performance standards state that buildings with more than 1,000 employees must have tickets and passes for sale on site for 40 hours per month, distribute information for all transit operators in the Bay Area, distribute promotional flyers semiannually to all building tenants describing when and where transit passes and information can be found, and arrange for transit operators to make presentations annually. Performance standards of similar detail are specified for the other measures required of new development.

The less specific program requirement options are more acceptable to the private sector and allow employers to develop programs suited to their own constraints and needs. However, employers may either do less under the more flexible options or need more guidance from the city about how to implement a good program. The specific performance standard approach is probably the best way to ensure that the required measures are implemented to their maximum effectiveness.

ADMINISTERING THE PROGRAM

This section identifies the main characteristics of a good TSM program's administrative structure and the roles needed in the organization. It also describes some types of administrative structure and the advantages and disadvantages of each.

Administrative Structure Characteristics

The following characteristics represent a good administrative structure:

- *Low cost.* The city will want to keep paid staff to a minimum and to maintain a low cost per commuter targeted by the program.
- *Personalized service.* Studies have shown that convincing commuters to change modes or travel times requires personalized service.
- *Centralized program management and service delivery.* Some professional citywide management staff time will be

needed to oversee the program, inform employers about program requirements, and bring problems and recommendations to a policy body. Delivery of some services, such as rideshare matching and transit ticket sales, should also be handled by a centralized professional staff to realize economies of scale.

- *Private-sector control.* Employers and developers will be more willing to support and take active part in the program if they have responsibility for policy direction.

Organizational Roles

The major tasks in administering a TSM program are program policy direction and management, employer plan preparation, promotion, operations, progress monitoring and reporting, and enforcement if the program is mandatory. Following are the organizational roles needed to carry out these tasks:

- *Policy setting.* This level hires employees, establishes guidelines for employer programs, evaluates program progress, and handles compliance problems if the program is mandatory. Generally a policy-setting body, either city staff or a city and private-sector task force, will make some policy decisions and defer others to the city council.
- *Program management.* Professional staff should oversee the day-to-day operations of informing employers about requirements, helping employers develop TSM plans and implement measures, informing the policy body of employer activities, and managing the data collection and monitoring function. Usually a city staff member will have this job.
- *Promotion and service delivery.* Staff assigned to this role provide carpool and transit information, sell transit passes, and manage preferential parking programs. Responsibility for this role can be handled in a number of ways. The city can provide services, such as accessing a centralized rideshare matching data base, providing promotional literature, and holding media events. Employer staff, through their daily contact with employees, can also perform some of this function. Alternatively, the city or the employer can contract with a professional rideshare agency, such as RIDES for Bay Area Commuters. The advantages of this option are that these agencies offer a high level of expertise and economies of scale in their operations. In addition, the contract can be modified or terminated easily.
- *Employer liaison.* The employer liaison, usually called the transportation coordinator, is the employer's staff person responsible for communications between employer management, employees, and city program management staff. The same staff member generally performs both service delivery and liaison functions. Liaison functions include working with city staff to prepare the employer TSM plan, coordinating company programs and policies with management, overseeing the monitoring and data collection effort, and preparing progress reports.

Types of Administrative Structures

The following options exist in choosing an administrative structure:

- *Administration by city staff.* A common approach to administering TSM programs is to allocate part of a city staff member's time to the task. Employer transportation coordinators may or may not be required. An advisory committee may help develop the program but does not remain operative after program implementation. Full responsibility for employer plan preparation, technical support, and program monitoring falls on city staff. This structure has not been effective at maintaining a high level of employer activity. Although inexpensive, it does not provide sufficiently for expert, personalized service delivery and employer involvement, usually because of staff resource constraints.
- *Transportation management associations.* These organizations are set up and financed by the private sector to provide ridesharing services. Participating companies usually appoint a transportation coordinator. Participation is voluntary. The advantage of these programs is that they are tailored to employer needs. However, employers may not provide sufficient funding for personalized service and the public sector has no say over program policies. Because they are voluntary, these organizations are sometimes short-lived.
- *Administration by city staff and employer task force.* This administrative structure type includes a city staff member to manage the program and provide some service delivery, an employer task force with some program management and policy making authority, and employer staff to act as transportation coordinators with service delivery and liaison responsibilities. The cities of Pleasanton and Concord both have this type of structure. The strength of this program is that the employer task force maintains a high level of employer involvement. Weaknesses are that the city's full-time staff member, with both management and service delivery responsibilities, may not have sufficient time to offer personalized service. Service delivery may rely heavily on the employer transportation coordinators, who generally have other high priority responsibilities within their companies.
- *Administration of a program oriented to small employers.* In cities with a high percentage of employees working for small employers, TSM programs will require more staff time. It is difficult for small employers to spare the staff time needed for the transportation coordinator role. Therefore, city staff can act as transportation coordinators for the small employers, or they can organize employers into "blocks," each with an appointed coordinator. Blocks can be formed out of existing business associations or based on geographic location.
- *Regional program administration.* Multijurisdictional TSM programs are being planned in various parts of the Bay Area, although none are operational at this time. The administrative structure tentatively planned for Marin County is an example of how regional organizations can be set up. It will include a policy body, with about 10 public- and private-sector representatives. Marin County staff will manage the program—prepare budgets and work programs, administer contracts, and recommend program changes to the advisory board. A centralized staff of professionals will promote the program and provide services. This staff could be provided under contract, at least initially. Service delivery will also be provided by employer and developer transportation coordinators. The advantage of this program structure is that several cities together potentially could have a substantial effect on regional (freeway) traffic conditions. Also, individual cities are prevented

from using a relatively lenient TSM program to gain a competitive advantage in attracting development.

CONCLUSION

We have found that well-designed TSM programs are a cost-effective way to increase vehicle occupancy and thus increase the efficiency of the street and highway system. They can also reduce traffic on highways by small amounts and on local streets by more significant amounts. Therefore, most cities should consider implementing a TSM program. However, in most cases, TSM programs alone will not solve the traffic problems. Rather, these programs should be considered just one part of a broader strategy that includes widening roads, operational improvements on city streets, and growth management policies. Local and regional TSM efforts are supported by state facilities—HOV lanes and park-and-ride lots. A complete strategy should involve comprehensive long-range planning to ensure that transportation system capacity will meet travel demand.

ACKNOWLEDGMENTS

This report is intended to help local governments developing TSM programs understand the key issues they must address in this process. The author learned much about the program development process by following the efforts of the Marin County Task Force as it worked to develop its model TSM ordinance. Interviews with about 30 local government TSM coordinators in the Bay Area also provided much of the information for this report. In addition, special thanks go to Chris Brittle of the Planning Section at MTC for his guidance throughout putting together this report.

REFERENCES

1. *Golden Triangle Strategic Plan, Phase I Technical Appendix*. CH2M Hill, San José, Calif., May 1986.
2. J. Bourgart. *Bay Area Council Survey on Employer Based Commute Alternatives*. San Francisco, Calif., March 1, 1987.
3. *Special Report 87: Highway Capacity Manual*. HRB, National Research Council, Washington, D.C., 1965.
4. *Survey at Bishop Ranch Business Park*. RIDES Planning Department, San Francisco, Calif., June 1986.
5. *Transportation System Management Ordinance Guide*. Caltrans, Division of Transportation Planning, Sacramento, Calif.

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First Hill Action Plan: A Unique Public/Private Approach to Transportation Demand Management

KATHLEEN L. SNOW

This paper describes a unique public/private approach to providing medical and university employees in an urban activity center with a package of transportation demonstration programs tailored to meet their commuting needs. The joint pooling of resources among eight major institutions and a cooperative arrangement with the Municipality of Metropolitan Seattle allows for the custom-designed program. The package of services includes experimental peak-hour transit service from outlying park-and-ride lots to the urban activity center, midday emergency backup through regular transit routes, and a taxi rider insurance program. It also provides program participants with 1 day of free parking per month, which allows for greater flexibility in trip planning. Expected benefits for the private sector include substantially reduced costs for employee transportation provision from what the institutions were individually paying; direct transit service to the institutions, reducing travel times by one-half over regular transit service; more parking availability for clients; and ability to enhance efforts in meeting the city of Seattle's required 50 percent high-occupancy-vehicle mode split. Expected benefits for the public sector include guaranteed 80 percent farebox recovery, guaranteed 274,000 annual riders, ability to test new strategies with minimum risk, and trip reduction on the King County road network and in the First Hill urban activity center. Follow-up papers in 1989 will evaluate the progress and success of the program and describe marketing techniques used to attract the unique population that the program is designed to serve.

Growth patterns in urban and suburban areas creating more dispersed employment activity are changing the way transportation professionals look at and serve these emerging activity centers.

This paper describes the process through which public transportation professionals and private institutions formed a partnership in the city of Seattle to develop a package of transportation services. The package was created specifically to serve a population characterized by variable work shifts. The programs were designed to meet the clients' needs for flexibility, improved commuting times, affordability, and convenience.

The First Hill Action Plan has several unique features:

- The union of competing medical institutions that face a nursing shortage and a diminishing labor pool for the benefit of all employees.
- Agreement by the institutions to collectively support the program by funding 80 percent of transit operating costs through a guaranteed minimum-pass-purchase arrangement.
- Programs that address the needs of employees with variable work shifts, allow for flexibility in their daily trip planning, and reduce travel times by one-half over existing transit travel times.
- Reduced financial risk for the public transportation provider with a guaranteed 80 percent operating cost recovery. The result is an additional 274,000 annual riders to the public transportation system.
- The ability to test new transportation strategies with minimum risk to the institutions and the public transportation provider.

Municipality of Metropolitan Seattle, 821 Second Avenue, MS/52, Seattle, Wash. 98104.

PROGRAM COMPONENTS

The First Hill Action Plan is a demonstration program, which began November 1, 1988, for an initial period of 8 months. The following "package of services" is offered:

- *Peak-hour express service*. Service from the six park-and-ride lots north, south, and east of First Hill with ½ hr headways to meet institution start times of 6:30, 7:00, 7:30, 8:00, and 8:30 a.m. Monthly passes are priced at $46 with a guaranteed minimum purchase by the institutions who will resell the passes to employees at a substantial discount. The service is also open to the general public who may purchase the monthly pass or pay a one-way cash fare of $1.30.
- *Midday and evening back-up service*. Three off-peak options are available to participating institution employees who purchase a monthly pass for the First Hill peak-hour express service.
  - — *Metro regular transit back-up option*. Anyone who purchases a pass for the First Hill express service may use the pass for any regular Metro transit service anytime at no additional cost. This will provide hourly service to or near the park-and-ride locations.
  - — *Rider insurance program taxi option*. This program provides taxi service to participating institutions' employees to reach their vehicles at park-and-ride lots when the First Hill express service is not in operation. Participation by the institution is optional. Institutions choosing this option guarantee all trip costs but may use their discretion in setting use limitations and the

TABLE 1 INSTITUTIONS' PROGRAM CRITERIA AND SUBSIDY LEVELS

Institution	Express Service Monthly Pass Purchase Guarantee at $46 per Pass	Express Service Employee Transit Pass Subsidy	Rider Insurance Trips/Subsidy	Parking Credit Days/Subsidy
1	122	57%	As needed	Not participating SOV parking = $36-80 per month
2	116	100%	1 trip per month 100% subsidy	As needed/60% subsidy ($3.00 day) SOV parking = $35 per month
3	116	50%	1 trip per month 100% subsidy	2 days per month/100% subsidy Raised SOV parking rates to $30 per month
4	99	50%	Trips as necessary 100% subsidy	1 day per month/100% subsidy SOV parking = $30 per month
5	37	50%	Not participating	Not participating SOV parking = $50 per month
6	22	50%	Not participating	Not participating
7	16	33%	1 trip per quarter 40% subsidy	1 day per month/58% subsidy SOV parking = $55 per month
8	11	50%	1 trip per month 100% subsidy	1 day per month/100% subsidy Raised SOV parking rates to $30 per month

amount, if any, an employee pays toward each trip. The taxi contract, which Metro negotiated on behalf of the institutions, provides a flat rate of $10 to all park-and-ride locations.

— *Parking credit program.* This program provides for 1 to 2 parking days per month at the employee's place of employment for each person who participates in the First Hill express service to allow for flexibility in trip planning. Participation in the program by the institution is optional. Institutions choosing to offer this program pay for all associated costs of the parking but may use discretion in setting usage limitations and the amount, if any, an employee pays toward parking fees.

Table 1 represents each institution's guaranteed monthly pass purchase, use limitations for the rider insurance and parking credit programs, and associated subsidies.

BACKGROUND

First Hill, about seven blocks east of downtown Seattle, provides employment for 14,600 commuters. They work in the area's seven medical institutions, one university, and several medical office buildings and support clinics. Access to the area is primarily by single occupancy vehicle (SOV) with transit trips representing only 16 percent of the work-trip mode split. This figure is significantly less than the 44 percent transit mode split for downtown Seattle, only seven blocks away.

Over the last 10 years, Metro has served the 4½ sq mi activity center with various high-occupancy-vehicle (HOV) modes such as vanpools, custom buses, neighborhood origin express buses direct to First Hill, and regular transit service. The majority of fixed-route transit routes serving the area involve a transfer in the Seattle central business district (CBD). The custom bus and neighborhood origin express bus did not meet agency productivity standards and were discontinued. The varying work shifts of the nursing population, ample and inexpensive parking availability, and inefficient transit travel times were identified by market research as significant factors that worked against the success of HOV travel modes.

As part of a comprehensive overhaul of its zoning code, in 1983 the city of Seattle established a special category for major institutions such as hospitals and universities. One of the primary reasons for a separate zoning category for major institutions was their traffic impact on surrounding neighborhoods. Working with Commuter Pool, the regional ridesharing agency at the time, the city established a performance standard that no major institution could have more than 50 percent of its commuters access the institution in SOVs. To achieve this goal, institutions were forced to examine their parking policies, initiate transit pass subsidy programs, establish parking discounts for carpools, and increase rates for long-term single occupancy employee parking. This work has been formalized in the form of a Transportation Management Plan, signed by each institution, the city of Seattle, and Metro.

In addition to stringent transportation system management (TSM) programs with substantial HOV subsidies, several of the institutions also chose to operate their own shuttle/park-and-ride systems from close-in parking lots to accommodate employee transportation. Although successful in transporting employees, these systems have proven extremely expensive, costing the institution $80 or more per month per employee. Consistent service has been impaired by cancelled park-and-

ride leases and the inability to find suitable parking for operating the private shuttle services. Also, more importantly, since the institutions' park-and-ride systems are just over 1 mi away from the neighborhood, the shuttles do little to reduce travel on crowded freeways and arterials, thus frustrating city of Seattle transportation objectives.

Despite aggressive programs that have increased total HOV commuting from about 15 to 30 percent in recent years, the SOV remains the mode of choice, and congestion continues. Transportation and traffic continue to be a major issue for the institutions, employees, and the community. Variable employee work shifts and indirect transit service requiring a transfer with an average travel time of 1 hr continue to discourage HOV travel.

One of the larger institutions, which operates its own shuttle system, approached Metro in December 1987 to see whether transit service could be improved. In evaluating current service for possible enhancements, Metro staff concluded that service enhancements would not necessarily be productive, and any restructuring would be impossible without ridership guarantees from the institution.

After further consideration and knowledge of the continuing transportation problems confronting the institutions on First Hill, Metro concluded that a collective effort by all of the institutions would be needed to successfully design new services. Metro brought top administrators together from eight First Hill institutions to initiate the formation of a consortium that would jointly analyze, develop, and implement a package of TSM services.

FIRST HILL ACTION PLAN ORGANIZATION

In January 1988, the First Hill Consortium was formed. The institutions and Metro agreed that Metro would guide plan development with input and guidance from the administrators' group. An existing group of employee transportation coordinators representing each institution would serve as the employee technical advisors. Metro's in-house team consisted of management at the administrator level and staff representing market development, service planning, facilities, sales, and research.

From the beginning, Metro requested full commitment from the institutions if the agency was to invest staff time into developing a plan. At the same time, because of budget constraints, Metro made it clear that it was constrained in offering additional transit service hours. The institutions, however, were individually contributing significant resources to their own systems and felt that, by pooling resources, they could support new services to the area. Regular monthly meetings with all groups were held. Particular attention was paid toward seeking the institutions' guidance and concurrence throughout the analysis and plan development.

GOALS AND OBJECTIVES

Historically, the institutions have been highly competitive. Therefore, it was important to rally them around common goals and objectives. These then became the guiding force for plan development.

The primary goal was to consolidate the eight First Hill major institutions into one consortium to provide efficient transportation services for their employees to the First Hill urban activity center, particularly those with variable work schedules.

The objectives were to

- Provide consistent flexible service to the area for less cost than some of the hospitals are currently doing on their own, by pooling resources among the eight institutions.
- Help the institutions reach the city of Seattle's Major Institution Code HOV performance standard of 50 percent.
- Provide flexible backup for employees by
  - — Using Metro's transit pass as the fare medium;
  - — Locating any shuttle system park-and-ride lots along existing transit routes; and
  - — Providing an emergency transportation back-up program should regular transit not be convenient.
- Relieve traffic and parking congestion in the area.

SCOPE OF WORK

From the goals and objectives, the teams developed the initial scope of work. Metro agreed to look at previously tried modes such as custom bus, vanpools, and additional regular service, which would require a transfer. Metro also agreed to consider some form of direct transit service.

DEMAND ANALYSIS

The following information was gathered from each institution and evaluated to determine potential demand for new services to First Hill.

- Employee zip codes and work start times;
- Current HOV mode split information;
- Current transit pass sales and HOV subsidy levels;
- Current parking rates; and
- Private shuttle system ridership, costs, and operations.

Two focus groups were held with employees from each institution to discover attitudes about carpools, vanpools, travel times, and direct service from park-and-ride lots and their particular problems in using HOV modes. The first group was composed of employees with fixed daytime hours. The second group was composed of employees with rotating shifts or irregular or changing hours.

Peak-Hour Trip Demand

Analysis of more than 4,500 pieces of information confirmed that employees lived north, south, and east of First Hill with the largest concentrations in the north and south.

Trip demand and time of demand from each of the three origin areas were calculated by adding the number of employees reasonably able to use targeted park-and-ride lots who began work at 6:30, 7:00, 7:30, 8:00, and 8:30 a.m. The existing 16 percent transit HOV mode split was deducted, and

then 20 percent of the remaining figure was calculated to become what Metro staff perceived to be a "conservative demand figure" of 539 daily round trips. Peaking characteristics occurred for the 7:00 and 8:00 a.m. work starts from all origin areas with enough demand to also warrant trips from the north and south for the 6:30, 7:30, and 8:30 a.m. start times.

Demand from the east warranted an additional trip for the 7:30 a.m. work start only. Typically, work shifts were 8½ hr including ½ hr for lunch.

Midday and Evening Trip Demand

Characteristic of the medical community are variable and often-changing work shifts because of staffing according to patient loads. Subsequently, on "low census" days staff may be sent home before completing regular shifts, or they may be required to extend their shifts if patient loads rise. Therefore, demand for midday and evening service was difficult to predict. The lack of available data did not support requests for costly direct midday and evening transit service. However, Metro agreed that some type of service provision was necessary to meet this need.

Institutions' HOV Mode Split

The latest mode-split information available was from a 1985 health center survey. These figures were probably outdated because of institutional growth. A 30 percent total HOV mode split was established through the use of regional journey-to-work data correlated with travel projections to the area. The city of Seattle surveyed each institution during Fall 1988 to determine baseline commuting information.

HOV Subsidies and Transit Pass Sales

All institutions offered HOV subsidies for transit and carpool parking. Staff analyzed the potential transit ridership increase if the institutions were to offer a 75 percent subsidy. Resulting figures indicated a marginal increase of only 101 new riders per month for Metro's existing system, which constituted a less than 1 percent increase in mode split.

Parking

All charges for employee parking ranged from $20 to $80/month. Market rate in the area averaged $30/month for uncovered long-term parking. Institutions with lower rates had plans to at least meet market rates within the next year. Parking was in short supply and in most cases was available only to those employees who had a demonstrated need for using their vehicles for work purposes. Those who continued to drive alone parked on streets and in lots scattered throughout the neighborhood.

Focus Groups/Technical Advisory Committees

The research suggested that, of the modes explored, express bus service to First Hill from outlying park-and-ride lots with midday service would be the best alternative. Vanpools were undesirable because of changing work shifts, costs, and the perceived difficulty in coordinating a vanpool. Increased bus service was not desirable because of the need to transfer in downtown Seattle, increasing travel time. Security while waiting for the buses was also a concern.

SERVICE ANALYSIS—REDUCING THE ALTERNATIVES

The employees told us what it would take to get them on the bus, and Metro and the institutions were determined to develop services they would use. Vanpools and carpools did not offer enough flexibility for these employees. Regular transit requiring a transfer in the Seattle CBD was also not an appealing choice for those who continued to be committed to their automobiles.

The Metro project team, based on employee input and previous service analysis, recommended a peak-hour express service from outlying park-and-ride lots with midday and evening service. The administrators, when presented with the findings, agreed that direct service options should be pursued. They were also advised that the costs for providing such a system may prohibit its implementation, leaving them with no obvious alternatives to solve parking and transportation problems.

Given the go-ahead to analyze direct transit service options, the next step in the process was to determine how to achieve a fast, safe, convenient system at the least cost. The following subsections describe the factors examined to determine the package of services offered in the First Hill express service program.

Park-and-Ride Selection

Individual employees' zip codes charted on a regional map showed heavy concentrations north, south, and east of First Hill. The distribution suggested trip origins would best be served by locating park-and-ride lots in these areas with the intent of capturing the majority of these commuters.

Staff focused on choosing existing park-and-ride lots with available capacity within a reasonable distance from First Hill. Figure 1 shows the location of the agreed-upon lots in relation to the First Hill Activity Center. Those lots were also served by regular Metro transit routes.

North

Two lots were chosen from the north. Greenlake park-and-ride, 5 mi from First Hill, was an ideal candidate. With an expected travel time of 24 min, transit travel times were reduced by one-half. Although the lot was at 60 percent capacity, the state Department of Transportation was willing to

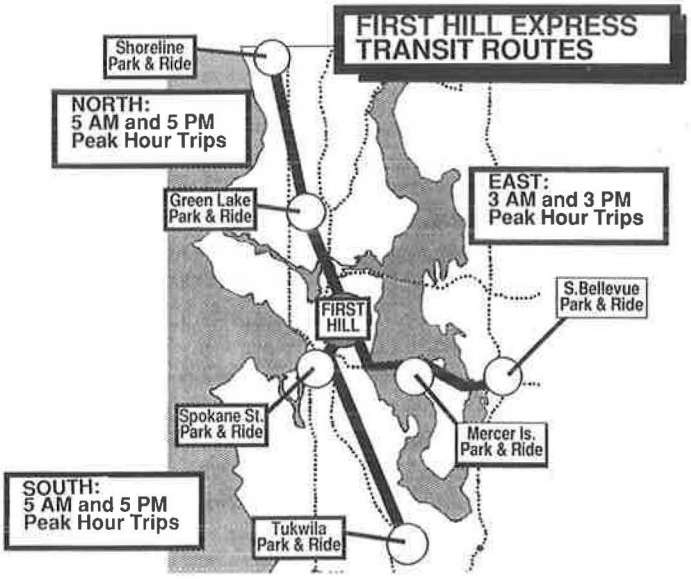

FIGURE 1 Location of park-and-ride lots in relation to the First Hill Activity Center.

terminate a lease they had with the Seattle Public Schools on adjacent land that would provide an additional 110 spaces when developed. Metro agreed to fund the $15,000 cost to develop the already asphalted area to allow for the extra capacity. Several sites nearby were also located to allow further expansion because demand from the north was the greatest. These sites were located with routes in mind so annual operating hours would not be increased. The sites, if needed, will be leased from churches for an average cost of $4/month per stall. Including the 110-space expansion, another 60 spaces are available in the existing lot and on adjacent streets signed for commuter parking.

Addition of the Shoreline park-and-ride lot was added 1 week before service implementation because of numerous requests from the institutions. Although demand was less from Shoreline, being 12 mi from First Hill, it was believed a sufficient market could be captured. That would further reduce SOV travel along Interstate 5. The Shoreline lot also had over 150 available parking spaces.

East

Two lots were chosen from east of First Hill with available capacity for more than 200 vehicles. They are adjacent to Interstate 90, the major east/west interstate highway with easy transit access. Travel times are expected to be about 35 min.

South

Two lots were chosen from south of First Hill with a combined available capacity for 250 vehicles. The lots are sited along the Interstate 5 corridor, the major north/south interstate highway, with an expected travel time of 30 min.

Service Options and Funding Mechanism

Metro looked at how the service should be designed, given the geographical distribution of employees, the calculated demand, and the availability of park-and-ride spaces within a reasonable distance of First Hill. Because travel times from identified park-and-ride lots were acceptable, the institutions were now most concerned with frequency of service, costs, equity of funding, and service consistency. Metro, facing rising costs of service provision, lower ridership figures, and decreasing farebox revenues, was most interested in providing a service with appealing amenities such as smaller 30-passenger vehicles with such features as high-back seats, schedules that would serve the needs of the unique community, and guaranteed farebox recovery higher than the Metro governing board's goal of 25 percent.

Peak-Hour Express Service

Three basic peak-hour express service options were analyzed with compromises made by all parties.

Option 1—Contracted Peak-Hour Express Service—The High-Cost Option Option 1 represented the "cadillac system," including peak-hour service frequencies of 15 to 20 min with midday and evening hourly headways and 30-passenger custom vehicles. The Urban Mass Transportation Administration tentatively agreed to fund 75 percent of the capital vehicle costs through a challenge grant if the system were contracted to a private provider. These features were appealing to the institutions and Metro. With the promise of the one-time-only 75 percent capital grant, operating costs were calculated to be $30/hr. This figure seemed reasonable; however, long-term service provision, including vehicle replacement costs,

brought the overall figure to more than $70/hr. This figure was confirmed by bids received for a similar service with similar vehicles. In addition, contracting meant a possible 3-year commitment, which the institutions were not willing to make.

Option 2—Custom Bus Option 2 evaluated service provision through the use of custom (subscription) buses. Metro requires a minimum of 33 riders per vehicle before custom service can be implemented. Within a reasonable time, ridership must increase to recover costs of the service. Although the cost was reasonable, calculated at $39/month per passenger, this option did not offer flexibility to meet the needs of the targeted employees. Requiring employees to sign up in advance for specific trips did not allow for early service implementation and did not give employees access to different subscription buses on demand in case their work shift changed.

Option 3—Metro-Provided Peak-Hour Express Service To bring costs down while maintaining flexibility, Metro proposed a baseline, no-frills, Metro-operated peak-hour express system. This option was designed to meet work start times with half-hour headways using standard 40-passenger coaches. The ability to meet increased demand was made possible by the availability of articulated 70-passenger vehicles.

Service hours were calculated to be 9,500 hr at a marginal operating cost of $37.47/hr. Based on the calculated demand of 539 daily round trips and the Metro objective of recovering about 80 percent through the farebox for experimental services, passes were priced at $46 each. This price was higher than that charged for regular Metro service.

Although the system would not provide customized buses or 20-min headways, it would provide direct express service at a reasonable cost with the flexibility to grow with demand. Because of Metro's governing board's commitment to experimental service that would "reasonably recover costs," the service could be implemented outside the normal service change process, which meant the service could be implemented earlier. The service could also be terminated or revised quickly if it proved to be unproductive. Following UMTA guidelines, the service was also offered for bid to private operators to ensure the most cost-effective operation. No bids for private operation were received.

In the face of agencywide budget cuts, a Metro Council objective to raise declining farebox revenues, and an inability to justify additional service hours for First Hill, Metro could offer little in the way of additional operating funds to this project. However, Metro could obtain approval to operate the program and provide park-and-ride spaces, vehicles, marketing materials, and service evaluation with the institutions' guarantee to provide 80 percent of the operating costs and a guaranteed ridership.

Daytime employee populations ranged from a high of 2,100 at the largest institution to a low of 180 at the smallest. Because of differing employee populations, demand for the service would be different for each institution. Metro staff recommended an equitable arrangement so that the calculated demand of 539 daily round trips for the peak-hour service was allocated on the basis of each institution's share of the total daytime employee population of all the institutions. The institutions agreed this was equitable, recognizing that actual use may vary. Metro agreed to evaluate the split after a demonstration period of 8 months and would adjust the allocation based on actual use. Refer to Table 1 for the proposed guarantee by each institution.

The institutions agreed to resell the passes to employees at a price below their current SOV parking rate and provide a subsidy at least equal to their current two-zone transit pass subsidy to ensure that the pass cost to the employee would be reasonable. Two of the institutions also raised their SOV parking rates as a part of the process. Refer to Table 1 for the institutions' current SOV parking rates.

Midday and Evening Service

The institutions believed that, besides allowing any pass purchaser access to any Metro regular route anytime, another alternative for midday and evening service was necessary to provide quick access to vehicles should the need arise. Three options were explored, with the last one, the rider insurance taxi option, chosen for implementation.

Option 1—Transit Shuttle Service Because two of the institutions provided midday and evening shuttle service up to 12:30 a.m. with 20 to 30 min headways, Metro was asked to provide costs for a similar back-up service. Analysis revealed that with hourly headways to 7:00 p.m., an additional 5,100 annual operating hr would be necessary bringing the monthly pass price to $69. The price, less than what the two institutions were paying per month per employee ($80 or more), was uncomfortably high for the other institutions. Rough midday demand estimates gathered from all of the institutions and actual midday use figures for the existing institutional shuttles indicated most of the proposed midday or evening trips would be unproductive and the vehicles needed could be put to better use in Metro's regular system.

Option 2—Use of Institutions' Vans About one-half of the institutions had security vans available that could be used occasionally to transport employees to park-and-ride lots. Price analysis per trip taking into consideration driver salary, maintenance, and fuel indicated a $10 per trip cost. This option, though cost-effective, was unacceptable to the institutions. Most of the vans were for security uses and would not necessarily be available on demand for their employees. Those institutions that did not have vans available would incur additional costs by adding vans and staff to operate their own systems.

Option 3—Rider Insurance Taxi Option—The Preferred Option Metro, having recently participated in a successful taxi emergency-ride-home program, looked at the feasibility of offering a modified version. This service would provide emergency taxi rides to the park-and-ride lots for program participants should regular transit service not be available. With the average trip cost to the park-and-ride calculated at

$10 and 24-hour-a-day on-demand taxi service, this option was adopted.

Metro agreed to negotiate a flat rate with a taxi provider to all of the selected park-and-ride lots from First Hill. The agreement included a substantial discount off the actual trip costs on behalf of the institutions. Because demand for this service was unpredictable, the institutions agreed to be responsible for all trip costs.

Participation by the institutions was optional allowing those who did not believe they needed the service to not offer it to their employees. Because the institutions all had different perceived demands and, thus, different potential costs, each was able to determine its own liability by setting use criteria and the amount, if any, the employee would contribute. In addition, if demand exceeded expectations, institutions could change the program to keep costs in line. Six out of eight institutions opted to offer the program as an incentive for employees to ride the First Hill express. Table 1 shows the wide variety of criteria adopted by the institutions. Most offered one trip per month at a 100 percent subsidy increasing potential total program costs per employee by about $10.

Metro proposed that each institution pay for actual costs because demand for this service was unpredictable. Metro negotiated the taxi contract on behalf of the institutions and achieved substantial reductions in actual trip costs with a flat rate of $10 to all park-and-ride lots from First Hill.

Besides negotiating the taxi contract, Metro also agreed to assist in the development of program policies and operational guidelines and to provide marketing materials and program evaluation.

Option 4—Parking Credit Program—An Extra Incentive The parking credit program was suggested by one of the institutions to provide both an extra incentive and flexibility in trip planning. This program provides employees with 1 to 2 days of guaranteed parking per month at their place of employment. Demand was theoretically limited by the number of passes each institution was required to sell. Therefore, each institution calculated that its costs would be limited to passes purchased times its parking fee. Although this program was optional with each institution able to set use criteria, five out of the eight institutions opted to participate. Table 1 shows the array of criteria adopted by the institutions. The program offers further flexibility in that institutions will be able to change their criteria if necessary to limit program costs, especially if demand is more than expected.

Each institution, having control over its own parking supply, agreed to fund this program 100 percent. Metro agreed to assist in developing program policies and marketing materials, and in evaluating the program.

SERVICE IMPLEMENTATION

On June 15, 1988, each institution verbally agreed to participate in the First Hill express service program. The service start date was set at November 1, 1988, which was 3 months earlier than the original target date of February 1, 1989. Metro staff began drafting contracts, refining service routings, expanding park-and-ride facilities, and developing marketing and promotional strategies.

A trial period from November 1, 1988, through June 1989 was agreed on to allow for a gradual buildup of ridership and the ability to evaluate the program over a reasonable length of time.

As of October 1988, all of the contracts with the institutions had been signed and implementation plans were well under way for service to begin November 1, 1988.

With careful attention to demand, customer needs, incentives, and HOV subsidies, all parties are optimistic that the program will prove successful in increasing HOV ridership. Metro is committed for the trial period to meet demand as it grows by adjusting vehicle sizes or adding additional routes from alternate park-and-ride locations, if necessary.

PROMOTIONS AND EVALUATION

The promotional strategy includes easy-to-use material that outlines service options including routes, schedules, stops, and Metro regular transit also serving the park-and-ride lots, and it describes the rider insurance and parking credit programs. Transportation promotions will be held at each institution, news releases will be sent to local community papers, and a system kickoff celebration will be held.

Evaluation of the first 6 months of service will focus on ridership, cost recovery, effectiveness of promotional strategies, and recommendations for program improvements. The institutions' employee transportation coordinators will be the primary contact for employee feedback, and on-board surveys will be conducted to assess how the programs worked. Valuable information will also be available to assess the effectiveness of the rider insurance and parking credit programs as incentives for HOV travel because each institution was able to set its own criteria, which varied widely.

Follow-up papers in 1989 will describe promotional strategies and evaluation results.

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Comparison of Travel Behavior Before and After the Opening of HOV Lanes in a Suburban Travel Corridor

LARRY WESEMANN, PAULETTE DUVE, AND NICK ROACH

Budgetary constraints coupled with the rapidly evolving urban infrastructure of southern California have created major problems for local transportation agencies in maintaining up-to-date travel data bases. In an effort to rectify data base deficiencies, local agencies have sought more innovative and cost-effective approaches to collect needed data. The Orange County Transit District and the California Department of Transportation have applied a survey methodology of corridor travel levels in Orange County that uses video cameras to photograph license plate numbers of travelers. The owners of the vehicles are then sent mailback postcard surveys to obtain information on their trip making. Responses are analyzed anonymously for use in commuter market studies, transit service plans, and travel demand models. Three corridors in Orange County have been surveyed to date using this technique. A follow-up survey was performed in one of the travel corridors 2 years later at the same location to allow for a detailed time series study of changes in travel behavior before and after the opening of carpool lanes in that corridor. The 1987 follow-up survey recorded some significant changes in corridor travel characteristics from the 1985 statistics for the morning peak period. The analysis of the results of the before and after surveys indicated that the facility with the median carpool lanes in operation had become more heavily used by home-to-work commuters during the morning peak period and more efficient at moving people rather than just vehicles. The data bases collected using this approach have been sizable (6,200 or more records), ensuring high statistical reliability in comparing the characteristics of small subsets of respondents, such as carpoolers commuting to work during the morning peak. The technique affords a high degree of control by location and time thereby allowing for detailed analyses of travel patterns. The four video postcard surveys conducted to date have not been disruptive to traffic, have experienced a high return rate, and have proved to be cost-effective at obtaining large-scale and accurate travel data.

Over the past 20 years, Los Angeles and Orange counties consistently have been among the fastest growing counties in the United States in terms of both population and employment. For example, over one-half million additional persons took up residence in Orange County between 1970 and 1980, a 36 percent increase in population. In addition, nearby Riverside and San Bernardino counties recently have experienced rapid residential growth as southern Californians search for more affordable housing and living space.

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The rapidly evolving southern California urban infrastructure has not only created an overall increase in travel demand, but progressively more complex travel patterns as a result of the rapid rise of intercounty commuting from Riverside and San Bernardino counties to Los Angeles and to numerous emerging suburban activity/employment centers in Orange County.

The rapidly evolving travel demands in southern California coupled with budgetary constraints have created major problems for local transportation agencies in terms of maintaining up-to-date travel data bases suitable for analyzing commuter markets, developing commuter service plans, and validating travel demand models. For example, transportation agencies have developed programs to build facilities to meet increased demand, such as Orange County's program for the construction of a 70-mi system of transitways and commuter (carpool) lanes in five major freeway corridors. (Transitways [busways] are barrier-separated, limited-access facilities reserved for buses, vanpools, and carpools located in the median of freeways. Carpool lanes are high-occupancy-vehicle [HOV] lanes with no physical barrier from general purpose freeway lanes.) However, little empirical data exist in southern California to validate travel models used to forecast changes in travel behavior related to the opening of exclusive HOV facilities. Therefore, local agencies lack the ability to predict facility use and effectiveness.

In an effort to rectify these data base deficiencies, local transportation agencies have begun to dedicate more resources to collecting travel data and have sought more innovative and cost-effective approaches to collect needed data. One approach that the California Department of Transportation (Caltrans) and the Orange County Transit District (OCTD) have developed to conduct corridor travel surveys incorporates the latest video technology to record license plate numbers of vehicles at a given freeway cutline location. The plate numbers are then entered on computer tape and transmitted to the California Department of Motor Vehicles (DMV), which, in turn, provides the names and addresses that correspond to the plate numbers. Participating agencies then have a comprehensive list of travelers who have passed a particular location in a given travel corridor during a specific time period. A sample of corridor users is then surveyed anonymously by means of a postcard mailback technique or by telephone, or both.

This survey technique was first applied successfully in 1984 when Caltrans conducted a postcard mailback survey of users of the San Diego Freeway in Orange County and the San

Bernardino Freeway/El Monte Busway in Los Angeles County. Since that time, the survey technique has been refined and applied on four separate occasions in Orange County travel corridors that are programmed for future transitways or commuter lanes (see Figure 1). Three additional corridor travel surveys are planned for 1988 and beyond to provide additional data bases to achieve the following objectives:

- To examine the effects of commuter lanes on corridor level and systemwide origin/destination patterns, vehicle occupancy, and overall travel behavior for use in conducting commuter market studies, developing transit service plans, and validating travel demand models;
- To examine the potential for shared ride modes on selected travel corridors to major destinations in the Los Angeles and Orange counties region; and
- To conduct time series studies of changes in travel patterns and characteristics both on a corridor level and systemwide level, particularly before and after the introduction of facility upgrades, such as the opening of new HOV facilities or additional general purpose freeway lanes.

The first opportunity to conduct a time series before-and-after study occurred when commuter lanes were opened in the median of the Costa Mesa Freeway (CA-55) in November 1985. CA-55 is a heavily congested, undersized facility running north-south in Orange County that carries a high percentage of long-distance intercounty commute trips that originate in Riverside and San Bernardino counties and terminate at various Orange County activity/employment centers. The commuter lanes are approximately 12 mi in length and save carpoolers 15 to 20 min in their commute to work on a normal weekday. Within 6 months of opening, the volumes of two-person-plus carpools per lane on the lanes had grown to 1,200 to 1,400 carpools per lane per hour during the peak periods of the day.

In May 1985, before the construction and opening of the CA-55 commuter lanes, a video camera cutline survey was conducted on the southbound lanes of CA-55 to examine commuter travel characteristics before the introduction of the commuter lanes. This study, which included a postcard mailback survey and a follow-up telephone survey, was a cooperative technical effort by OCTD, Caltrans, the Orange County Transportation Commission (OCTC), the Southern California Association of Governments (SCAG), and the Orange County Environmental Management Agency and involved collecting, analyzing, and reporting information on current users' travel paths and attitudes toward commuter lanes.

In May 1987, 18 months after the opening of the commuter lanes, the agencies conducted a follow-up study consisting of both a postcard mailback and a telephone survey. The CA-55 postcard mailback survey collected data on basic travel characteristics, whereas the telephone survey (not covered in this paper) sought more in-depth information on travel behavior and daily trip making.

SURVEY METHODOLOGY

The 1985 and 1987 video camera surveys were performed in an identical manner, at the same location on CA-55, on the same day of the week (Tuesday), and over the same time period to ensure consistency for comparison of data bases. The 1985 and 1987 postcard mailback surveys were identical in methodology and scope. The follow-up survey in 1987 was expanded to differentiate between users of the three southbound general traffic freeway lanes and of the parallel commuter lane. Also, the 1987 survey included a second group of cameras shooting from a more southerly overpass on CA-55 to better analyze traffic flow south of an interchange with the Santa Ana Freeway (I-5), the major north-south freeway in Orange County. The sequence of survey steps was as follows:

1. The videotaping of license plates took place on May 5, 1987, between the hours of 6:30 a.m. and 7:30 p.m., the envelope of daylight hours suitable for photography. Five high-speed video cameras were positioned on the La Veta Avenue overpass and were focused to pick up the rear plate numbers of southbound traffic in each of the three general traffic lanes, the commuter lane, and one of the transition lanes from southbound CA-55 to westbound CA-22. To provide total traffic counts for determining the overall survey sample size, one wide-angle-lens camera recorded all activity at this location and 24-hr traffic counts were recorded at a Caltrans count station north of La Veta Avenue.
2. Two cameras were placed on the more southerly McFadden Street overpass, one viewing the southbound CA-55 commuter lane, while a second camera was rotated on an hourly basis among the three southbound general traffic lanes at this location. These provided a sample of freeway users for the follow-up telephone survey to be conducted by the OCTC.
3. License plate numbers were read from the videotapes and entered onto computer tape, with out-of-state and heavy-duty commercial-vehicle license plate numbers deleted from the survey. Only a 50 percent sample of plate numbers was entered during the midday hours (9:00 a.m. to 3:00 p.m.).
4. By using the license plate data, addresses of registered owners of passenger vehicles recorded on the southbound CA-55 freeway and commuter lane were obtained from the California DMV and printed on labels, which were then affixed to postcard surveys.
5. Postcard surveys requesting the origin, destination, purpose, frequency, and vehicle occupancy for the trip observed were mailed to the registered vehicle owners. There were two versions of the survey, with users of the CA-55 commuter lane asked additional questions on travel mode and trip start time used before the opening of the commuter lanes. A sample of the mailback postcard survey form sent to commuter lane users is shown in Figure 2.
6. The survey returns were coded and key-entered, and tabulations and cross-tabulations of travel data were produced using the Statistical Package for Social Science (SPSS X), Release 2.1.
7. Travel data were analyzed to determine travel characteristics and these were compared to the data base from the 1985 postcard survey to determine changes in travel behavior associated with the different travel conditions before and after the opening of the CA-55 commuter lanes.

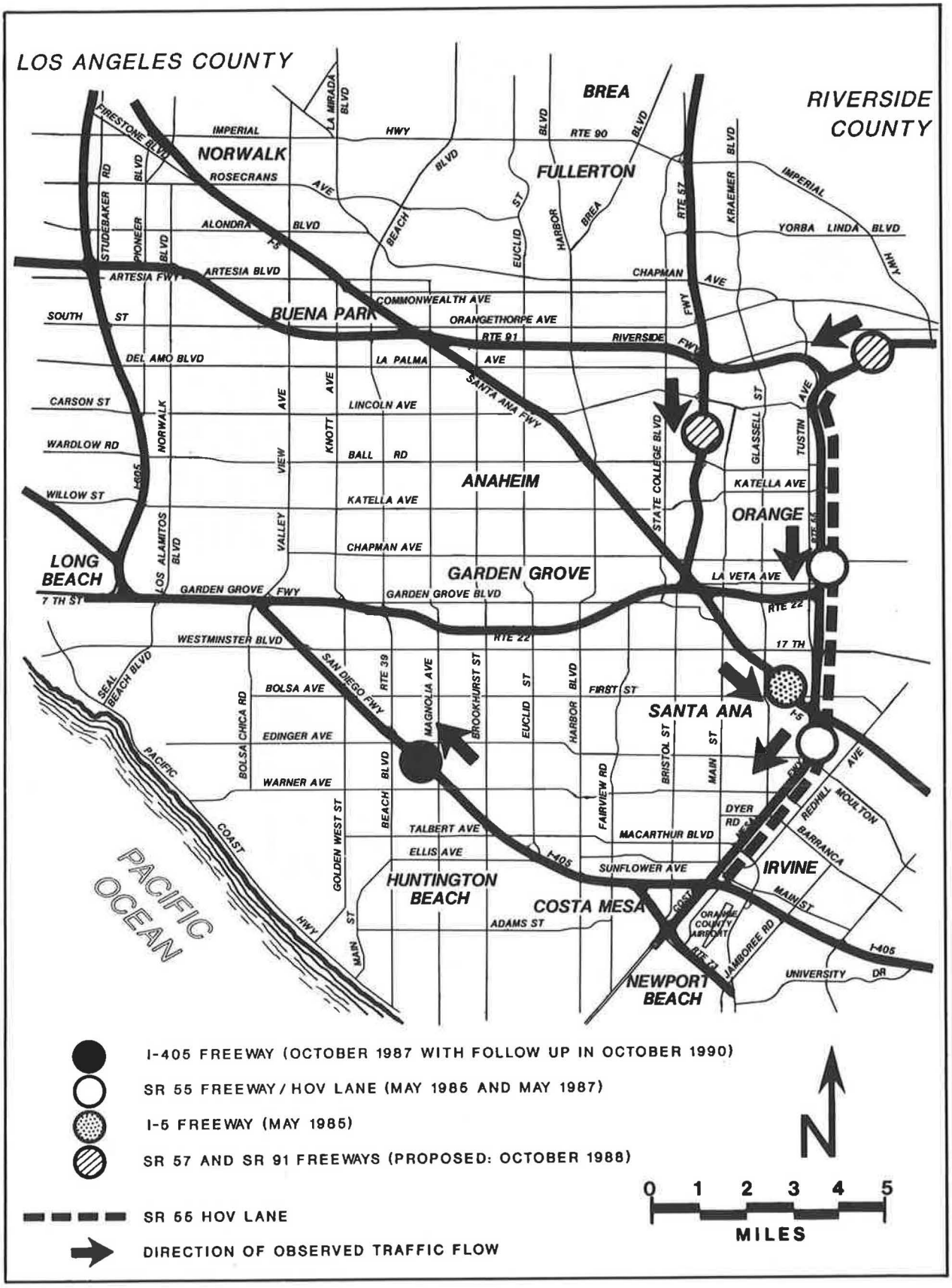
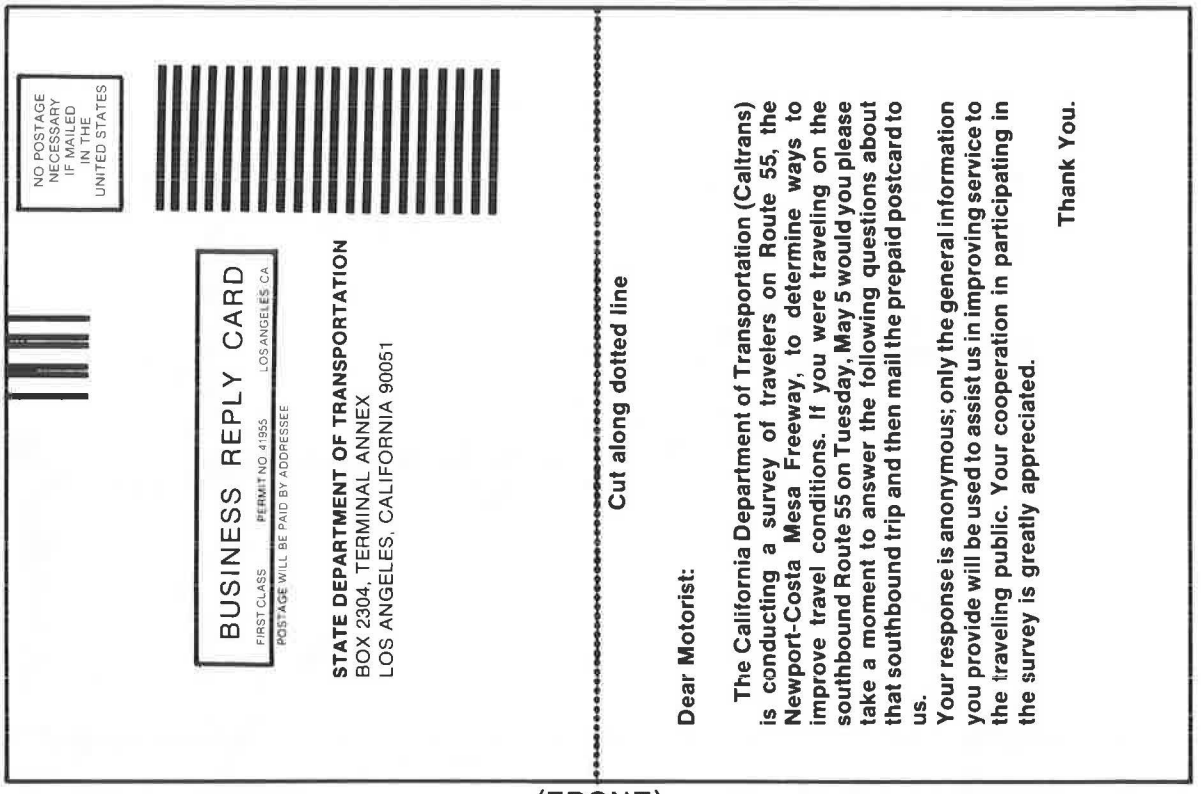
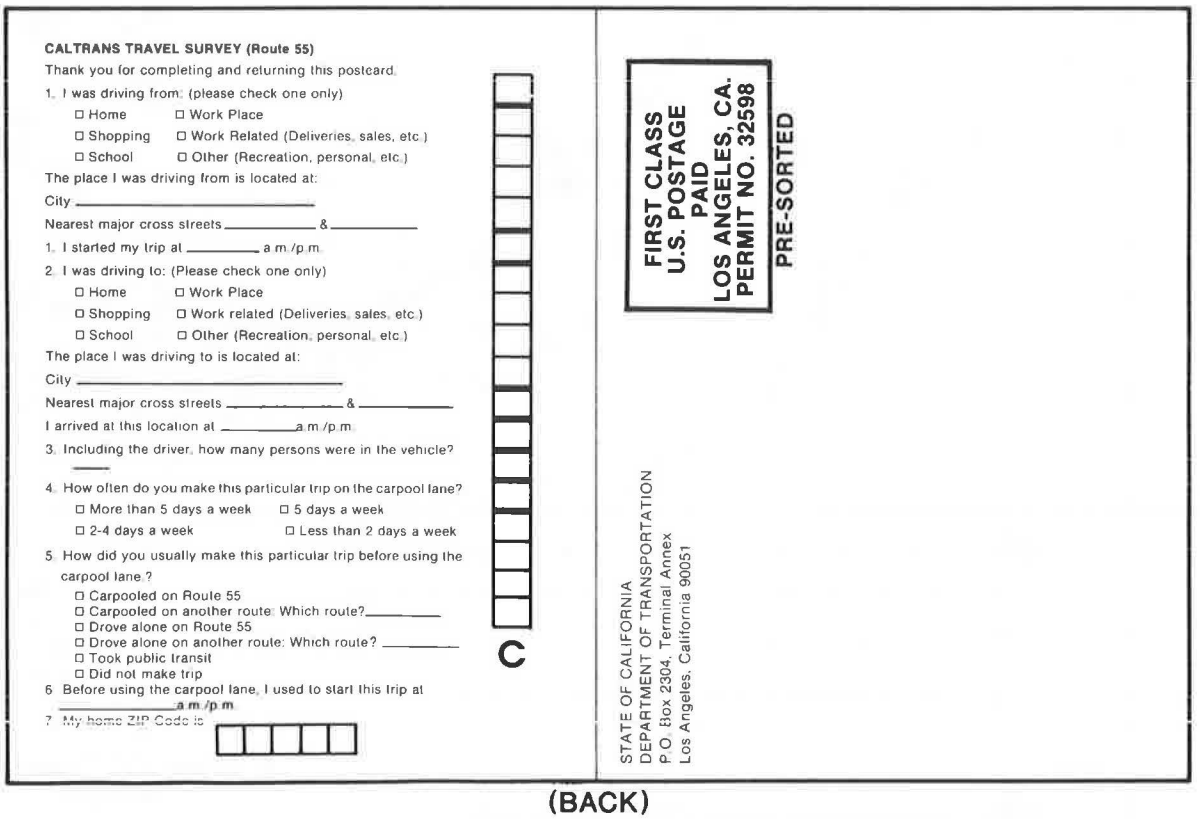


FIGURE 1 Cutline survey sites.



(FRONT)



(BACK)

FIGURE 2 Cutline survey form.

TABLE 1 SUMMARY OF 1985 AND 1987 TRAVEL SURVEY STATISTICS

	1985 AT LA VETA AVE.[a]	1987 AT LA VETA AVE.		1987 AT McFADDEN ST.		
Data Category	General Traffic Lanes	General Traffic Lanes	Comm. Lanes	General Traffic Lanes	Comm. Lanes	1987 Totals
Survey Forms Mailed	18,697	30,259	4,272	7,881	3,085	45,497
Survey Forms Returned	6,208	6,546	862	1,271	460	9,139
Survey Response Rate	33.2%	21.6%	20.2%	16.1%	14.9%	20.1%
ADJUSTED CONTROL COUNT (Southbound)	48,945	51,126	7,147	---	---	---
Percent Forms Returned of Control Count	12.7%	12.9%	12.1%	---	---	---

[a]Includes data from four southbound on-ramps (CA 22, McFadden, 17th, and 4th streets).

TABLE 2 COMPARISON OF CA-55 TRAVEL CORRIDOR CHARACTERISTICS BEFORE AND AFTER OPENING OF COMMUTER LANES, FROM RESPONSES TO 1985 AND 1987 TRAVEL SURVEYS OF SOUTHBOUND TRIPS FOR A.M. PEAK PERIOD AT LA VETA

	May 1985 Survey: 6 Months Prior to Opening	May 1987 Survey: 18 Months After Opening	Change Relative to 1985
• **Morning Peak Survey Returns**	2,103	2,504	--
• **Total Morning Peak Carpools**	332	653	--
• **Average Vehicle Occupancy Rate**	1.213	1.343	+11%
• **Home-to-Work Trips**	70%	79%	+13%
• **AM Peak Trip Origins**			
Orange County	61%	65%	--
Riverside County	29%	25%	--
Other External	10%	10%	--
• **Major Destination Cities For All Morning Peak Period Trips**			
Santa Ana	26%	20%	--
Irvine	22%	26%	--
Newport Beach	16%	11%	--
Costa Mesa	15%	13%	--
Tustin	11%	10%	--
• **Percent Carpools of Total Vehicles**	15.8%	26.1%	+65%
By Origin County:			
Orange County	13%	20%	+54%
Riverside County	23%	35%	+52%
San Bernardino County	17%	39%	+129%
Los Angeles County	16%	45%	+181%

SURVEY STATISTICS

Table 1 summarizes the basic statistics of the 1985 and 1987 cutline travel surveys on southbound CA-55. The overall response rate for the 1985 survey, which was conducted only during the morning and afternoon peak periods, was 33.2 percent versus 20.1 percent in 1987 for a 13-hr period from 6:30 a.m. to 7:30 p.m. In each case, the survey responses represented slightly over 12 percent of the total southbound traffic flow during survey hours at the La Veta Avenue overpass.

COMPARISON OF 1985 AND 1987 SURVEY DATA

Table 2 contains a comparison of significant findings from the 1985 and 1987 mailback surveys at the La Veta Avenue location on the southbound CA-55 for the morning peak period (6:30 a.m. to 9:00 a.m.). The 1985 survey recorded 2,103 returns in the morning peak period as compared to 2,504 from the 1987 survey.

As shown in the table, the 1987 survey recorded some significant changes in corridor travel characteristics from 1985 for the morning peak period. The analysis of the results of the before and after surveys indicates that the CA-55 facility with the median commuter lanes in operation is now more heavily used by home-to-work commuters during the morning peak period and is more efficient at moving people rather than just vehicles (i.e., the average vehicle occupancy rate has increased 11 percent). Significant findings from the 1985 and 1987 surveys are described in the following paragraphs.

- *More capacity on freeway lanes is available for Orange County commuters because of the high percentage of external origin carpools in the commuter lane in the morning peak.* Because of a large-scale shift of trips with external origins into carpools that use the commuter lane, an estimated 1,300 more vehicles from Orange County origins are traveling southbound on the CA-55 general traffic freeway lanes in 1987 versus 1985 during the morning peak period. The results of the 1987 survey indicate that the commuter lane has captured a high percentage of the long-distance intercounty commute trips that take up the most miles of freeway lane capacity. Fifty-one percent of the morning peak period commuter lane users surveyed at La Veta Avenue in May 1987 indicated that they began their trips outside of Orange County. This translates into approximately 5,600 persons with external origins being carried in 2,400 carpools on the southbound CA-55 commuter lane during the morning peak period in 1987.

Although these intercounty carpoolers certainly benefit from the travel time savings they gain by using the commuter lane, the shift of these trips into carpools on the commuter lane also greatly benefits Orange County commuters because vehicles are removed from traffic that would otherwise take up capacity over many miles of both CA-55 and CA-91 (Riverside Freeway) during the morning peak period. Survey statistics indicate that the percentage of peak period users on the southbound CA-55 general traffic lanes that reported external origins dropped from 39 to 31 percent from 1985 to 1987.

- *More 1987 morning peak period CA-55 commuters with external origins were in carpools than drove alone.* One of the most dramatic changes in travel in the CA-55 corridor between 1985 and 1987 was the 76 percent rate of growth in long-distance intercounty carpools from Riverside, San Bernardino, and Los Angeles counties during the morning peak period. Based on the survey responses, the percentage of total vehicles reported as carpools from these counties grew from 21 to 37 percent from 1985 to 1987.

As shown in Figure 3, carpools as a percent of total vehicles increased from 16 to 45 percent for Los Angeles County, 23 to 35 percent for Riverside County, and from 17 to 39 percent for San Bernardino County, from 1985 to 1987. Carpools from internal origins in Orange County grew from 13 to 20 percent over the same time period. Based on an average occupancy of 2.32 persons per carpool (from the survey responses) in 1987, 58 percent of person-trips with external origins on southbound CA-55 during the morning peak period were carried in carpools, versus 42 percent who drove alone. This compares to only 37 percent of person-trips from Orange County origins traveling in carpools in 1987 on CA-55 during the same time period.

- *Person-trips carried in the CA-55 corridor increased by 45 percent from 1985 to 1987.* The vehicle-carrying capacity of the southbound CA-55 was expanded from three to four lanes with the addition of the commuter lane in late 1985. As shown in Figure 4, the peak usage of the southbound CA-55 grew from 5,400 vehicles per hour to 7,000 vehicles per hour (assuming 1,800 vehicles per hour per lane for a freeway lane and 1,600 for the commuter lane). Based on the survey responses, the average number of people carried per vehicle in the southbound CA-55 corridor during the morning peak period increased from 1.213 persons per vehicle in 1985 before the opening of the commuter lanes to 1.343 in 1987 after the lanes were in operation for 18 months. This 11 percent increase in average corridor vehicle occupancy, coupled with the 30 percent increase in vehicle volumes translates into a 45 percent increase in persons being carried in the corridor during the morning peak hour.

Table 3 shows vehicle occupancy breakdowns and person-trips by mode for a.m. peak period users of the southbound CA-55 freeway and commuter lane for 1985 and 1987. It is interesting to note that although carpools grew by a sizable percentage from 1985 to 1987, the average vehicle occupancy rate for carpools dropped slightly from 1985 to 1987 (2.35 persons per vehicle to 2.32) in the morning peak period. With the CA-55 commuter lanes open to all vehicles with two or more persons, no extra impetus exists for the formation of higher-occupancy carpools in the travel corridor.

- *Morning peak period carpools have more than doubled from 1985 to 1987.* The percent of CA-55 survey respondents reporting that they were in carpools of two or more persons increased dramatically from May 1985 to May 1987. The percent of carpools to total vehicles (general traffic lanes and commuter lane combined) southbound in the morning peak increased from 15.8 percent in 1985 to 26.1 percent in 1987,

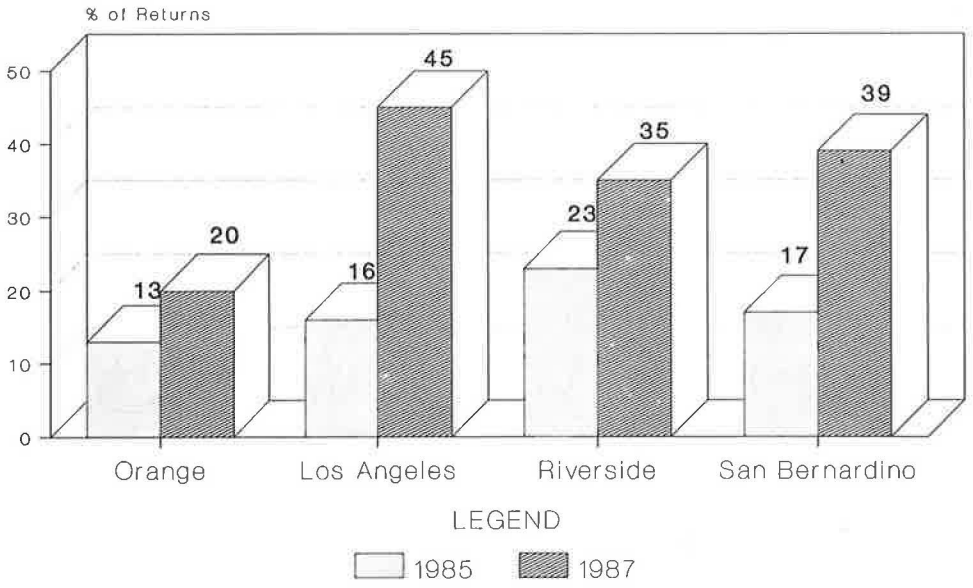
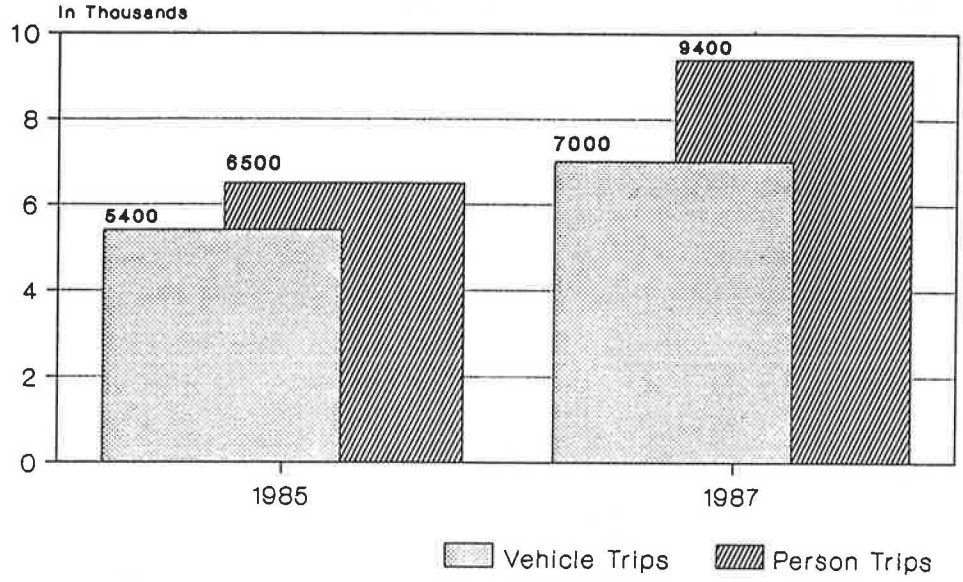


FIGURE 3 Carpools as a percentage of total vehicles for 1985 and 1987, by origin county.



1985 OCCUPANCY RATE: 1.21 1987: 1.34

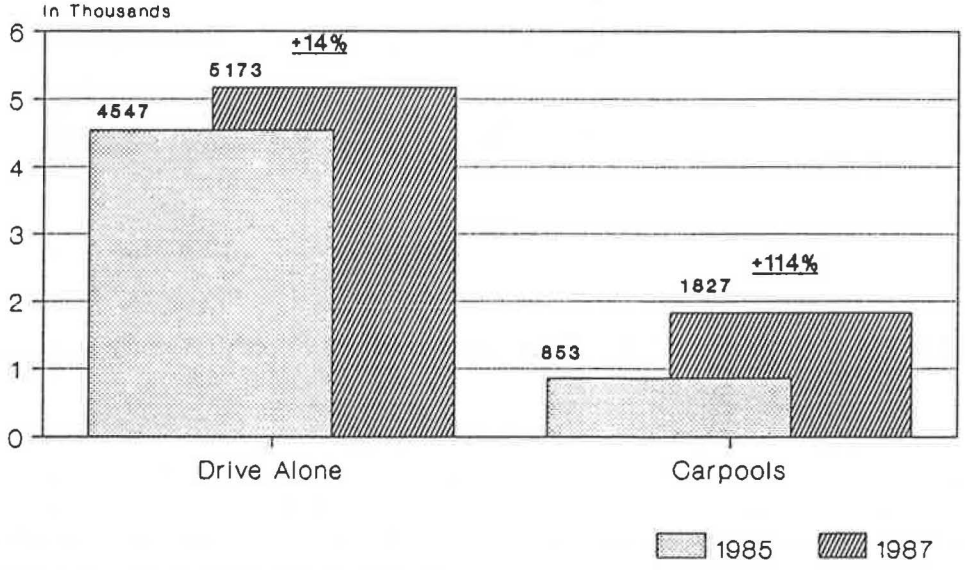
FIGURE 4 Comparison of 1985 and 1987 peak-hour vehicle and person-trip throughput on CA-55, southbound at La Veta.

a 65 percent increase. As shown in Figure 5, when growth in peak-period volumes on CA-55 from 1985 to 1987 resulting from the added lane is factored into the calculations, carpool volumes have more than doubled in the morning period (114 percent increase from 1985 to 1987). In addition, the 1987 survey indicated that 45 percent of morning-peak-period person-trips on southbound CA-55 were in carpools versus only 30 percent in 1985.

- *Morning peak period trips originating in Orange County increased from 61 to 65 percent from 1985 to 1987.* Although the CA-55 travel corridor continued to carry a high percentage of intercounty trips in 1987 (31 percent southbound in the morning peak period), the survey indicated that the percent of trips from Orange County origins grew from 61 to 65 percent from 1985 to 1987 for the freeway lanes and commuter lane combined. The percentage of respondents from Riverside County who indicated that they travel in the morning peak period declined from 29 to 25 percent from 1985 to 1987. However, in absolute numbers, this commuting group actually grew, because the level of overall traffic carried on CA-55 grew by an estimated 30 percent from 1985 to 1987 with the addition of another travel lane in the southbound direction.
- *Morning peak period person-trips originating in Orange County grew by 49 percent compared to a 35 percent growth*

TABLE 3 COMPARISON OF CARPOOLING IN CA-55 FREEWAY CORRIDOR BEFORE AND AFTER OPENING OF COMMUTER LANES, FROM RESPONSES TO 1985 AND 1987 TRAVEL SURVEYS OF SOUTHBOUND TRIPS FOR A.M. PEAK PERIOD AT LA VETA

	MAY 1985 SURVEY: 6 MONTHS PRIOR TO OPENING				MAY 1987 SURVEY: 18 MONTHS AFTER OPENING			
	Vehicles	%	Persons	%	Vehicles	%	Persons	%
Drove Alone	1,771	84	1,771	70	1,851	74	1,851	55
2 Person Carpools	259	12	518	20	508	20	1,016	30
3+ Person Carpools	73	4	261	10	145	6	497	15
Total Carpools	332	16	779	30	653	26	1,513	45
Total Responses	2,103	100	2,550	100	2,504	100	3,364	100
AVERAGE VEHICLE OCCUPANCY RATE	$\frac{2,550}{2,103}$ = 1.213 persons per vehicle				$\frac{3,364}{2,504}$ = 1.343 persons per vehicle			
AVERAGE VEHICLE OCCUPANCY RATE FOR CARPOOLS	$\frac{518 + 261}{259 + 73} = \frac{779}{332}$ = 2.35 persons per carpool				$\frac{1016 + 497}{508 + 145} = \frac{1513}{653}$ = 2.32 persons per carpool			
PERCENT CARPOOLS OF TOTAL VEHICLES	$\frac{332 \text{ Carpools}}{2,103 \text{ Vehicles}}$ = 15.8%				$\frac{643 \text{ Carpools}}{2,504 \text{ Vehicles}}$ = 26.1%			
PERCENTAGE INCREASE IN CARPOOLS OF TOTAL VEHICLES FROM 1985 TO 1987	$\frac{\text{1987 carpools/vehicles}}{\text{1985 carpools/vehicles}} = \frac{26.1\%}{15.8\%}$ = +65%							



PERCENT CARPOOLS OF TOTAL VEHICLES
1985: 15.8% 1987: 26.1%

FIGURE 5 Growth in a.m. peak-hour carpools 1985 to 1987 on CA-55, southbound at La Veta.

for external trips from 1985 to 1987. Based on survey responses, the 45 percent rate of growth in person trips carried on CA-55 southbound in the morning peak from 1985 to 1987 was more heavily oriented toward Orange County residents than residents of Riverside, San Bernardino, and Los Angeles counties, although trips from these counties also grew. The survey indicated that morning peak period trips originating in Orange County grew by 49 percent compared to a 35 percent growth for trips with external origins. Person-trips originating in Riverside County and traveling southbound on CA-55 in the morning peak period were estimated to have grown by 25 percent from 1985 to 1987, even though the relative percentage of survey responses from Riverside declined from 29 to 25 percent. These seemingly contradictory trends for Riverside exist because overall vehicle trips on CA-55 grew by an estimated 30 percent from 1985 to 1987 with the added lane, and survey respondents from Riverside County who indicated they were in carpools increased from 23 to 35 percent in 2 years.

Trip Purpose of CA-55 Carpool Lane Users	*Formerly Carpooled (%)*	*Formerly Drove Alone (%)*	*Did Not Make Trip (%)*
Morning peak period—work	35	58	7
Morning peak period—nonwork	31	49	20
Total daily composite	33	56	11

- *Morning peak period home-to-work trips increased from 70 to 79 percent*. Seventy-nine percent of the morning peak period respondents to the 1987 travel survey reported that they were journeying from home to work versus 70 percent from the 1985 survey. When the 30 percent increase in peak volumes associated with the extra southbound lane is factored into the calculations along with the 11 percent increase in average vehicle occupancy, the CA-55 is now carrying 65 percent more home-to-work person-trips during the morning peak period than in 1985.

COMPARISON OF USERS OF GENERAL TRAFFIC AND CARPOOL LANES IN 1987

Table 4 contains some of the significant characteristics of the users of the southbound CA-55 freeway lanes and commuter lane from the 1987 postcard travel survey. Many of these statistics, such as the percentage of work trips in the morning peak and destination cities, closely mirror the overall corridor characteristics presented in the previous section. However, some significant findings about the formation of carpools and differences between users of the commuter lane and the general traffic lanes in areas such as trip origin and trip frequency are discussed in the following paragraphs.

- *Sixty-seven percent of carpools in CA-55 corridor did not exist before the opening of the commuter lanes*. CA-55 commuter lane users were asked to indicate which mode of travel they used before using the commuter lanes. Fifty-six percent indicated that they previously drove alone, whereas 11 percent reported that they did not make the trip before November 1985. Twenty-eight percent of the commuter-lane users said that they were carpooling on CA-55 before the opening of the lanes, and another 5 percent indicated that they carpooled on another route. At first glance, it would appear that the opening of the commuter lanes has had a dramatic impact on travel behavior by influencing many persons who formerly drove alone to carpool. However, caution must be used in interpreting these survey results because 18 months had elapsed since the commuter lanes were opened and some degree of natural turnover in trips occurred during that time. Studies of the duration of individual carpools from around the country indicate that as much as a 50 percent turnover in carpools may occur over an 18-month period.

As the following data show, a slightly higher percentage of journey-to-work CA-55 carpools named carpooling and driving alone as prior modes than did nonwork peak period carpools. Conversely, a much-lower-than-average percentage of morning peak period users of the lanes traveling to work indicated they did not make their trip before the opening of the carpool lanes in November 1985.

- *Forty-five percent of commuter-lane users responding to the 1987 survey started their trip outside of Orange County in morning peak period*. The southbound CA-55 commuter lanes are carrying a large number of intercounty carpool trips in the morning peak period. Fifty-one percent of the commuter lane users in the morning peak period at the La Veta cutline originated outside of Orange County, compared to 31 percent of the users of the general traffic lanes at La Veta. The more southerly McFadden Street location picked up 32 percent external origins in the commuter lane in the morning peak; however, the percentage of externals passing McFadden might be higher because trips picked up at La Veta were deleted from the McFadden data base. The percentage of morning peak period commuter lane trips with external origins for both locations combined is 45 percent.
- *In 1987, the CA-55 commuter lane and general traffic lanes carried approximately the same percent of work trips in the morning peak period*. Eighty percent of the CA-55 commuter lane users (La Veta and McFadden locations combined) for the morning peak period indicated that they were traveling to work versus 82 percent of the respondents using the general traffic lanes.
- *Eighty-five percent of users of the general traffic lanes in morning peak period commute 5 days per week versus 74 percent on the commuter lane*. Respondents on the southbound commuter lane in the morning peak period indicated a lower frequency of use than the respondents using the general traffic lanes. It should be noted that when part-time users of CA-55 (2 to 4 days per week) are added to everyday users, the difference narrows (87 percent commuter lane versus 94 percent for the general traffic lanes).
- *The average vehicle occupancy rate in the morning peak period is 2.11 persons per vehicle on the commuter lane versus 1.16 for the general traffic lanes*. As reported earlier, the 1987

TABLE 4 COMPARISON OF CA-55 FREEWAY AND COMMUTER LANE USERS' TRIP CHARACTERISTICS FROM MAY 1987 SURVEY OF SOUTHBOUND TRIPS

Survey Characteristics	Users of CA 55 Commuter Lane [a]			Users of CA 55 General Traffic Lanes at La Veta
	La Veta Cutline	McFadden Cutline	Total Commuter Lane Carpools	
Survey Returns	862	460	1,322	6,546
Percent Traveling to Work in Morning Peak Period	82%	78%	80%	82%
Origins for Morning Peak Period				
Orange County	49%	68%	55%	69%
Riverside	33%	18%	28%	23%
Los Angeles	8%	8%	8%	3%
San Bernardino	10%	6%	9%	5%
Mode Used Prior to Opening of CA 55 Commuter Lanes				
Carpooled on CA 55	28%	28%	28%	--
Carpooled another route	5%	5%	5%	--
Drove alone	57%	55%	56%	--
Did not make trip	10%	12%	11%	--
Frequency of Usage Per Week for Morning Peak Period				
5 days or more	76%	71%	74%	85%
2-4 days	13%	13%	13%	9%
Vehicle Occupancy Rate in Morning Peak Period	2.16	2.06	2.11	1.16
Trip Duration in Minutes Morning and Afternoon Peak Periods	55.8	--	--	56.0

[a]License plates recorded at both locations were deleted from the McFadden database.

survey showed the CA-55 travel corrridor with an average southbound morning peak period vehicle occupancy rate of 1.34 persons per vehicle. This breaks down to 2.11 persons per vehicle in the southbound CA-55 commuter lane and 1.16 for the southbound general traffic lanes.

- *Trip durations reported for southbound CA-55 commuter lane and general traffic trips were nearly identical.* Respondents to the 1987 travel survey were asked to indicate their trip start and end times. An estimate of trip duration was made from their responses. The computed morning peak period trip durations for users of the freeway and commuter lanes were nearly identical, even though CA-55 commuter lane users travel faster southbound according to Caltrans field surveys. Although analyses of trip length data have not yet been completed, they will probably show longer average trip lengths for carpool lane users, as indicated by the increase in the percent of external origins from 1985 to 1987.

- *Seventy-seven percent of CA-55 commuter-lane users indicated that they now start their trip later (by 10 min or more) than before they started using the commuter lanes.* Carpoolers using the commuter lane were asked to indicate their trip start time before using the commuter lanes as well as their present start time. A comparison of these times indicated that a vast majority—77 percent—of the commuter lane users now start their trip 10 min or more later, presumably because of a faster, less congested commute to work. Only 5 percent of the commuter lane users indicated that they now start their trip earlier, whereas 18 percent indicated little or no change in start time.

- *Home-based work trips predominate in both the a.m. and p.m. peak periods on the CA-55 freeway, but only in the a.m. peak on the southbound commuter lane.* Eighty-six percent of the morning peak period survey respondents on the southbound CA-55 freeway were making a home-based work trip,

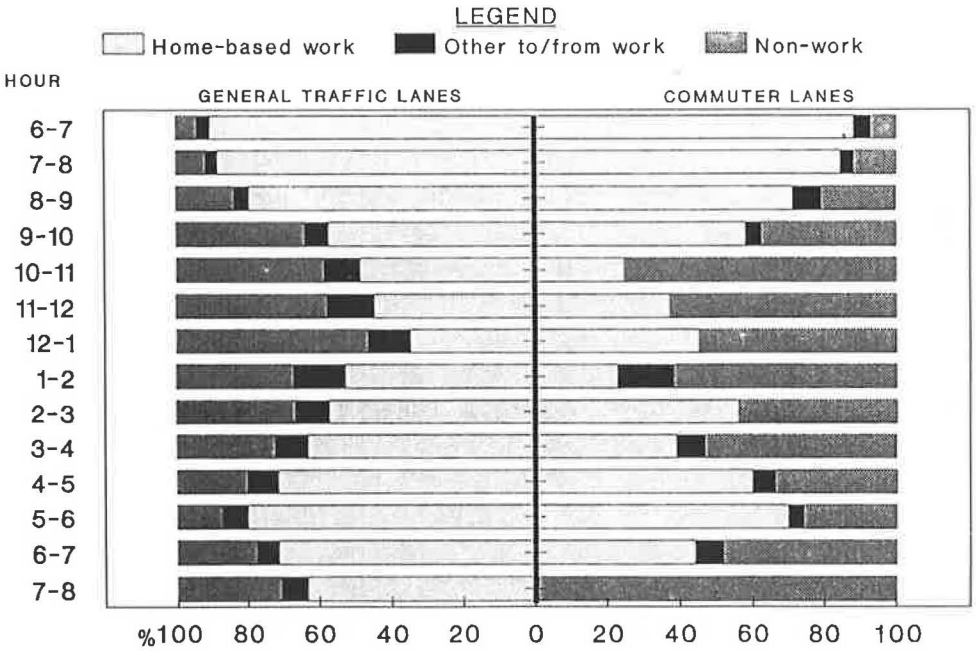


FIGURE 6 1987 general traffic and commuter lane comparison of trip purpose by hour of day on CA-55.

as were 73 percent of the p.m. peak period freeway users. While 82 percent of the morning peak period carpools on the southbound CA-55 commuter lane reported a home-based work trip, only 57 percent of the p.m. peak period commuter lane users did so. Thus, the CA-55 commuter lanes appear to have a much more pronounced commute directionality than do the parallel freeway lanes. Figure 6 indicates trip purpose by hour for both the southbound freeway and commuter lane.

- *Over one-third of carpools on CA-55 used the general traffic lanes in the morning peak period.* Thirty-six percent of the morning peak period carpoolers responding to the 1987 CA-55 survey at the La Veta cutline were picked up using the general traffic lanes rather than the commuter lane. This corresponds closely to recent Caltrans CA-55 observations at Walnut and Santa Clara streets, which indicated that 31 to 38 percent of carpools were using the general traffic lanes in the morning peak hour. Carpools not in the commuter lane are possibly in the process of weaving in or out of the commuter lane when recorded or do not use the commuter lane for other reasons. However, short trip length does not appear to be a primary reason because 41 percent of morning peak period carpoolers using general traffic lanes had origins outside of Orange County as compared to 51 percent external origins for the commuter lane carpools. A lower number of morning peak period carpools in the general traffic lanes were going from home to work (64 percent) than carpools in the commuter lane (75 percent).

PROS AND CONS OF SURVEY APPROACH

The corridor cutline survey technique employing high-speed video cameras to photograph license plate numbers has proved to be a relatively effective method for obtaining a large-scale sample of corridor traffic and detailed travel data for southern California transportation agencies. Thus far, four video-camera/postcard-mailback surveys have been performed in Orange County, all with a relatively high response rate (19 percent or higher) and large number of responses (6,200 or more records). The large number of responses ensures a higher statistical reliability in comparing the characteristics of small subsets of respondents, such as carpoolers commuting to work in a given peak hour.

The video camera approach also has proven to be a rather cost-effective approach in that large field survey teams, normally required to conduct massive corridor surveys, are replaced by a group of cameras monitored by a field technician. Survey costs have averaged between $5 and $10 per return for all categories of costs including camera rental, manpower, postage, mail order house, printing of address labels and postcard surveys, data entry, coding, key entry, computer analysis, and so on.

In addition to cost-effectiveness and large numbers of returns, the video/postcard-mailback-survey approach has other strong points that make it useful for surveying high-volume travel corridors, such as

- *Little disruption to traffic.* When strategically placed, video cameras photographing rear license plates are invisible to the corridor traveler. This allows survey work to progress without traffic disruption, which so often occurs with manually distributed surveys on facilities that carry high volumes of traffic.
- *Sample control and tracking of data.* Videotaping of plate numbers at a specific location in a travel corridor, in a specific lane, in a given direction, during a specific time affords the surveyor a great deal of control in establishing a sample for survey purposes. For the 1987 CA-55 survey, users of the commuter lane were easily segregated from travelers in the general traffic lanes and were sent a separate survey form.
- *Focused framework for analysis.* Because of the great

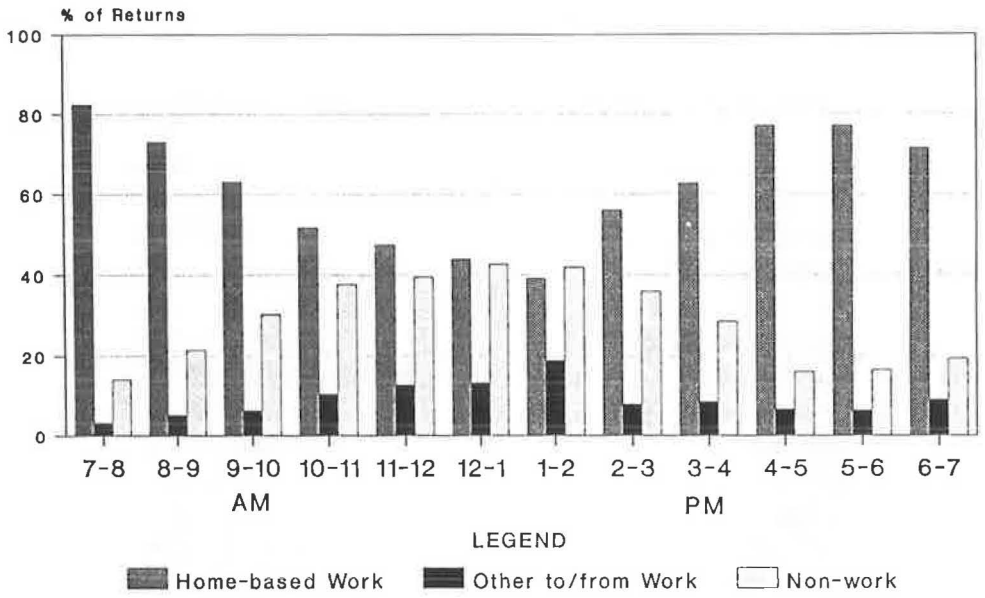


FIGURE 7 Trip purpose by hour of day on I-405 northbound at Heil cutline.

degree of control of location and time, specific travel characteristics from the returns can be analyzed within the focused framework of the travel corridor cutline. Therefore, origin-destination travel paths are known to be traveling through a specific link in the transportation network.

One of the shortcomings associated with the license plate video cutline survey approach is the potential for built-in biases in the survey population and the respondents. Although the participating agencies chose to deliberately slant the survey population by deleting out-of-state license plates and plates on heavy-duty commercial vehicles, other subsets of travelers also appear to have been lost to the survey because license plate numbers could not be easily linked to the drivers of the vehicle using DMV records. Drivers of vehicles registered to businesses, some leased vehicles, and rental cars fall into this category.

Another possible bias is associated with the lag time between the day the vehicle plate numbers are photographed and the day the households of the registered vehicles receive the postcard or telephone survey. The longer the lag time, the greater the probability that travel corridor users will not remember their trip on the day of the survey with equal accuracy. Everyday commuters may report their normal inbound trip, but occasional travelers making nonwork trips may not recall their trip if too much time has elapsed. This appears to be the case in both of the most recent video/mailback corridor surveys conducted during 1987 on CA-55 southbound and on the northbound lanes of the San Diego (I-405) Freeway in Orange County. As shown in both Figures 6 and 7, based on survey responses, nonwork trip purposes are never predominant in either travel corridor, even during nonpeak hours. For both surveys, frequent users (5 days or more per week) constitute a high percentage of the total responses (73 percent for I-405 and 77 percent for CA-55).

CONCLUSIONS AND FOLLOW-UP STUDIES

The cutline mailback surveys conducted to date have provided needed large-scale information on travel characteristics in three of the major travel corridors in Orange County. The 1985 and 1987 travel surveys of the CA-55 travel corridor provided comparable data bases for a detailed before and after study of the effects of the opening of exclusive commuter lanes on travel behavior within the corridor.

As shown earlier in Figure 1, OCTD and Caltrans have agreed to perform additional video/postcard surveys to document "before" travel conditions in two other travel corridors in Orange County that are programmed for future HOV facilities: CA-91 (Riverside Freeway) and CA-57 (Orange Freeway). In the future, when exclusive facilities have been opened in these travel corridors, surveys could be performed at the same cutline locations to document "after" conditions. As more "before and after" travel data bases are developed in the future in southern California, greater accuracy can be built into travel demand models used for commuter market studies, transit service planning, and facility development.

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Evaluation of Springfield Instant Carpooling

ARLEE T. RENO, WILLIAM A. GELLERT, AND ALEX VERZOSA

This paper describes and evaluates the phenomenon of "instant carpooling" in the Springfield area of Northern Virginia, wherein about 2,500 strangers form ad hoc carpools each morning in order to use the high-occupancy-vehicle (HOV) express lanes on the Shirley Highway to downtown Washington, D.C. and the Pentagon. It presents the results of field observations on the magnitude and operation of the carpools and of informal interviews with the carpoolers. Safety and parking considerations are discussed, as well as the effect of the carpools on public-transit use. Instant carpooling is found to result in significant savings in travel time for the passengers and drivers and in transit operating cost savings for public agencies. Planners and decision makers are urged to encourage instant carpooling as a means of enhancing the overall effectiveness of park-and-ride and HOV-lane programs. Recommendations are presented for strengthening and protecting the current Springfield instant carpool operations, and the necessary conditions for replicating instant carpools elsewhere are discussed.

To most Americans, the image of the hitchhiker is that of either a scruffy hippie or a down-and-out-bum. A hitchhiker gets a ride out of kindness or pity. Hitchhiking is not an activity in which affluent, middle-class Americans would engage, except in the most desperate of emergencies.

But at two sites in suburban Washington, D.C., well-dressed and proper middle-class people of all races, male and female, line up each morning 5 days a week to ask for rides with strangers. And those drivers who are strangers, also well-dressed, of all races, and male and female, stop their cars and invite the first one, two, or three people into their Ford, Chevy, Plymouth, Cadillac, Mercedes, or BMW. Does this occur on a university campus or as part of a federally funded demonstration project? No, the hitchhikers and drivers initiated it and organized it by themselves, without the influence of any social experimenters and without any outside financial support. It started in 1974 when carpools were first allowed on the express lanes of the Shirley Highway, and it has evolved and grown since then.

This is the Springfield area of Fairfax County, Virginia, one of the nation's most affluent counties. Some have called these middle-class hitchhikers and carpool drivers the "Springfield Underground." The members of this underground are far from being revolutionaries, however. They collectively present a clean-cut and stable image, which is representative of their fellow residents of the county.

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The Springfield Underground commuters have developed their own solution to the problem of commuting (which we call "instant carpooling") in the Shirley Highway corridor (I-95/I-395) of Northern Virginia. They take advantage of a rule that allows carpools with four or more persons to use the two uncongested, peak-direction express lanes in the Shirley Highway corridor. Cars with fewer than four persons must use the three or four congested regular lanes, which require about 20 min more travel time to the Pentagon or to downtown Washington, D.C., during the morning peak period. The arrangements made by the drivers and the passengers allow each group to get to work more quickly. (As of January 1989 the requirement for the express lanes has been dropped to three persons per car.) Buses and standard, preorganized carpools and vanpools are the major users of the special express lanes in terms of both vehicles and persons, but the Underground does make up a significant component of the express lane usage.

TRAVEL IN THE SHIRLEY CORRIDOR

The Shirley Highway express lanes and bus routes were implemented in stages from 1970 to 1974. The express lanes and the new bus services were implemented from 1970 to 1973, and in 1974 carpools of four or more persons were allowed on the express lanes. The two barrier-separated reversible express lanes in the median of the freeway were an immediate and resounding success in terms of providing high-quality and high-capacity peak-hour services in the corridor, and the use of the lanes by buses—and after 1974 by carpools—grew rapidly. By 1977, the express lane buses and carpools were carrying 60 percent of the peak-period inbound person-travel in the Shirley corridor, in two of the five or six inbound travel lanes along the various segments of the highway.

Despite some fluctuations and impacts from the opening of Metrorail services, the express lanes have continued to carry about 60 percent or more of peak-period-corridor person-trips—over 30,000 bus and carpool users during the morning peak and about the same number during the evening peak. The counts of persons on the high-occupancy-vehicle (HOV) lanes in 1986 showed over 18,000 persons using the lanes at the Beltway, with most of those in carpools.

Carpools are used more than buses on the Shirley lanes by Fairfax County commuters from outside the Beltway, whereas inside the Beltway there are more bus passengers than carpoolers, likely because of the greater availability of bus services. Data from a 1977 study show that 75 percent of the express lane users from inside the Beltway were on buses,

whereas over 60 percent of those from outside the Beltway were in carpools. The ramp from Old Keene Mill Road in Springfield onto the Shirley express lanes is one of the principal points for Fairfax County carpools, and it is on the approach to that ramp that the Springfield Underground has developed.

There have been no origin/destination studies in the past 10 years, but the cordon counts of vehicles and passengers on the Shirley Highway at the Beltway indicate that the proportion of carpoolers to total HOV-lane users has been rising. A 1986 study by the Metropolitan Washington Council of Governments indicates that about 79 percent of those crossing the Beltway in HOVs during the peak period in 1986 on the Shirley Highway were in carpools or vanpools as opposed to buses. (This figure includes the regular lanes as well as the express lanes to account for the buses and carpools that had not yet switched over to the express lanes at the point they were counted.) Outside the Beltway can be considered to be carpool and vanpool territory.

Continued adjustments in overall bus and carpool use of the Shirley express lanes can be expected, as the populations of Fairfax and Prince William counties grow, as bus services are adjusted by Fairfax County, the Washington Metropolitan Area Transit Authority (WMATA), Prince William County, and private operators, and as travel times on the regular Shirley lanes change. An additional impact on the express lanes may occur in conjunction with the opening of the Franconia-Springfield line of Metrorail in the 1990s, or in conjunction with the initiation of commuter rail services. The impacts on the Springfield ridesharing are likely to be fairly small, however, since carpool costs to most of the users are likely to remain well below the out-of-pocket costs of the newer transit services.

FORMATION OF INSTANT CARPOOLS

After parking, potential carpool passengers walk to the ride-share pick-up points in the driveway of the Springfield Cinema and in the parking lot of the Long John Silver's Restaurant. According to some commuters, the Marriott Corporation owns the property and has allowed the Long John Silver's parking lot to be used as a match point. Those destined to downtown D.C. (20th and K vicinity) line up at the Springfield Cinema driveway, whereas those destined to the Pentagon, Federal Triangle, Capitol Hill, or other points in D.C. form a line or lines in the Long John Silver lot. (Some destined for 20th and K line up at Long John's also.)

When there are potential passengers waiting, drivers pull up to the head of the line, announce their destination, and ask for a number of persons necessary to achieve four persons to fill out their carpool (which could be one, two, or three depending on how many passengers the driver already has). The carpool passengers next in line and with the appropriate destination get into the vehicle, and the vehicle exits onto Old Keene Mill Road (or possibly out the back entrance of the cinema) and heads for the Shirley ramp. Virtually all vehicles leave the lots with four persons, even if they could carry more. When there are no appropriately destined passengers, the drivers (or passengers already in their cars) solicit riders from those walking up to the lot. The most aggressive of the drivers who need passengers leave their cars parked within the Long John Silver's lot and walk to Old Keene Mill Road in order to meet the new arrivals as soon as they cross Old Keene Mill Road. They do not walk into Old Keene Mill Road or distract the potential passengers crossing Old Keene Mill Road, so this is not a safety hazard.

The Underground's matches usually are made rapidly. The waiting times are usually extremely short, although some drivers or passengers destined to the less likely destinations, such as Southwest D.C., may be there for up to 10 min.

When there are passengers waiting for rides, there are orderly lines at both the Long John's and the cinema match points. Drivers at the cinema also form lines if waiting for passengers to the 20th and K area. At the Long John Silver parking lot, cars are spread all over if many drivers are waiting. When there are cars waiting, persons from each car attempt to intercept arriving passengers as they cross Old Keene Mill Road or enter the Long John's lot from behind (from the cinema lot). The most aggressive of the drivers who are waiting may make matches more quickly, but all eventually make matches. In our observations, no passengers waiting for carpools were left stranded, and no cars left the central business district (CBD) lots without their desired complement of four passengers. Of course, cars could simply bypass the lots if there were no passengers waiting, because potential passengers are clearly visible from Old Keene Mill Road.

MAGNITUDE OF SPRINGFIELD UNDERGROUND INSTANT CARPOOLING

Our investigation of the instant carpooling phenomenon in Springfield indicates that approximately 1,700 persons per morning are involved at the Springfield CBD, filling up carpools and vanpools in the parking lots of Long John Silver's Restaurant and of the Springfield Cinema on Old Keene Mill Road. Table 1 shows the counts made of the number of instant carpools formed in the Springfield CBD by time period from 6:00 a.m. to 9:00 a.m., after which there is no further carpool matching at these locations. The table also shows the number of occupants who were already in the vehicles when they arrived at the Long John Silver or Springfield Cinema pick-up points and the number who boarded carpools there.

We also have counted another 900 persons per morning forming instant carpools at the Rolling Valley park-and-ride lot. The Rolling Valley park-and-ride lot is discussed in detail later. Because there are over 14,000 Shirley carpool and vanpool participants crossing the Beltway on Shirley Highway during the peak period (6:30 to 9:30 a.m.) each morning, it is clear that instant carpooling constitutes a minority, but an important element of the overall Shirley Highway carpool and vanpool activity originating from beyond the Beltway.

Table 2 shows counts of the cars parked at the Springfield CBD lots and at the Rolling Valley park-and-ride lot. Based on observations, almost all of the Springfield CBD lot patrons are engaged in the instant carpooling behavior during the morning. At the Rolling Valley lot, 25 persons were counted boarding buses during the morning peak in July 1987 and 553 boarding carpools. At Rolling Valley, 96 percent of the morning parkers are engaged in casual carpooling and 4 percent are taking the bus.

TABLE 1 PERSONS AND VEHICLES ENGAGED IN INSTANT CARPOOLING IN SPRINGFIELD CBD BY TIME PERIOD, JULY 16, 1987

Time Period	Autos	Arriving Occupants	Boarding Occupants	Cumulative Boarding Occupants	Leaving Occupants	Cumulative Leaving Occupants
6:00–6:15 am	11	18	26	26	44	44
6:15–6:30	45	85	100	126	185	229
6:30–6:45	38	70	82	208	152	381
6:45–7:00	46	88	97	305	185	566
7:00–7:15	43	79	93	398	172	738
7:15–7:30	39	75	81	479	156	894
7:30–7:45	42	74	94	573	168	1,062
7:45–8:00	37	63	85	658	148	1,210
8:00–8:15	44	80	96	754	176	1,386
8:15–8:30	30	55	66	820	121	1,507
8:30–8:45	35	55	85	905	140	1,647
8:45–9:00	6	7	17	922	24	1,671
	416	749	922	922	1,671	1,671

Vehicles Parked at 5:45 a.m.

Springfield Plaza	7
UMC	3

One carpool formed before 6:00 a.m. with 2 arriving and 2 boarding occupants.

No carpools formed after 9:00 a.m.

PARKING CAPACITY AND USE

Within the Springfield CBD, potential carpool passengers can park in one of three official lots: the Springfield Cinema lot, where about 150 out of 235 spaces are used by commuters, the United Methodist Church lot, where 75 spaces reportedly are set aside for commuters, or the Springfield Plaza lot, where 105 spaces reportedly are set aside for commuters. This yields a total of 330 spaces in the CBD that reportedly are set aside as authorized spaces for commuters by the respective property owners. However, more than 330 spaces are used within the designated parking areas, because additional vehicles squeeze into both the Springfield Plaza commuter area (up to 138 were counted parked within the commuter area) and the Methodist Church lot (up to 101 have been counted in the church lot).

Persons who buy monthly passes for the Springfield Cinema are allowed to park in the Springfield Cinema lot "for free." All other offical commuter parking is actually free. The 150 (or more) Springfield Cinema lot users arrive regularly throughout the morning (as only those with passes can park there). Table 2 shows counts of 148 and 155 vehicles in the Springfield Cinema lot on 2 days when counts were made.

At the Springfield Plaza lot, 105 spaces are set aside at no charge for commuter parkers on a first-come, first-served basis. These spaces are filled by 6:45 a.m. Nearly 140 cars can park in the designated commuter area on a typical weekday, by making use of the aisles and cross-hatch areas in addition to the striped commuter parking places. Other instant carpoolers also park at the Springfield Plaza lots outside the spaces set aside for commuters. On a typical weekday there may be 150 to 160 additional commuter vehicles parked in other parts of the Springfield Plaza lots, for a total of 290 to 300 vehicles at Springfield Plaza.

The United Methodist Church provides parking for commuter cars in an area that can hold 75 to 85 cars. The designated commuter parking area is closed off when it is full, which occurs at 6:45 a.m. on weekday mornings. The lot is

TABLE 2 VEHICLES COUNTED AT SPRINGFIELD LOTS

Lot	Vehicles	Date(s) Counted
Springfield Plaza		
commuter area	133	11/12/86
	138	05/21/87
street	22	11/12/86
	18	05/21/87
other	156	05/21/87
Springfield Cinema		
legal	148	11/12/86
	155	05/21/87
Springfield United Methodist Church		
lot	101	11/21/86
	92	05/21/87
Spring Road	31	11/12/86
	28	05/21/87
Rolling Valley P & R		
lot, mall, road	459	10/10/86
	492	11/20/86
lot only	349	10/10/86
	342	02/02/87

reopened at 8:30 a.m. and an additional 10 or more vehicles may use the lot for commuter parking, before about 9:00 a.m., when the carpool formation activity ceases in the Springfield CBD. (As can be seen in Table 1, there is little carpool formation activity from 8:45 to 9:00 a.m. and none after 9:00 a.m.)

About 30 additional commuter vehicles are parked on Spring Road adjacent to the church lot on a typical weekday. Others are parked at nearby lots in the Springfield CBD where it is difficult to differentiate commuter parkers from other parkers. Taking the highest counts from Table 2 and adding them yields 603 parked cars, whereas taking the lowest counts yields 575 cars. Because others may be parked elsewhere near the CBD, we estimate that probably about 700 commuter cars are parked in the Springfield CBD area in total on a weekday morning. As Table 1 indicates, there are about 900 persons who board the casual carpools at the Long John Silver and Springfield Cinema pick-up points. The difference between 700 estimated cars and 922 boarding persons counted in Table 1 is because vehicle occupancy is greater than 1.0 for those parking in the Springfield CBD and some boarding carpool occupants arrive by walking or are dropped off.

SAFETY

The persons parking at Springfield Plaza who want to be passengers walk across six lanes of traffic on Old Keene Mill Road to the Long John Silver parking lot or the Springfield Cinema. There are no lights or other traffic control devices at this crossing point, but pedestrians use gaps in traffic created by the nearest lights to cross each direction of Old Keene Mill Road. Pedestrians wait in the center median of Old Keene Mill Road after crossing the three westbound traffic lanes (which is the lighter direction during the morning peak period). Significant waits are sometimes experienced by pedestrians

in the median before it is safe to cross the eastbound lanes (which are heavily traveled because they are the access to the Shirley Highway). When Old Keene Mill is backed up in front of the Long John Silver's lot, pedestrians cross through the backed-up eastbound traffic lanes. This is clearly undesirable from a safety standpoint. It would definitely be preferable if the parking spaces were on the same side of Old Keene Mill Road as the staging area.

EVOLUTION TO CARPOOL DOMINANCE

It has previously been reported that drivers wanting to pick up persons from carpools in the Springfield CBD did so at bus stops. The Springfield instant carpools have now evolved to the point where the staging points are not at bus stops. The passengers soliciting the rides are not close to bus stops and are not choosing between buses and carpools depending on which opportunity arises first. They are lined up waiting for carpools only. A bus stop within easy walking distance is available as a back-up mode, but during observations several mornings at the Springfield CBD, no one was ever seen leaving the carpool staging area to go to a bus stop.

The operations at these carpool pick-up points resemble several giant carpools, with the advantage that no driver or passenger of the carpool has to wait for stragglers or late carpool members if there are enough persons in line waiting for a ride to his or her destination. Users are mostly regulars and are generally familiar with many of the others in the line and with the drivers as well. Many waiting passengers said they had used the instant carpools for years, some citing numbers between 5 and 15 years.

OBSERVATIONS FROM INTERVIEWS OF CARPOOL PASSENGERS

During May of 1987, informal interviews were conducted among the persons waiting for a ride in the Springfield CBD. Not all users could be interviewed, and most interviews could not be completed because carpool passengers would simply enter autos when a ride was being offered and because many passengers were enticed into waiting carpools at the same moment that they stepped onto the lots.

Because of these factors affecting interview opportunities, no percentage breakdowns of responses are considered to be representative of the entire population of Underground passengers, because we have no way of knowing whether those who had to spend a few moments waiting, and could be interviewed, were distributed across destinations or across any other attribute in the same way as those who were intercepted more rapidly by the drivers. However, the responses are considered to be fairly indicative of the general characteristics of the Springfield Underground.

The following questions were asked:

- What is your destination?
- How many days each week do you carpool like this?
- For how long have you been doing this?
- What other modes do you use in the mornings when you do not rideshare here?
- How do you get back here in the evening when you rideshare in the morning?
- Do you ever pay the driver?
- Why do you rideshare here (cost, time, both, or other)?
- Do you know or recognize the other passengers or drivers?

Responses to these questions are discussed in the following paragraphs.

Destinations may not have been reasonably monitored because only those with longer waiting times could be checked. Two-thirds or more of the passengers were destined to somewhere in the Washington CBD (especially the Federal Triangle employment area between Pennsylvania and Constitution avenues, and the "private office" downtown centered on 20th and K), with the remaining one-third going to the Pentagon. As might be expected, no one was attempting to rideshare to destinations other than these, which are the ones most directly served by the express lanes.

Virtually all respondents used the rideshare area 5 days per week. Some worked only 4 days. The respondents' estimates of how long they used the CBD rideshare operation ranged from 1 week up to 15 years (the express lanes were opened to carpools in 1974). About two-thirds said they would be getting back via carpool (similar carpools form during the afternoon peak at the Pentagon and at 14th Street and Constitution Avenue in D.C.) and one-third via bus or subway and bus. Some of the passengers said that they used to be drivers but had switched to being passengers.

None of the passengers indicated that fares had ever been exchanged, and none are ever expected in this operation. It is interesting to note that in Marin County and San Francisco, an attempt was made to establish such informal carpooling in 1979 and 1980, but that even with a (nominal) fare being suggested by the carpool organizing agency, fares were hardly ever collected because drivers were too embarrassed to ask, or as in Springfield, did not need the fare to be able to afford the trip.

Most of the Springfield CBD passengers indicate some general familiarity with the other passengers or drivers, because they all had been traveling in the same manner at the same time of day for a long period of time. Some waiting drivers indicated that they had regular carpools but that one or two members were absent that morning. The cars entering the lots to pick up passengers had from one to three occupants. Quite a few men or women drivers alone were stopping to pick up three passengers, indicating the high degree of trust that people had in this arrangement.

METROBUS USE

There apparently has been an evolutionary decline in the role of Metrobus compared to carpooling from the Springfield CBD area. In 1974, 330 commuter vehicles parked at Springfield Plaza were counted (*1*), of which 235 were attributed to bus riders and 95 to carpool users. The balance has shifted strongly to carpools since that period, and we estimate that virtually all those who park during the morning in the Springfield CBD are carpooling.

Metrobus operations have been adjusted over time to the differences in the morning versus evening bus commuter

demands related to the relatively greater use of the ridesharing in Springfield during the morning. On the primary lines serving Springfield there are 36 morning-peak-period bus trips arriving at the Pentagon from 6:00 to 9:30 a.m., and 46 evening-peak-period bus trips departing the Pentagon between 3:45 and 7:00 p.m. (There are no direct bus routes along the Shirley corridor into downtown Washington. Commuters working downtown must transfer to or from Metrorail.)

Therefore, there are 10 more peak buses in the evening than in the morning, which at 40 passengers per bus, on average, translates into 400 passenger trips already accounted for in the current Metrobus schedules as the difference between expected morning and expected evening ridership. Because Metrobus and Fairfax County (which pays the Metrobus subsidy) are avoiding substantial costs associated with the morning services, the Springfield instant carpools result in a cost savings to WMATA and the county.

Table 3 shows morning and evening ridership counts on the Metrobus Number 18 lines, as compiled by Fairfax County staff during the winter of 1987. As can be seen, there are probably at least 600 more bus users during the evening peak than during the morning peak on the principal routes serving the Springfield CBD and the Rolling Valley lot. (The morning counts on March 27, a Friday, seem unrepresentatively low when compared to the other counts taken by Fairfax County.) The 10 fewer trips operated during the morning compared to the evening are indicative that the service levels have been reasonably tailored to ridership.

ROLLING VALLEY PARK-AND-RIDE LOT USE

At the Rolling Valley lot, there are 340 spaces in a Virginia Department of Transportation facility that was specifically constructed for commuter parking. Use of the lot and of spaces in the adjacent mall lot and along Shiplett Boulevard totals about 500 cars on a typical weekday.

Counts by Fairfax County in late 1986 and early 1987, shown in Table 3, indicate 42 to 111 persons boarding buses at the Rolling Valley lot in the morning but considerably more persons, 276 to 306, getting off the buses at the Rolling Valley lot in the evening. As shown in Table 4, counts of bus passengers made by project staff in conjunction with counts of carpool passengers on July 22, 1987, indicated 25 morning peak bus passengers boarding at the stop within the Rolling Valley facility. (Total bus passengers were not counted on July 22, 1987.)

Table 4 shows the use of the Rolling Valley lot by casual carpoolers. The carpool behavior at the Springfield CBD is virtually replicated at the Rolling Valley lot, with the exceptions being that the Rolling Valley lot handles about one half as many persons and that it starts and ends somewhat earlier than the Springfield CBD. This early start and end can be expected based on the added distance to the Shirley Express lanes (about 5 mi) for Rolling Valley versus the CBD lots.

EVALUATION

The Springfield Underground is an unusual type of travel behavior for U.S. commuters. (To our knowledge, the only other area where similar activity takes place on a large scale is in the East Bay section of the San Francisco area.) It goes against the general tendency to avoid inviting strangers into one's private home or vehicle. Those who have engaged in this instant carpooling over many years are convinced that in this very particular travel market it is reasonably free of risk.

The operation of the Springfield Underground is a positive phenomenon to which levels of transit services have been adjusted. Users save time, and some users (the passengers) also save money compared to any alternate modes. The public agencies, Fairfax County and WMATA, save bus operating costs and subsidies. Congestion on the regular Shirley Highway lanes and other roads is lower in comparison to what might occur in the absence of the phenomenon. The Springfield instant carpooling should be allowed to continue and should be replicated where possible. It could be replicated, however, only in places where significant travel-time savings are possible and where a sufficient size lot could be located so that matches could be made quickly, as in the Springfield CBD and at the Rolling Valley lot.

Demand for parking spaces at the Springfield CBD and the Rolling Valley park-and-ride has been estimated using approximately the same methodology as has been applied to Metrorail stations to estimate the existing demand for added parking spaces. This methodology is based on a comparison of the accumulation rates of passengers boarding carpools at the two sites and the kiss-and-ride accumulation rates at the Huntington Metrorail station.

The analysis results in an estimate of current use of about 593 spaces in the Springfield CBD and a demand for about 751 if the spaces were clearly marked as authorized. For Rolling Valley, we estimate a total demand of 631 spaces, implying that 290 more authorized spaces could be used there.

Spaces to serve Rolling Valley users could be located in the Springfield CBD, because the Rolling Valley users pass by the Springfield CBD anyway. However, significant amounts of vehicle-miles of travel will be saved by locating spaces at Rolling Valley consistent with the demand for spaces there.

REPLICABILITY OF INSTANT CARPOOLING

Replication of this instant carpooling behavior is unlikely elsewhere unless some specific conditions are met. There are several aspects that will render this difficult.

First, the phenomenon is not reproducible on a small scale. The benefits to both the drivers and the passengers depend on having a sufficient market of users such that waiting times to form each carpool will be short. This will be impossible at usage levels much below what exists in the Springfield CBD or at the Rolling Valley lot today. At least 500 persons wanting to have rides from a general area would appear necessary, although it appears that the service will be more frequent if the demand is similar to that at Rolling Valley—near 1,000 if spaces were unconstrained. (In San Francisco's East Bay area, instant carpools form at many locations, chiefly bus stops, with a small number of commuters at most locations. However, commuters at low-demand sites may be choosing between buses and carpools, depending on which arrives first, and over time there has been a tendency toward concentration at fewer locations, chiefly those most convenient to freeways.)

TABLE 3 METROBUS LINE NUMBER 18 COUNTS

Route	Count Location	Morning Date	Trips	Passengers	Evening Date	Trips	Passengers
18D	a	2/25	5	107	3/24	5	100
18E	a	2/26	8	208	3/25	8	260
18G	b	2/13	9	270	2/10	14	439
18G	b	3/27	11	207	3/31	14	565
18P,R	b	2/13	13	417	2/10	17	682
18P,R	b	3/27	13	289	3/31	17	767
18H,K	b	2/13	12	333	2/10	13	501
18H,K	b	3/27	12	212	3/31	14	674
Subtotals	b						
		2/13	34	1,020	2/10	44	1,622
		3/27	36	708	3/31	45	2,006
18P,R	c	10/10	13	On 42	1/05	18	Off 276
				Leave 209			Leave 37
18P,R	c	12/18	13	On 51	2/02	16	Off 306
				Leave 237			Leave 315
18P,R	c	1/09	13	On 56			
				Leave 270			
	c	2/02	13	On 111			
				Leave 338			

[a] Edsall Road at Shirley Highway

[b] Old Keene Mill Road at Spring

[c] Rolling Valley Park-and-Ride

Note: Dates listed are in the last quarter of 1986 or the first quarter of 1987.

Source: Fairfax County counts.

TABLE 4 PERSONS AND VEHICLES ENGAGED IN INSTANT CARPOOLING AT ROLLING VALLEY PARK-AND-RIDE BY TIME PERIOD, JULY 22, 1987

Time Period	Autos	Arriving Occupants	Boarding Occupants	Cumulative Boarding Occupants	Leaving Occupants	Cumulative Leaving Occupants
6:00-6:15 am	17	25	44	22	69	69
6:15-6:30	31	48	76	120	124	193
6:30-6:45	34	52	84	204	136	329
6:45-7:00	34	44	92	296	136	465
7:00-7:15	33	51	81	377	132	597
7:15-7:30	12	18	30	407	48	645
7:30-7:45	26	42	62	469	104	749
7:45-8:00	19	27	49	518	76	825
8:00-8:15	11	15	29	547	44	869
8:15-8:30	2	2	6	553	8	877
8:30-8:45	0	0	0	553	0	877
8:45-9:00	0	0	0	553	0	877
	219	324	553	553	877	877

Note: 27 cars were parked by 5:50 a.m. Before 6:00 two carpools exited with eight occupants, comprised of four arriving occupants and four boarding occupants.

Bus boardings: 25 from 6:00 a.m. to 8:45 a.m.

Second, travel-time benefits must be available to nearly the same degree as in the Springfield commute to the Pentagon or D.C.—at least 15 to 20 min. This will require creation of similar incentives as are found in the Shirley corridor in terms of relative travel time for carpools versus no carpools.

Third, the afternoon trip back requires high-quality, high-frequency bus services or a location for forming carpools for the outward commute, or both. It may be necessary to concentrate bus routes to pass a particular point where carpool formation could occur.

Fourth, and as important as the rest, the development of this behavior is evolutionary over time. Instant carpools appear to have originated at bus stops (where a back-up mode is readily available if no ride is obtained). As instant carpooling became more popular and more reliable, it has become increasingly separated from bus operations. A further development has been the increasing use of instant carpools for the return trip in the afternoon. This kind of gradual evolution may be necessary to overcome commuters' reluctance to rely on such an unusual mode.

An important reason for this reluctance is the psychological resistance to offering or accepting rides with strangers. Instant carpooling has a number of characteristics that differentiate it sufficiently from hitchhiking to help overcome this resistance. It involves riding with three strangers instead of one, and some of those strangers may be persons that riders have already observed standing in line. Of course, HOV requirements vary from city to city. (In the San Francisco area, only three persons are required to be designated as a carpool.) A requirement of only two persons per vehicle to use the HOV lanes would undoubtedly result in a much higher level of psychological resistance to instant carpooling.

Another characteristic of instant carpooling that decreases the psychological resistance is that no one is forced to accept a ride. In fact, conversations with riders indicate that some occasionally do turn down rides if the driver's appearance makes them uneasy. However, trust in the safety of instant carpooling evolves with time, partly because of the familiarity of the experience and partly because of the recognition of familiar faces and vehicles over time. A final factor in reducing

resistance to riding with strangers is the appearance of the instant carpool users: they are for the most part well dressed and well groomed, reflecting the fact that they are overwhelmingly white-collar professionals and clerical workers.

There has been great interest in the kind of carpooling carried out in Springfield, as exemplified by a major study by Cambridge Systematics for UMTA in 1977, "Feasibility Study of Shared Ride Auto Transit" (*2*). However, that study contemplated an exchange of money for providing rides to passengers. Only the achievement of mutually beneficial time savings has been a substantial incentive for the drivers of shared-ride vehicles in the Springfield area.

As mentioned earlier, Marin County and San Francisco experimented briefly with an organized form of ridesharing in 1979 and 1980. Persons were registered and issued an ID, which showed that they belonged to the "Commuter Connection." Passengers and drivers tried to make matches at many points to combine for rides across the Golden Gate Bridge to San Francisco. The benefit to the driver was the use of an express carpool lane (but of only 3.7 mi) and avoidance of a $1 toll. For at least part of the experiment, fares were suggested but, as mentioned, were rarely collected.

The Marin/San Francisco experiment was dropped after disappointing use. The major flaws, not all of which were noted in an evaluation conducted for UMTA (*3*), were that too many points were identified for matches, travel-time incentives were not great enough for the drivers, and strong efforts to combine the match points with commuter park-and-ride lots and bus services were not made. Instead the project's emphasis was on marketing and promotion efforts. Thus, in the Marin County demonstration, the Springfield Underground's major keys to success (concentration, travel-time advantage, park-and-ride lots, and good bus frequency) were not emulated, and the efforts were placed instead on a marketing aspect, which has never been necessary for the success of the Springfield Underground.

RECOMMENDATIONS FOR SPRINGFIELD

Given the experience of the Springfield Underground, what can Fairfax County or other public or private entities do to protect, enhance, or strengthen the success so far at the Springfield CBD and Rolling Valley lot? Also, what can be done elsewhere in Fairfax County or in other jurisdictions to encourage similar ridesharing choices by commuters?

The first need is to protect the Springfield Underground from the potentiality that private property owners may someday refuse to allow their properties to be used for the staging or parking areas. Consequent impacts on Shirley Highway traffic and on bus subsidy costs would be large. Protection requires some degree of public control of the staging and parking areas—either through outright ownership or through a long-term contractual relationship with the relevant property owners. This could involve both the existing lots in the CBD, or new facilities.

Parking capacity and unauthorized parking are the other two key issues currently at the Springfield CBD and Rolling Valley lot. Half of those who park at Springfield Plaza are outside the designated commuter parking area, and more commuters are parked in other nearby unauthorized lots in the Springfield CBD area. About one-third of the parkers at the Rolling Valley lot are outside the commuter lot, parked along the adjacent streets or in the shopping center lots. Although many have shown themselves to be undeterred from parking if the authorized spaces are full, it is also likely that many others do not park because there are not enough authorized spaces. The expansion of authorized parking would resolve any potential conflicts and serve to attract additional users.

Expansion at the Springfield CBD can be accomplished through either public or private actions. Public actions could include an outlay of public funds either to buy new properties and construct new spaces or to buy or rent existing spaces. Private actions also could be taken to allow more commuter parking in return for better proof that the commuters are patronizing the facilities, such as the Springfield Cinema requirement of a purchase of a monthly pass to allow commuter parking. Other merchants or combinations thereof could sell gift certificates that included stickers allowing commuter parking for a month (or 2 or 3) in additional designated spaces. This would expand the authorized supply of parking and ensure that the merchant was helping mostly his patrons. However, all private solutions may be revocable in the short term as well as the long term. In addition, a new Springfield CBD match point, one actually designed for parking and for persons to line up and wait (as at Rolling Valley), would improve the safety of those using the facility. For these reasons, we recommended to Fairfax County that a new facility close to the Springfield CBD be developed under public ownership.

RECOMMENDATIONS FOR OTHER PLACES IN FAIRFAX COUNTY

The conditions for success of the instant carpools that have evolved at Springfield are stringent, and some would be expensive to satisfy elsewhere. The most restrictive is the existence of incentives for commuters to park and share rides, because those incentives should include travel-time benefits for the drivers. In Fairfax County, the I-66 and related Dulles corridors offer the principal other opportunities for instant carpools. These opportunities would be strengthened if the carpool restrictions on I-66 were extended to the west and if carpools were allowed on the Dulles Toll Road. For I-66, the Fair Oaks Mall area, Greenbriar, or other areas adjacent to or leading directly to an I-66 ramp would be candidate locations for a park-and-ride facility that would be served by high-quality, high-frequency bus service during peak hours and where carpool formation could be built up over time (leading, perhaps to an eventual reduction in bus service as demand falls).

Another candidate location in Fairfax County is in Reston, which has excellent access to the I-66 HOV lanes and where ridesharing has traditionally been extensive. Springfield-type instant carpooling has not yet emerged at the current Reston commuter lot. The lot is too small (240 spaces) and currently is used half for buses and half for organized carpools. It would be reasonable to expect instant carpooling to emerge at a larger facility in Reston. Fairfax County should place high priority on implementing such a facility and on working to allow carpools using this facility onto the Dulles Toll Road.

RECOMMENDATIONS FOR OTHER AREAS OF THE COUNTRY

Bus and regular carpool and vanpool travel can be expected to predominate on any HOV facility, with instant carpooling only one element in overall ridesharing from any area. However, to the extent that the instant carpooling can be encouraged, its expansion can enhance the operation of HOV facilities and bring additional travel-time and cost savings to both users and nonusers of the HOV facility.

For other corridors or urban areas, the construction of an HOV lane or facility is the primary expense in making it possible to build up a ridesharing operation such as occurs in Springfield. Such additional facilities are not planned in Fairfax County outside of the current Shirley and I-66 corridors. In other areas of the country where HOV lanes already exist or are planned, there may be good opportunities for actions to encourage instant carpooling behavior.

Institutional barriers may occur in other urban areas. Replicating the Springfield experience will require enlightened policies on the part of the transit operator or the agency that controls the operator's schedules. The transit service must help to build up ridership that can eventually be taken over by instant carpools. Many transit operators may see this as a threat to their own performance objectives. This institutional problem does not arise in Fairfax County, because the county controls the level of bus services or provides the bus services itself.

Encouraging instant carpooling is potentially cost-effective when HOV facilities exist. It will, however, require close integration with bus service decisions, and it will take time for instant carpools to evolve. Noting these caveats, planners and decision makers should consider encouraging instant carpooling as a means to enhancing the overall effectiveness of a park-and-ride and HOV-lane program.

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The authors gratefully acknowledge the advice and comments of Andy Szakos of the Fairfax County, Virginia, Office of Transportation, who provided exceptionally helpful guidance throughout the course of the research reported here and whose high professionalism also provides a model toward which all associated with him aspire. Robert Lepore and Lynn Burgin of Cambridge Systematics provided helpful comments on earlier versions of this paper, a draft of which was written as part of a study of commuter park-and-ride needs conducted by Cambridge Systematics for Fairfax County. The Urban Mass Transportation Administration sponsored this research.

REFERENCES

1. J. McQueen and G. Miller. *The Shirley Highway Express Bus on Freeway Demonstration Project: A Study of Park-and-Riding*. National Bureau of Standards, Gaithersburg, Md., March 1975.
2. G. Kocur, D. Zaelke, and L. Neumann. *Feasibility Study of Shared Ride Auto Transit*. Report IT-06-014407701. Cambridge Systematics, Inc.; UMTA, U.S. Department of Transportation, Sept. 1977.
3. Crain and Associates. *Commuter Connection: Flexible Ridesharing in Marin County, California*. Report CA-06-0128-81-1. UMTA, U.S. Department of Transportation, Dec. 1981.

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George Washington Bridge Bus-Carpool Lane: 1-Year Operational Report

JOHN C. POWERS

A reserved lane has operated on the New Jersey approaches to the George Washington Bridge providing a time savings for buses and carpools in the peak a.m. commuter hours since October 1986. In addition to Interstate 95, the bridge provides access to Manhattan for much of northeastern New Jersey for six other major routes all of which converge within a mile of the bridge. This report reviews operational data for the first 12 months of the operation. Included are carpool, bus, and violator trends and enforcement activities. Also presented are long-term trends, a review of the potential for further preferential treatments, and some observations pertinent to measuring operational "success." The following conclusions have been reached. The reserved lane has achieved its operating goals. The presence of the bus-carpool lane has had a favorable effect on carpool formation. Continued daily presence of Port Authority of New York and New Jersey (PANYNJ) police should be adequate for effective enforcement. The eligibility of motorcycles for reserved lane use is not well understood. Added promotional efforts by the PANYNJ are in order. Operational data contained in this report should be used to review the possibility of opening a local-access toll booth for carpools only.

A feasibility study was undertaken in 1975 to identify opportunities in the I-80/95 corridor for instituting bus-carpool lanes (BCPLs). The study had the objective of identifying locations for lanes that had the capability of "increasing the person-moving capacity of existing highways" (*1*).

Reserving lanes on I-80 and 95 was a major focus of the study. Although this was found to be not feasible, the study recognized that improving the "bus only" reserved lane at the George Washington Bridge (GWB) was appropriate. A time savings of up to 10 min for buses and carpools (vehicles with three or more persons) was identified. In addition, this lane could operate without affecting nonusers because the reserved lane would use the shoulder where the road is narrowest. Design of the project was initiated in 1979, and construction began in 1985.

The GWB serves as a major link between northeastern New Jersey and Manhattan. In addition to local street access, five separate roadways come together on the bridge's New Jersey approaches. As shown in Figure 1, these roads provide access for a considerable number of vehicles traveling on I-80 and 95; US-1, 9, and 46; US-9W; NJ-4; and the Palisades Interstate Parkway (PIP).

Bureau of Transportation Systems Research, Division of Research and Demonstrations, New Jersey Department of Transportation, 1035 Parkway Avenue, Trenton, N.J. 08625.

Three separate toll plazas funnel traffic to the bridge's seven eastbound lanes, four of which are on the bridge's upper level and three of which are on the lower level. Westbound lanes are similar although no tolls are collected in keeping with the policy for all Hudson River crossings run by the Port Authority of New York and New Jersey (PANYNJ).

I-95 forms the central focus of the eastbound Bridge approaches and is the primary route for the reserved lane of Figure 2. Termed a bus-carpool lane to distinguish it from its predecessor, the reserved lane was inaugurated in October of 1986. Lane-use restrictions exist from 7 to 9 a.m. on weekdays to provide a path for buses and cars with three or more persons to bypass the congestion generated by the confluence of 23,000 peak-period commuters at the upper- and lower-toll plazas. This congestion typically extends to the intersection of NJ-4, a mile to the west. As constructed, the reserved lane allows users to save up to 8 min each.

Access to the lane is relatively simple because the lane has no entrances per se. Standard lane striping separates it from adjacent concurrent flow lanes. The reserved aspect of the lane is emphasized by standard high-occupancy-vehicle (HOV) lane diamond symbols (◇), which are repeated on all signing.

Cars and buses must have access to the I-95 express or local roadway at or before the NJ-4 ramps to take advantage of the reserved lane. As a result, carpools on US-1 and 9, as well as US-46, are unable to use the lane without a route change. Because the PIP accesses the upper level of the bridge at a point downstream of the I-95 toll plaza, PIP carpools are also unable to use the reserved lane without a route change. Signs are standard as shown by Figure 3.

OPERATIONAL HOURS

Data were collected throughout the a.m. peak period on a regular basis during the first year of operation. Observers sampled car occupants, vehicle use of the reserved lane, and total car and bus volume at the three toll plazas. Supplementary counts were made on several occasions to determine motorcycle use of the lane and to identify the commuter bus portion of the total bus volumes. Data were collected in each month except February and August when the weather interfered.

Some 26,000 cars, 3,000 trucks, and 180 buses cross the bridge between the hours of 6:30 and 9:30 a.m. on a typical weekday morning. Figure 4 illustrates how volumes and delays

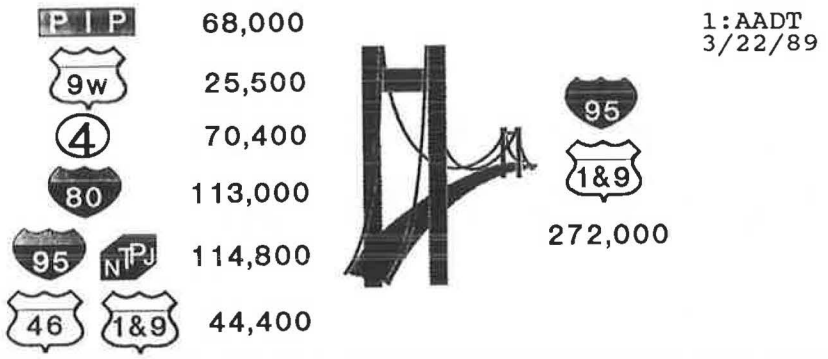

FIGURE 1 New Jersey approach roads' average annual daily traffic.

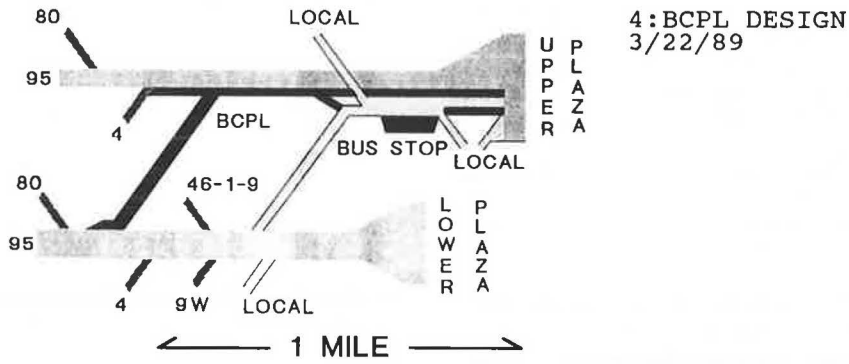

FIGURE 2 BCPL location.

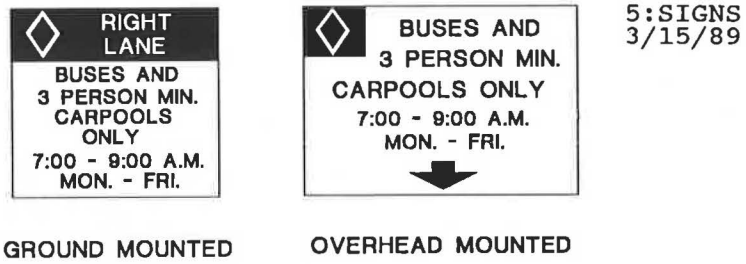

FIGURE 3 Typical signs.

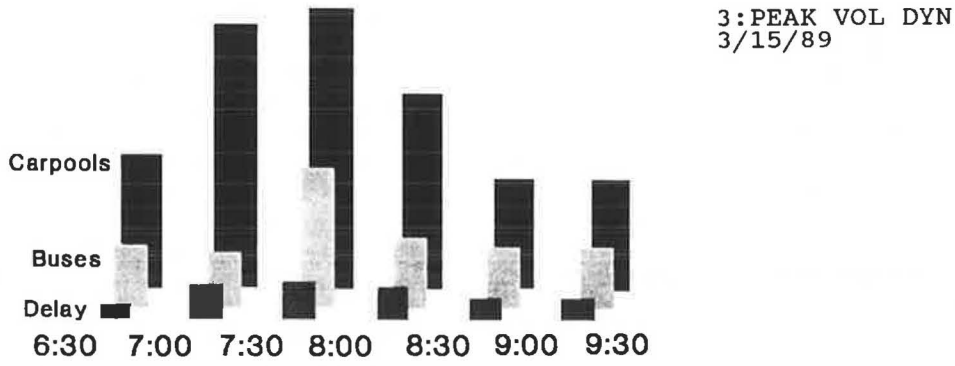

FIGURE 4 Peak-period characteristics.

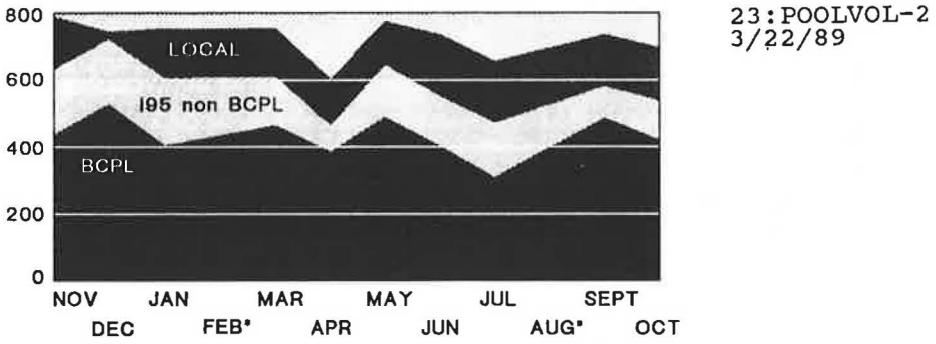

FIGURE 5 7 to 9 a.m. carpools.

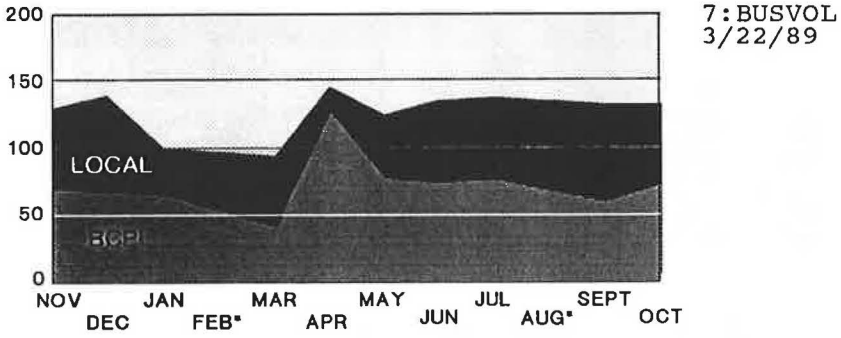

FIGURE 6 7 to 9 a.m. buses. (NOTE: Data not collected in February and August because of bad weather.)

vary within this time frame. The concurrent peaking nature of the carpools, buses, and delay (a function of all traffic) led to the choice of reserving the lane from 7 to 9 a.m.

FIRST YEAR SUMMARIES

Figure 5 illustrates how carpool volumes varied from month to month. On average, 730 carpools were present. About 580 used the I-95 approaches of which about 430 used the BCPL. Access via the local street system accounted for about 150 carpools.

Figure 6 illustrates in a similar fashion the bus data. An average of 70 I-95 buses used the BCPL. I-95 non-BCPL buses were virtually zero. The additional 50 buses arriving via the local street system bring the total to 120, on average.

The totals for all buses show considerable variability from month to month despite rather stable commuter bus schedules. For example, bus totals for all approaches combined were as low as 89 in March and as high as 140 in April. Calls to New Jersey Transit confirmed that few variations occur day to day in the operation of the commuter lines serving the bridge and the bus terminal in New York.

On-site counts revealed that only about 57 percent of buses observed using the lane were commuter buses, however, and the remainder of the buses serve a variety of purposes, such as school trips and charters. Noncommuter buses also show up on the PIP averaging 18 in June and July. Since no prequalification of drivers is required for BCPL use and the lane is quite accessible, all buses on I-95 tend to use the reserved lane. Commuter buses, the most stable portion of the daily peak period, average about 40 and the I-95 volume ranged from about 60 to more than 80.

BCPL Use

Use of the BCPL during a typical weekday is illustrated in Figure 7. Carpool presence is heaviest between 7 and 8 a.m. when about three-fourths of the 2-hr total arrive. Violators have distinctly different arrival habits being concentrated in the first and last 15 min of operation when they sense that police will be less likely to issue summonses. This effect is apparently typical of reserved lanes invoked for limited hours. During the core 1.5-hr period, violations occur at a rate of about 100 per hour and account for about 30 percent of lane use. In the other 30 min, the rate is about 360 per hour, a substantial amount since it is 20 percent of lane capacity. It is also about 70 percent of lane use. As a result, total violations average 330 and are more than 40 percent of lane use.

Despite a fully functional lane throughout the 7 to 9 a.m. peak period, the percent of the carpools that use the reserved lane is quite dynamic, as shown in Figure 8. Use typically approaches 80 percent of I-95 carpools at the main and lower plazas during the first ½ hr of the lane's operation and runs above the peak period average of 65 percent for the entire first hour.

Figure 8 also illustrates the range of delay commonly encountered during the peak period. The right vertical axis indicates the scale for minutes of delay, which equates to time

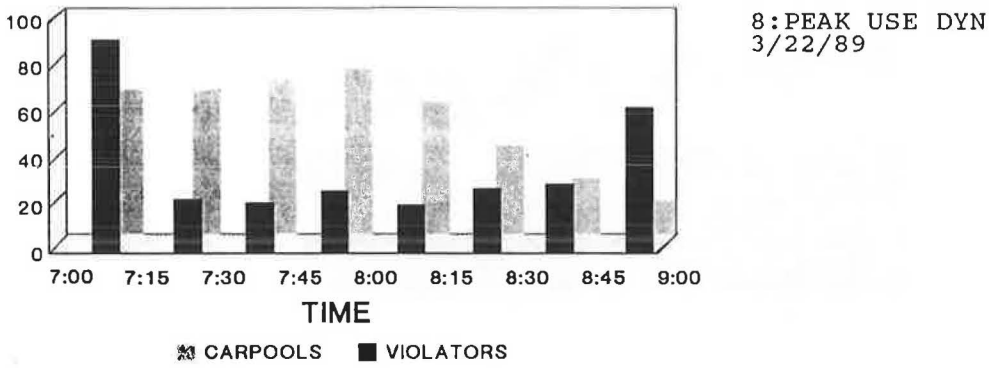

FIGURE 7 BCPL users.

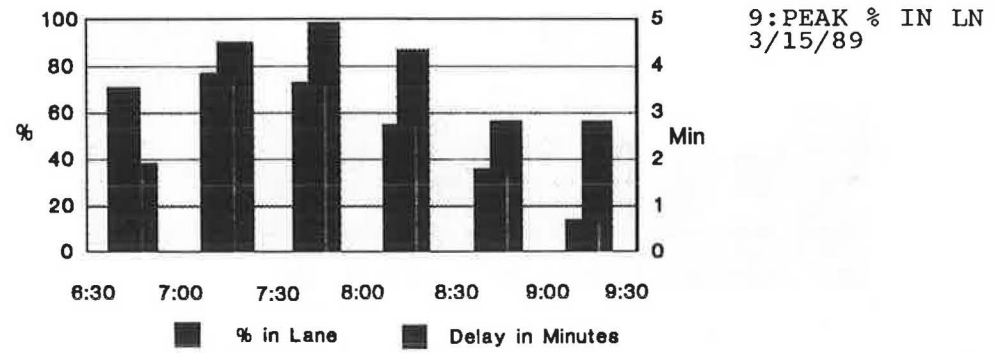

FIGURE 8 Use and delay.

savings available to reserved lane users. The range of delay is drawn from data taken during the 4 years preceding the lane's initiation and emphasizes the choice of 7 to 9 a.m. as a minimum operational period. As can be seen, carpool use of the reserved lane follows the variations in the delay. Although lane users decline after 8 a.m., the 8 to 9 a.m. totals remain substantial at a time when delays are still significant.

Despite the fair amount of carpools present before 7 a.m., congestion is not great. Also, carpool totals fall off greatly after 9 a.m. For these reasons, 7 to 9 a.m. is clearly a proper operational period. Although not shown, bus use is also greatest in the 7 to 9 a.m. period. Should congestion increase before 7 a.m., some reconsideration could be given to opening the lane earlier.

Enforcement

The rates of violation, previously presented on Figure 7, have been roughly stable at about 30 percent throughout the first year during the core 1.5 hr. Despite occupying as much as 20 percent of lane capacity, violators have not interfered with the viability of the lane because the peak rate of lane users (400 to 500 vehicles per hour) is well below the capacity of the lane.

Whether continued disregard for lane rules will escalate violations to the point where they inhibit operations is a concern. Because large increases in carpool use of the lane are not expected, maintaining violations at or near the current levels should be adequate to ensure continued proper operation of the lane.

Summonses by the Port Authority police on selected days during the first year, summarized in Figure 9, were reviewed to get an idea of what level of continued enforcement may be appropriate. As is often the case, heavier summonses in the early months of the lane's operation have been followed by gradual reductions, despite virtually daily presence of personnel throughout the first year. The implication from the experience with enforcement during the first year is that violations are manageable in the 100-to-200-per-day range, and continuing regular presence of enforcement personnel will be more important than the actual level of summons activity.

Peak-Period Summaries

Table 1 shows a summary of the first year data. To support long-term trend analysis, 4 months of the year have been chosen to represent the "summer" season and 4 additional months represent "winter." November through February are termed "winter" because they were found to best represent the lowest carpooling months, and April through July are termed "summer" because they best represent the highest carpooling months. Data taken on freeways in other states show similar trends.

The total number of carpools on all approaches now varies from 1,000 to about 1,100, including the 300 or so carpools using the PIP. Table 1 also shows the BCPL percentage of I-95, an important factor in our evaluation of the BCPL operation. Selection of this and other measures of effectiveness is described in more detail in the next section.

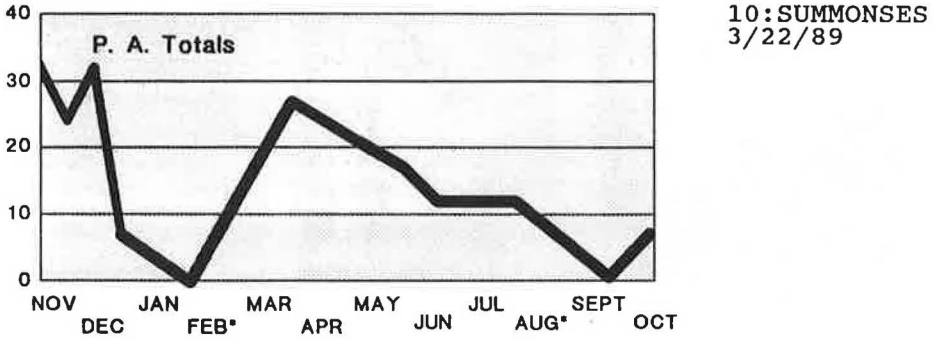

FIGURE 9 Summonses by Port Authority police. (NOTE: Data not collected in February and August because of bad weather.)

TABLE 1 7:00 TO 9:00 A.M. PEAK-PERIOD AVERAGE VOLUMES

	11/86 to 1/87[a]		4/87 to 7/87	
Location	Carpools	Buses	Carpools	Buses
Bridge Totals				
PIP plaza	337	2	320	14
I-95 plaza	765	120	745	132
Total	1,102	122	1,065	146
I-95 Plazas				
Upper via I-95	424	67	363	87
Upper via local	111	53	214	44
Lower	230	1	168	1
BCPL percentage of I-95 plazas				
Excluding local	65	99	68	99
Including local	59	56	57	66

[a]Although February is included in winter months, data were not available for this study.

MEASURES OF EFFECTIVENESS

In order to measure the effectiveness of the BCPL, the data were analyzed for several aspects of BCPL use.

Capture

Figures 10 and 11 illustrate how well the BCPL was able to "capture" its intended users. Buses and carpools at the main plazas fall into three groups: those on I-95 in the BCPL, those on I-95 out of the BCPL, and those arriving via the local streets.

Figure 10 shows how the carpools fall into each of the three groups in each month observed. On average, about 35 percent of the carpools did not use the BCPL. This group was fairly stable. The fluctuation in December is interesting as many local carpools appeared to have experimented with route diversions to gain access to the BCPL. Preopening analyses suggesting that the time savings would not support such diversions and the return to November-like splits are considered to confirm this effect. Preopening estimates also placed the I-95 nonuser portion at about 15 percent, close to the amount observed in most months. The substantial amount of pools that cannot use the lane (including PIP pools, which formed the control group) has been cause for a review of other opportunities to provide preferential pool treatment. The results of this review are discussed in following paragraphs.

Figure 11 similarly shows the percentage of buses. The portion of I-95 buses that did not use the BCPL is virtually zero. The volatility of bus trends, previously discussed in detail, is visible here as well. Unlike carpools, provision has been made for buses arriving via the local streets to access a preferential booth. Because of this advantage, further bus preferential opportunities appear unnecessary.

People Versus Vehicles

Figure 12 recaps how carpool and bus preferential treatments (including the BCPL and the preferential toll booths) pay off in terms of passenger use instead of vehicle use. The fact that 32.5 percent (some 7,500 people) receive a time savings although occupying only 4.5 percent of the vehicles (550) is primarily a function of the number of buses present. However, the carpool contribution is significant and represents an important reinforcement for existing carpooling behavior. At the same time, there is virtually no negative impact on nonusers because the lane operates primarily on the shoulder and the PANYNJ manages flows to the booths so that they do not go unused if there is a gap in BCPL arrivals.

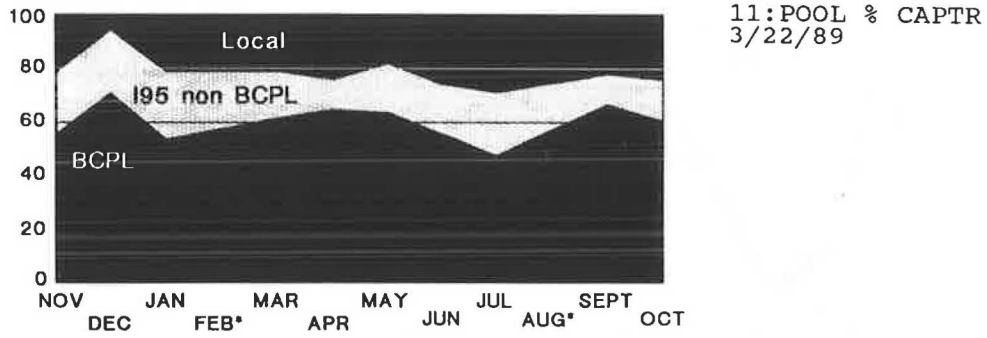

FIGURE 10 Carpool capture. (NOTE: Data not collected in February and August because of bad weather.)

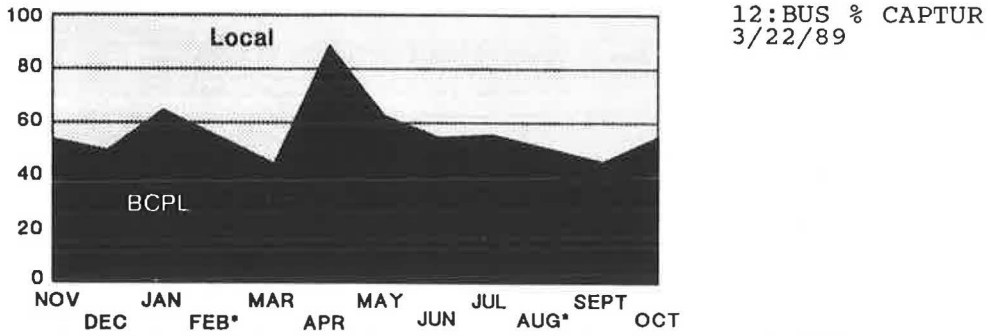

FIGURE 11 Bus capture. (NOTE: Data not collected in February and August because of bad weather.)

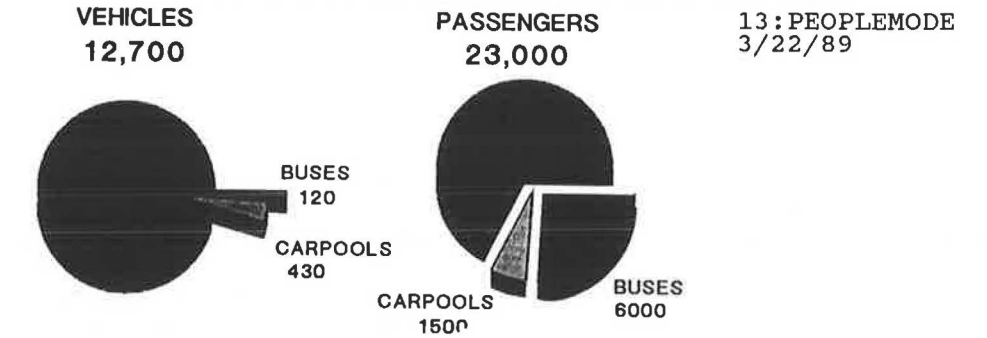

FIGURE 12 Preferential treatment payoffs in terms of passenger use versus vehicle use.

Trends Analysis

A trend analysis was performed to better understand the results and to form an opinion as to the success of the BCPL. Previous experiences, both in New Jersey and elsewhere, aided the design of the data collection and this analysis. The percentage of cars that are carpools, referred to as the "% 3+," is the primary tool for this analysis.

Banfield

Figure 13 illustrates data for the BCPL instituted on I-80 in Banfield, Oregon (*2*). Like the GWB, the minimum occupancy requirement of this reserved lane is three or more people per vehicle. It is of particular interest because data were collected throughout the first year as well as a full subsequent year. A comparison of the 2 years shows the danger of limiting analysis to the first year of operation. The follow-up data, taken 3 years later, not only give an entirely different perspective on carpooling trends, they also suggest that carpooling is subject to seasonal variation.

Garden State Parkway

Figure 14 illustrates the use of control-site observations to filter background trends such as seasonality. The information

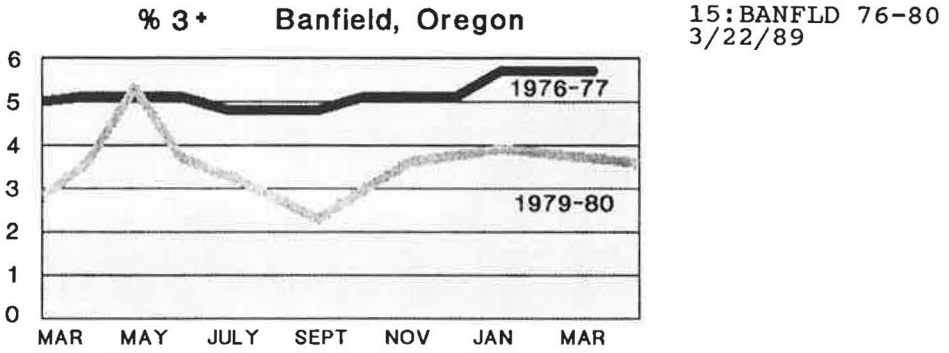

FIGURE 13 Percent 3+, Banfield, Oregon.

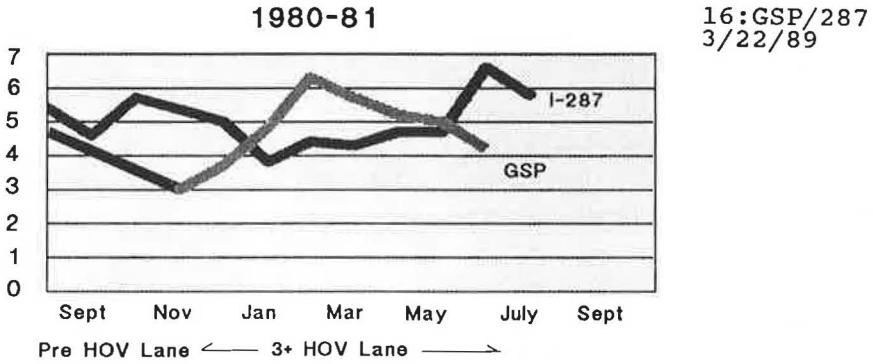

FIGURE 14 Percent 3+, Garden State Parkway.

is taken from the analysis of the now defunct Garden State Parkway (GSP) HOV lane, reported previously in *Transportation Research Record 906* (*3*). For that analysis, data were collected simultaneously at a nearby but independent section of I-287 before as well as during the HOV lane's operation. In this way, increases during the first 3 months, typical of new HOV lanes, could be clearly attributed to the HOV lane's presence. Similarly well accentuated is the dramatic dropoff that occurred in the next 3 months.

The conclusion that, in the short term, the lane was not functioning as well as desired could have been reached without the concurrent monitoring of I-287. However, the availability of the control-site data left no room for doubt. Certainly such confidence in the analysis should be present when making major decisions such as reducing the minimum eligibility requirement as was done in the case of the GSP. Note again that the I-287 data, free from the influence of the HOV lane, suggest that a seasonal trend exists.

GWB Data Collection

Figure 15 illustrates the application of multiple years of data collection and concurrent control-site monitoring to the GWB BCPL site review. The availability of 3½ years of "before" data, a direct result of long delays encountered during the design and construction of the lane, illustrates the value of monitoring the site on a continuing basis. Without such data to explain the substantial drop in carpooling, explaining the opening day volumes would have been impossible.

Data for 1983 and part of 1984 were analyzed for seasonal influences and remaining data collection was reduced to sampling 8 of the 12 months. In this way, costs were reduced by one-third without compromising the quality of the data.

BCPL Impacts on Carpooling

In addition to the distinct seasonal nature of carpooling, the long-term negative trend of carpools is clearly evident. Knowledge of this trend is important to understanding the true value of the BCPL because dramatic increases in carpooling have not occurred during 1987, the first year of operation. Instead of concluding the BCPL a failure, the evaluation is based on how well the lane supports existing carpooling behavior and reinforces the time savings previously available only to buses—the objectives set prior to the opening of the BCPL.

Discussion and Supplemental Analyses

Caution must be advised against overuse of such data. For example, the data might appear to support the theory that the BCPL has changed carpooling trends at the I-95 plazas. Such a conclusion could be based on the increase in carpooling (0.5 percent) evident between June 1986 and June 1987, an amount greater than any seasonal or year-to-year change since 1984. At the same time, carpooling on the PIP has continued to show a negative year-to-year trend and has actually become lower in percentage than at the I-95 plazas. Proper statistical

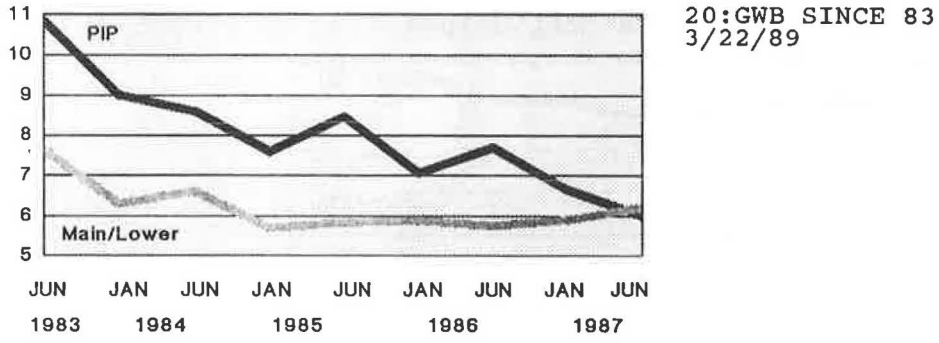

FIGURE 15 Percent 3+, GWB seasonally.

analysis is impossible with only two data points for "after" data, thus such interpretation of the data is interesting to note only as a possibility and as a focus for further data collection efforts, although none are currently planned.

In forming an opinion as to the success of any BCPL, immediate increases in carpooling are certainly impressive. The GWB BCPL data demonstrate that an operation may provide important benefits despite less dramatic performance. In fact, it is probably unrealistic to expect that a BCPL will, by itself, be responsible for major changes in carpooling behavior. Thus, to set major increases in carpooling as the goal without careful consideration of the entire ridesharing program and the current trends is more likely to be a formula for measuring failure, rather than success.

Toll Rate Changes

On April 12, 1987, daily commuter toll rates increased from $1 to $2 and noncommuter rates increased from $2 to $3, whereas carpool rates remained at $0.50 a trip. Thus the apparent trend toward increased carpooling might be attributed to this new rate structure. However, effects of an increase in toll fees on carpooling, if present, should be observable at all plazas because the discount was not conditioned on presence in the BCPL. In fact, rather than increasing, the trend at the PIP is quite the opposite, as previously discussed.

This result should not be surprising because most of the automobiles present during the peak hours carry daily commuters to whom toll fee increases of $1/day ($250/year) can be considered minor in light of substantial employer subsidies. In summary, the toll increases that took effect on April 12, 1987, do not appear to have affected carpooling rates at the GWB.

Motorcycles

In order to decide how well motorcyclists understand their eligibility for lane use, several motorcycle-specific counts were made. These counts identified that only one motorcycle was a regular user of the lane, although as many as 42 were present between 7 and 9 a.m. Clearly then, motorcyclists are not generally aware of their ability to use the BCPL. Although it is not obvious that they would in fact use it, a contact with a motorcycle organization confirmed that motorcyclists are not generally aware that the rules permit motorcycle use. This is understandable because the word "motorcycles" is too long to be accommodated on any of the signs. Thus, distributing more explanatory information has been recommended.

PIP

The dramatic and apparently continued dropping of the number of carpools on the PIP seen in Figure 15 is disturbing. In particular, the summer 1987 dropoff to less than 6 percent carpools is unprecedented in that it fell below the average at the I-95 plazas. A similarly large nonseasonal drop in PIP carpooling was previously observed in the summer 1984 data.

Attempting to reverse this trend by providing preferential treatment for carpools on the two lane approaches to the PIP plaza is not feasible because of physical constraints. The only apparent alternative, a preferential toll plaza at a local street access point, was ruled out several years ago by a study sponsored by the PANYNJ (*4*). The booth then studied is currently used only for oversize load permit operations. Because much of the data on carpools for that previous PANYNJ study can now be updated, revisiting the study has been recommended.

An additional benefit of such a booth operation would be that all carpools now accessing the main plaza via the local streets could potentially reroute. Certainly, any resulting impacts on traffic patterns on the local street system would need to be ameliorated. As previously discussed, local buses, which do not use the BCPL, would not need this booth because PANYNJ police give all buses priority at one toll booth. Similar treatment of local-access carpools at the toll plaza is not feasible, however. Thus exists the need for a separate local-access carpool booth.

As mentioned previously, sampling techniques have been used to reduce data collection costs. Data were collected for a full year with data collected in each month to establish seasonality. A sampling method was also used during each peak period. Figure 16 illustrates how the % 3+ varies during a typical peak period.

Experience on previous efforts led to the choice of 15 min as the basic analysis period and data were taken in 10 of every 15 min throughout the peak (*5*). As can be seen, data were collected from 6:30 until 10 a.m. despite the choice of 7 to 9 a.m. as the BCPL operational period.

Summaries of data were simultaneously assembled for 6:30 to 9:30 a.m. (although not presented here) to aid in the anal-

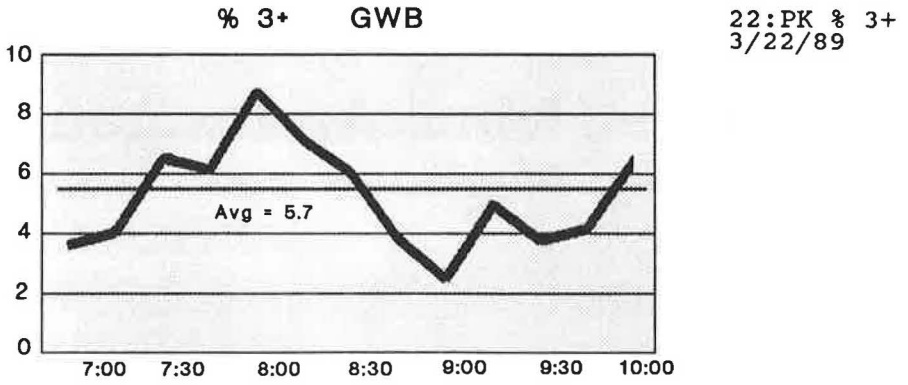

FIGURE 16 Percent 3+, GWB peak period.

ysis in the event of time shifts of delay or carpooling behavior. These shifts did not occur. Data were also collected and summarized through 10 a.m., for separate comparisons to toll-collection data (again not presented here). The highly dynamic carpooling rates in the peak period suggest that selective sampling in only a portion of the peak can lead to erroneous estimates of average behavior, especially in the event of time shifting. Thus exists the benefit of extended data collection periods. Ironically, comparing the summaries for the three basic analysis periods (7 to 9, 6:30 to 10, and 7 to 10 a.m.) led to an average of about 5.7 percent carpools in each case because of the specific nature of the trends at this location.

ACKNOWLEDGMENTS

The contributors to this project were many and varied. Essential in a 13-year process from conception to full operation is unwavering support from management and coworkers; this project was certainly blessed in that regard. But for the understanding, cooperation, and belief in eventual success by the New Jersey Department of Transportation's Design and Traffic Engineering staff, the complexity of this effort would have been its downfall. FHWA funding and participation by New Jersey State Police and numerous people within the Port Authority of New York and New Jersey were also important to the planning and operation of the reserved lane. Neither the need for nor the success of the operation could be understood, however, without the dedicated support of those who put up with the long and often difficult hours and work conditions involved in providing vehicle occupancy data. Last but not least are those who assisted in the preparation of this report.

REFERENCES

1. C. O. Pratt and H. S. Levinson. *Route 80/95 Bus-Carpool Lane Feasibility Study*. Project Report 78-002-7616. Wilbur Smith and Associates; Bureau of Operations Research, New Jersey Department of Transportation, Trenton, 1978.
2. *Banfield Freeway High Occupancy Lane Traffic Study*. Metropolitan Section, Oregon Department of Transportation, Salem, 1982.
3. J. C. Powers. Garden State Parkway HOV Lane. In *Transportation Research Record 906*, TRB, National Research Council, Washington, D.C., 1983, pp. 54–56.
4. M. C. Gersten. *George Washington Bridge, Borough of Fort Lee Traffic Study*. URS Company, Inc.; Port Authority of New York and New Jersey, New York, June 1985.
5. J. Powers. *An Analysis of Peak Period Auto Occupancy—An Interim Report for the George Washington Bridge Bus-Carpool Lane*. New Jersey Department of Transportation, Trenton, Aug. 1985.

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Guaranteed Ride Home: An Insurance Program for HOV Users

EILEEN KADESH AND LAURIE ELDER

The purpose of this paper is to describe a demonstration program that has been successful in increasing high-occupancy-vehicle (HOV) use among a small group of program participants. The Guaranteed Ride Home program, developed by the Municipality of Metropolitan Seattle, reimburses eligible HOV users for a fixed number of miles of travel to or from work using taxis. The 6-month demonstration project was tested in two distinct areas of Bellevue, Washington, a suburban activity center, starting in September 1987. The objectives of the initial phase were to assess interest in the program, test program procedures for efficient operation, and determine if the program increased HOV use. Major findings of the first phase of the evaluation were that (a) registrants increased their HOV use by 12 percent, (b) 69 percent of the registrants felt the program was important in their decision to continue to rideshare, (c) participants saved their mileage allotment for unanticipated emergency use, and (d) the program was relatively inexpensive to operate.

The Guaranteed Ride Home program was developed by the Market Development section of the Municipality of Metropolitan Seattle (Metro), a full-service public transportation agency providing transit, vanpool, and carpool services. The program was initiated as one component of an overall action plan to improve public transportation services in East King County, a rapidly growing suburban area 10 mi east of Seattle. Research had shown that one reason commuters who drive alone to work do not use high-occupancy-vehicle (HOV) modes is their concern about being stranded without a car in case of an emergency or unplanned change in work schedule. The Guaranteed Ride Home program was designed to encourage those who commute primarily by single occupancy vehicle (SOV) to switch to any of the HOV modes—bus, carpool, or vanpool—by providing a low-cost back-up ride home.

TARGET AREAS

The program was tested in two distinct business centers: the Bellevue central business district (CBD), the fast-growing heart of downtown Bellevue with an employment size of 20,000, and the I-90 area, a series of office park developments along an interstate corridor with an employment population of 8,000.

Although transit service to downtown Bellevue is well developed, the situation in the I-90 area is much different. During the peak period, there is express service from several Eastside park-and-ride lots to downtown Bellevue and local service from neighborhoods to Eastside activity centers, downtown Bellevue being the primary center. Commuting from Seattle neighborhoods to downtown Bellevue often requires a transfer, however.

Midday, evening, and weekend service on the Eastside is radially oriented to the Bellevue Transit Center, with a pulse of up to 12 buses every 30 min. Thirty-minute service exists between downtown Bellevue and other major activity centers on the Eastside. Transit service to the I-90 corridor is much less extensive. Midday headways are 60 min on average, and travel within the area to access restaurants and other services is especially difficult.

Another major difference in the two areas is the availability of parking. Research has shown that nearly 100 percent of SOV commuters in the I-90 area were likely to have free parking available to them. In the Bellevue CBD, that percentage is approximately 50 percent, and the HOV/SOV mode split reflects this difference. The HOV mode split is about 18 percent in the Bellevue CBD compared to 10 percent in the I-90 area.

PROGRAM GOALS

The goal of the program was to provide an incentive for the SOV driver considering switching to an HOV mode. Because Metro provides transit, carpool, and vanpool services, this study was not concerned with whether commuters chose a ridesharing mode versus transit.

The first phase of the demonstration began September 1, 1987, and ended February 29, 1988. The objectives of the initial phase of the program were to

- Assess the interest of the commute population on the Eastside for this service, as measured by the number of program participants;
- Test the program procedures for efficient operations for the user and administrators; and
- Determine if an increase in HOV use among program participants occurred during the program demonstration.

During the first 6 months, 142 people registered for the program and a total of 11 taxi rides were taken. The program has been extended indefinitely in the Bellevue CBD and until June 30, 1989, in the I-90 area.

Service Planning and Market Development Division, MS 52, Municipality of Metropolitan Seattle, 821 Second Avenue, Exchange Building, Seattle, Wash. 98104.

PROGRAM DESCRIPTION

Two staff positions for transportation coordinators were created to market and administer the Guaranteed Ride Home program and support other special transportation projects on the Eastside.

Commuters learned about the program by various means, ranging from general notices and newspaper articles, to targeted distribution of brochures and direct telephone contact by the transportation coordinators. Commuters were responsible for initiating their participation in the program by contacting a transportation coordinator. Eligible commuters applied for the program by completing a registration form and certifying that they traveled to and from work by transit, carpool, or vanpool at least 3 days per week and worked in one of the target areas. If both requirements were met, program registrants received vouchers good for reimbursement of 40 mi of taxi travel if they worked in the Bellevue CBD and 60 mi of travel if employed in the I-90 area.

Different mileage allotments were used in each area based on providing four trips at the average commute distance for workers in that area. A fixed mileage allotment and a limit to the number of participants allowed Metro to monitor its project budget easily. The budget was based on each participant using his or her entire mileage allotment. The only travel restriction was that one end of the taxi trip had to be in the test area.

The development of a payment method was based on consideration of four factors: ease of administration, convenience to the user, potential for abuse, and simplicity. A reimbursement system, rather than a scrip method, was selected because it provided more information about the use of the program and was less likely to allow abuse.

Under the reimbursement system, the user was required to contact Yellow Cab Company for a ride and pay the cab driver out-of-pocket. Yellow Cab agreed to provide Metro a variable rate discount based on the level of use, in return for exclusive use by program registrants. The participant was responsible for submitting the voucher to the transportation coordinator, along with a receipt for the cab ride. Transportation coordinators were responsible for keeping track of each registrant's accumulated mileage and forwarding the approved reimbursement request to Metro Accounting. Metro mailed the user a check for the cost of the trip, minus $1. The user was asked to pay this minimal amount in order to share some of the responsibility for the cost of the service.

The reimbursement method had several advantages:

- The potential for abuse of the program decreased because the user had to pay up-front and out-of-pocket.
- Metro's only paper work was to issue a check and mail it.
- Monitoring of the user's cumulative mileage was automatic. The user would not be reimbursed for a particular trip if his or her mileage allotment had been expended.
- Information could be gained about trip purpose, cost, and distance from the reimbursement voucher.
- The user did not need any special paper work to take a taxi ride.

The burden of administration fell more heavily on the user with the reimbursement method than with a scrip system. However, in return, the user was able to take 40 to 60 mi of taxi rides for only $1 per trip. The process was streamlined by using vouchers already stamped with a return address that could simply be folded and sent, postage-free. Metro guaranteed reimbursement within a 2-week period.

EVALUATION

An evaluation was conducted at the end of the first 6 months.

Data were collected in several ways. Information about all 142 registrants' travel mode, trip length, age, and occupation was gathered through the registration form. All participants who took taxi rides submitted a voucher with information about each trip. Information about participants' attitudes and opinions was gathered from a questionnaire sent to all participants at the end of the first 6 months. In order to assess the administrative procedures of the program, staff involved in the program were interviewed at the end of the 6-month trial period.

Finally, two focus group sessions with program registrants and one session with nonregistrants were held in each of the test areas to gather more information on pricing, mileage, and other issues that were being considered for possible changes in the future.

FINDINGS

The number of participants and their interest and support for Guaranteed Ride Home indicated that it is a worthwhile service that fills a need for a particular commuter market. The program was successful from a number of standpoints.

Program Participation

First, commuters were interested enough in the program to register. By the end of the first year, there were a total of 260 registrants. Registration in the I-90 area was about 25 percent less than in the Bellevue CBD, which could be explained by the difference in size of the commute population, less extensive transit service, and an abundance of free parking. In addition, the Bellevue CBD has a well-established network of corporate contacts in major businesses, which facilitated the marketing of the program. Metro is still in the beginning stages of establishing its contacts in the I-90 area. Focus group discussion revealed that most registrants learned about Guaranteed Ride Home from personal contacts, indicating that employer cooperation is a vital factor in marketing the program.

Importance of Guaranteed Ride Home

The second indicator of success was that participants believed the program was important in their commute-mode-choice decision. Overall, 69 percent of survey respondents, including commuters who shifted from an SOV mode to an HOV mode when they joined the program, indicated that the Guaranteed

Ride Home program was somewhat or very important in their decision to continue to take the bus, carpool, or vanpool to work. Twenty-two percent rated it very important. Respondents to the questionnaire were interested enough in the program to suggest changes that would allow greater use of the program, that is, adding more free miles and extending the valid time period to use the subsidized miles.

In addition, most respondents said they would pay a greater portion of the trip cost, from 10 to 50 percent of the cost of the trip. Most survey respondents (58 percent) indicated they would pay about 10 percent, slightly more than the current $1 copayment.

HOV Use

A third indication of success was that there was a significant increase over the 6-month trial period in the number of HOV passenger trips for Guaranteed Ride Home participants responding to the survey. A 12 percent increase in trips can be attributed entirely to the 12 commuters—8.5 percent of total program participants—who had changed from driving alone to an HOV mode after they heard of the Guaranteed Ride Home program.

Those who were already using an HOV mode and met the HOV requirement without changing their commute pattern (91.5 percent of registrants) actually showed a slight decrease in HOV use since participating in the Guaranteed Ride Home program. In terms of passenger trips per week, HOV use for those people decreased by 1 percent. The opportunity to increase HOV use for this group of people was limited, because 96 percent of participants were already using an HOV mode at least 4 days per week (72 percent, 5 days per week) when they registered for the program. Table 1 shows the total change in the number of passenger trips by each travel mode. The net increase in HOV trips for those participants who responded to the questionnaire was 12 percent. Correspondingly, there was a large decrease in the number of SOV trips for this group.

Program Cost

The fourth indicator of the program's success was its low cost. Out of $8,000 budgeted for the program in each of the two areas, approximately $3,500 was actually spent. Forty-two percent of this amount was attributable to salaries of Metro Market Development staff; 28 percent to evaluation; 19 percent to postage, printing, and promotional materials; and only 11 percent to taxi-ride reimbursement. Because this was a demonstration program, much of the salary cost can be attributed to program planning and evaluation. This level of effort would not be required in successive years. However, some administration will still be necessary, either centrally located or done by field representatives. The two transportation coordinators spent only a small fraction of their time promoting the Guaranteed Ride Home program as distinct from overall promotion of public transportation at individual buildings. The time required to send information packets to potential registrants, track cumulative mileage of users, and forward reimbursement vouchers to Metro was minimal.

TABLE 1 TWO-WAY PASSENGER TRIPS PER WEEK (N = 71)

	Beginning of Program	End of First Phase	Percent Change
SOV	52	15	−71
HOV			
Bus	65	73	12
Carpool	180	177	−2
Vanpool	42	69	64
Combination[a]	10	15	50
Total HOV Trips	297	334	12

[a]Two different modes to and from work.

Taxi-Ride Use

The actual number of rides taken was low, between 2 and 4 percent of the maximum number of subsidized miles available for registrants to use. Survey data showed that most participants did not use their free miles because they had no need, were saving the miles for a real emergency, or had solved unplanned schedule changes in other ways. A more detailed discussion in the focus groups verified that users were intentionally saving their miles in anticipation of an emergency. In response to a question about how their use would change if more miles were subsidized, most participants agreed that they would probably continue to save the miles.

Regardless of how many miles were subsidized, most of the focus group participants indicated that they would use the taxi miles as a last resort, when no other transportation arrangements were feasible. The fact that registrants did not plan to use the miles did not diminish its perceived importance to them as a "safety net" for emergency use.

Several aspects of the program structure helped to minimize actual taxi-ride use: low mileage subsidy, reimbursement payment method, slow taxi response, and negative attitudes about taxi drivers. Another factor contributing to low program use was that most of the program participants were already using an HOV mode when they signed up for Guaranteed Ride Home. As experienced HOV users, they had already had to manage day-to-day schedule changes and were probably more likely to save the taxi rides for a real emergency. Some focus group participants indicated that they tried to take a taxi ride for a nonemergency purpose, but, when told of a 20 to 30 min wait, they simply took the next bus or arranged for a more convenient ride home.

The potential benefit to the user, along with elements of the program that limit its use, proved to be a successful combination from Metro's perspective. The high degree of importance of the program to commute-mode decisions indicated that it appealed to the commuter market. The low use in terms of taxi rides reduced program costs significantly and proved that little, if any, abuse had occurred.

Market

Because the long-term goal of the program is to increase HOV use, the obvious target market for the Guaranteed Ride Home

program is commuters who drive alone to work. In this phase of the program, an increase in HOV use was achieved because of the number of SOV commuters who shifted to an HOV mode and joined the program (8.5 percent of total participants). At the time of registration, nearly all of these commuters indicated that Guaranteed Ride Home was somewhat or very important to their decision to shift to an HOV mode. By the end of the first year of operation, SOV commuters shifting to an HOV mode had increased to 25 percent of the total number of registrants, as a result of an increased emphasis on targeting SOV drivers with information about Guaranteed Ride Home. Although it cannot be concluded from these data that Guaranteed Ride Home was the one thing that influenced a commuter who drove alone to shift to an HOV mode, it was important to those who did shift.

There may be value in continuing to market the program to commuters who are already using an HOV mode to travel to and from work. Metro plans to continue to monitor the participants in the program to try to ascertain how Guaranteed Ride Home influences their stability and longevity in an HOV commute mode.

FUTURE CHANGES TO THE PROGRAM

Based on the results of the demonstration project, the Guaranteed Ride Home program is being extended, and some program changes are being planned.

Program Expansion

The rate of taxi-ride use has provided Metro with a different basis for projecting program costs. Little of the budgeted funds for taxi-fare reimbursement was spent in the first 6 months (11 rides), and this amount remained low in the second 6 months (21 rides) from a pool of 260 registrants. Based on the assumption that new registrants will continue using the program at a low rate, Metro is planning to lift the limit on the number of registrants per area as well as expand the program into several other areas. The program is being marketed to major employers, such as Seattle's First Hill hospitals and King County government as an employee incentive funded by the employer.

Pricing

Current registrants appear to be comfortable with sharing some portion of the cost with Metro. Focus group discussion about pricing alternatives was inconclusive, varying from enthusiastic support of paying up to 40 percent of the cost of a trip to questioning why even $1 was charged. It is clear from the variety of responses to pricing alternatives that increasing the cost of the program to the user will limit the potential market.

The second year of the demonstration project will include some experimentation with different pricing structures in target areas. The response to various pricing scenarios will provide more information about the program's market potential and target markets, with the goal of reducing the subsidy provided by Metro, the sponsoring organization. Some alternatives include

- Promoting Guaranteed Ride Home as an actual insurance program, in which users or employers pay an up-front premium for coverage of a certain number of subsidized miles;
- Increasing the amount the user pays per trip by a flat fee or a percentage; and
- Establishing subscription levels, that is, allowing the user to pay a small percentage (10 to 15 percent) of the trip cost for a limited number of miles, increasing to 25 percent or more for additional miles.

Procedures

Registrants in the focus groups made two suggestions, which will be tested in the future:

- Open the program to the use of any taxi company, instead of limiting it to Yellow Cab. With the minimal number of trips taken, the discount provided by the cab company was negligible. One of the major complaints of users concerned the unreliability of cabs. Although this may improve the taxi response time for the registrants, it may also result in more taxi rides taken and, thus, higher cost.
- Base the subsidy on a number of trips rather than a fixed number of miles. Focus group discussions revealed that users felt that a fixed number of miles excluded those commuters with long commutes and that it was more equitable to provide each commuter with a trip equal to his or her commute distance. Cost calculations show that this approach could be structured to cost no more than a fixed-mileage approach. However, it will be important to monitor if this is more attractive to commuters and if it results in more taxi rides, in order to measure its long-term impact on the success of the program.

The focus group discussions confirmed the experience of the transportation coordinators that the Guaranteed Ride Home program, in conjunction with other ridesharing activities and incentives, is an important factor in encouraging SOV commuters to shift to HOV modes. The challenge to Metro is to maintain a balance in the program elements between offering the most attractive service to the public and keeping costs low. Costs could be minimized by structuring the program so that taxi use continues to be low or by shifting more of the cost to users or employers.

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Evaluation of Ridefinders and Central Richmond Association's Transportation and Parking Information Service

PHILIP L. WINTERS

In vibrant cities the demand for parking often exceeds the available supply. Pricing mechanisms are used to balance the demand for off-street parking needs for commuters, clients, and customers. The high cost of parking often makes commuters more receptive to transit and ridesharing alternatives. Reaching the commuter before he or she contemplates his or her parking options provides a marketing opportunity for transit and ridesharing agencies. The commuter may have been forced to reassess his or her parking decision because of new building construction or a rise in out-of-pocket parking costs. It may be a decision of choice, such as changing jobs. Ridefinders and the Central Richmond Association used a marketing technique used by the retail industry to combine the downtown business community's desire for a single source of parking information and the need for ridesharing and transit agencies to reach commuters in the midst of making a commuting mode choice. Retailers frequently discount items to lure customers into the store with the probability that many will purchase other items. Ridefinders offers information on the location and cost of commuter parking to attract commuters with the probability that many will request and use ridesharing and transit information. The effects of the provision of parking information on the frequency of requests for carpool ridematching information and on the enhancement of the image of transit and ridesharing alternatives and providers, as well as the measures used to design and implement the project, are described. It is concluded that such strategies contribute to the increasing demand for ridematching services, enhancing the image, and expanding the exposure of the ridesharing agency's services to commuters.

The city of Richmond's Downtown Plan identified parking as "the most pressing transportation problem facing Downtown." The City Downtown Plan recommends constructing an additional 3,100 new commuter parking spaces to absorb a projected 22,000 or 41 percent more commuters to downtown by the year 2000. However, the Downtown Plan recognizes the importance of applying traffic mitigating solutions to meet the majority of the increased parking demand.

> It should be understood, however, that unless the entire program of improvements for all transportation modes recommended [in this plan] is implemented, congestion and parking problems Downtown will be intense and the projected rate of [economic] growth will probably not be attainable.

Ridefinders, 1001 East Main Street, Suite 525, P.O. Box 1239, Richmond, Va. 23209.

Even with a modest increase in parking supply, the city projects a decrease in the number of parking spaces per 100 employees from 53 to 47. The city has also implicitly set objectives for the Greater Richmond Transit Company (GRTC) and Ridefinders. Transit's share of the commuter market must increase from 20 percent in 1980 to 24 percent by the year 2000. Ridesharing's market share must increase from 27 percent to 34 percent. In other words, GRTC must increase its ridership from 11,000 to 18,000 daily riders to downtown, or by 64 percent. Ridefinders must increase the number of carpoolers and vanpoolers from 13,000 to 23,650 carpoolers to downtown, or by 82 percent. These ambitious objectives call for the use of new measures for penetrating the market. The transportation and parking information center is an example of an innovative measure to meet the needs of commuters and foster consideration of alternatives to driving and parking alone.

The Central Richmond Association (CRA), a not-for-profit organization of 600 businesses dedicated to making the central city a better place to work, shop, live, and visit, conducted a survey of its membership to determine whether such a project was "a wise use of CRA's resources." Of the 52 responses received from the 275 surveys distributed to downtown employers, 92 percent answered affirmatively. The CRA executive director then made two calls to prominent employers and the local match funds were raised.

GOALS AND OBJECTIVES

There were several goals this experimental project was designed to address. The contributing objectives to these goals were established by approximating the impacts such parking information and ridematching services have had independently.

- Develop a central parking information service in response to an employer-identified transportation need.
  - — Within 12 months, inventory all commuter parking facilities available to the general public and prepare a map of all those facilities.
  - — Concurrently with the development of the map, develop and maintain a current listing of all those parking facilities and their hourly, daily, and monthly rates.
  - — Process at least 6,000 requests for the transportation and parking packets by project's end.

- Use the opportunity to provide downtown parking information to promote and facilitate ridesharing and transit alternatives.
  - — By the end of the project period, have at least 10 percent of those consumers of parking information also request ridematching assistance.
  - — By the end of the project period, place 60 of the parking information consumers into a ridesharing arrangement.
- Improve the image of public transportation.
  - — By the end of the project period, improve the parking information consumer's opinion of Ridefinders.
  - — By the end of the project period, improve the parking information consumer's opinion of the GRTC.
  - — By the end of the project period, improve the parking information consumer's opinion of carpooling.
  - — By the end of the project period, improve the parking information consumer's opinion of transit.

ORGANIZATION AND MANAGEMENT

Ridefinders was the primary contact point for commuters, employers, media, and other organizations for parking data. Grant administration, monitoring, and final project design were also Ridefinders' responsibilities. CRA assisted in marketing the program to its members and the media. GRTC provided transit marketing materials and follow-up information to commuters interested in specific transit services.

A previous study prepared by the Richmond Regional Planning District Commission (RRPDC) provided a slightly dated inventory of parking spaces downtown from which to begin. An intern was hired for the first 3 months to prepare a business plan for the service under the close supervision of Ridefinders and CRA's Transportation Committee. A clerk was budgeted to handle and process the calls. Once the project was under way, it was apparent that the primary source of requests would be funneled through employers rather than by phone, and the clerk position was never filled.

MARKETING STRATEGY

The experiment's strategy applied a common product marketing technique to attract potential new customers. Retail stores typically entice customers into the store by offering items at a steep discount under the probability that many will purchase other items. Ridefinders used a current inventory of commuter parking spaces to attract commuters who were facing a commuting problem (i.e., the lack of convenient, affordable commuter parking spaces) and offered them transit and ridesharing information under the presumption that some will "buy" our products. In short, we were differentiating our products (carpools, vanpools, and public transit) with the costs of commuting and parking alone.

Marketing any service or product requires a well-thought out strategic plan with clearly defined goals and objectives. There are four basic components to the process: product, price, distribution, and promotion.

Product Strategy

A successful marketing strategy depends on finding and communicating its unique selling proposition. Our unique selling proposition is the single source for information on all commuting options. Each customer would receive the following information for free:

- Map of downtown parking decks open to the public for commuter parking on an hourly, daily, or monthly basis. The cost sheet was updated every 4 to 6 weeks. Generally, less than 10 percent of the lots had any changes during the periods between updates.
- Price list of all those parking facilities including map reference number; street address or intersection; number of spaces; hourly, daily and monthly rates; whether the facility was a lot or deck; whether it had an attendant on duty; and the operator's name, address, and phone number.
- Postage-paid ridematching application.
- Cover letter using a spreadsheet template to estimate the before-tax equivalent of the savings that might accrue to the individual if he or she shared the ride with someone.
- Postage-paid card for requesting transit service information including schedules and trolley information.
- Postage-paid card to solicit comments on the product's usefulness to the customer.

Only minor modifications were made to the product. The price list was originally sorted by parking operator. It is now sorted by the map reference number to facilitate use by the commuter. The cover letter was updated to reflect changes in the tax law and allow Ridefinders to customize the information to the customer's income and filing status. Additional consideration is being given to changing this information into tabular form or replacing it with the method used by Hertz to estimate costs.

Pricing Strategy

Decisions regarding pricing were reached to stimulate commuter interest and, at the same time, ensure that our employer distribution channels had sufficient supply to meet identifiable demands. The decision to make the parking information available to commuters for free was one of the key factors that influenced all other components of the marketing strategy. The design of the product limited our ability to produce enough copies for every employee, visitor, shopper, and tourist. We had to provide some selectivity.

The map had to be large enough to permit every lot with more than 10 spaces to be shown. Various screens were used to distinguish between lots, roads, landmarks, and trolley routes. As a result of these design features, the map did not lend itself to inexpensive reproduction by other parties.

It became readily apparent early on that employers preferred to take a shotgun approach and distribute the packet to every employee regardless of current mode or even the employee's desire to have a map. We intentionally sought to prevent this indiscriminate distribution of the parking packets so as not to encourage current ridesharers or bus riders to change their mode. We would not refuse to provide the park-

ing information to anyone who was ridesharing or riding the bus who requested one. We simply were not going to go out of our way to do so. To discourage employers from using this approach we changed our pricing strategy.

Initially, the parking packets were to be made free to anyone who requested a map. We informed any employer who sought to give every employee a map that we would (a) provide up to five copies free to each organization and sell additional copies at cost ($1.25 each) or (b) provide every employee who actually requested parking information by completing a survey form or card a free copy.

We provided the employer with an economic incentive for participating in our ridematching surveys without charging the end user (i.e., commuter) anything. The modified pricing policy resulted in employers opting not to give a parking and transportation packet to every employee. However, several employers did buy several for internal use. Although we expected most employers simply to inform employees how to obtain this information by calling Ridefinders, many employers chose to offer the information in conjunction with the transportation audit survey.

Thus, the pricing decision was based on targeting commuters in need, as well as on budgetary concerns.

Distribution Strategy

Effective marketing requires determining when, where, and from whom the product is to be distributed. Ridefinders already had a cadre of employee transportation coordinators (ETCs) at most downtown employers serving as the primary distribution channel for order taking and delivery of our ridematching product, the matchlist. Orders for the information and completed packets were to flow through our ETC "pipeline." Broader distribution methods, such as displays and magazine racks, were rejected as being too expensive to stock and maintain. Such channels also would not inform us who was entering our store and "buying" our products. By knowing who is using the service we can then follow-up the orders in future marketing efforts.

During the course of the project, Ridefinders was conducting "transportation audits" of several large employers. This audit of employee commuting habits and willingness to pay for various traffic-mitigating solutions to the perceived parking problem offered Ridefinders a method to offer our new "product" to thousands of potential customers. It also enabled us to more directly position our ridematching product as a solution to the "parking problem." By adding the parking packet and ridematching options to the questionnaire distributed to everyone in the downtown work force of several employers, we stretched our marketing budget and increased the incentive for returning the questionnaires for analysis. In general, for every 10 employees returning the questionnaire, 3 requested parking information and 1 requested ridematching assistance.

The cost to mail the packet was high (90 cents) except when large employer batches were mailed together and bulk rates (16 cents each) could be used. Labels were typed on the typewriter rather than the computer. Later, we plan on adding the names of persons who requested only the parking packet to our files for future marketing campaigns.

Promotion Strategy

Promotional strategies are designed to create awareness of the product or service, pique interest, obtain inquiries, generate use, and foster continuing support as well as use. Ridefinders used public relations, personal selling, and advertising as its promotional methods.

To reach the primary market of downtown commuters who need parking or are interested in decreasing their parking expenses, Ridefinders targeted a secondary market of employers who find the "parking problem" to be a problem for their organization. Ridefinders and CRA met with an ad hoc group of personnel directors of major downtown employers. They expressed a high degree of support for promoting the availability of this new service to their employees on our behalf. With employers expressing a keen interest in the service and agreeing to generate awareness of the new service within their organizations, Ridefinders could focus on obtaining inquiries for ridematching information.

The key to the program's success in fostering inquiries for ridematching information and ultimately as a result of providing this information, initiating new ridesharing arrangements, rested in the ability to personally sell each person who called for the parking map. After obtaining the information necessary to mail the customer the parking map, commuters would also be told they could receive the names of other commuters who live and work nearby and who are interested in sharing the costs of commuting, including parking.

Although personal selling continued to play a major role in obtaining inquiries for ridematching information, too much dependence was placed on employers for generating awareness of the new service. Though many employers did include some mention of the new service, it generally has not been continuously promoted. Electronic mail appeared to be the most innovative method used by employers.

Most of the demand generated for the service was the result of Ridefinders including the availability of this product when conducting transportation audits of employee commuting habits and concerns. Commuters were offered both products (ridematching and parking information) at the same time. Because both products were marketed together through these transportation audits, no personal selling was directed at individuals who requested only the parking information. The inclusion of the ridematching registration form in each parking packet also provided these commuters with another opportunity to request ridematching information once they had the costs of parking in front of them.

Ridefinders supplemented personal selling promotions and employer outreach efforts with broad coverage advertising as well as providing employers a direct-mail method for internal promotions. We posted 11 billboards for a month, ran customized radio ads for 2 weeks, and developed a special payroll insert for employers. Although limited resources were dedicated to each of these methods, we concluded that these media were not targeting the market sufficiently to make them cost-effective. The most cost-effective form of advertising has proven to be the Yellow Pages under the section listing parking operators. This listing accounts for about 4 percent of our requests for ridematching assistance. The $25/month cost is extremely low relative to its reach.

For the transportation and parking information service, public

relations activities also seemed to provide better promotional value than paid advertising. Local media, in particular, now call Ridefinders when doing stories about parking downtown. These stories, in which another transportation issue is the primary purpose, offer an excellent opportunity to present ridesharing's case. Usually, after a story was aired or an article printed, we could expect a slight surge in demand. More often than not, the press also included our telephone number in the story.

The public relations exposure also contributed to elevating Ridefinders' visibility and the opportunities for growth of services into related areas. As the sole inventory of parking information, Ridefinders has also been asked to assume other projects, such as the administration of a proposed retail parking validation program, the marketing of a proposed parking shuttle bus system, and the administration of a proposed on-street preferential parking program for carpools and vanpools.

It is management's belief that our involvement in this demonstration project had a direct bearing on the consideration by other public and private bodies of additional alternatives to driving alone and of Ridefinders' management capabilities.

EVALUATION

A sample of 400 users of the services was selected to evaluate how we met our goals and objectives. Demographic data were also collected to determine if there were any factors that could improve the marketing of the service.

The sample was split evenly between persons who only requested the parking information and those who received both a matchlist and a parking information packet. The sample was further stratified based on mode split (Table 1). In other words, the sample's mode split for each group reflected the mode split at the time Ridefinders filled the order. We received 56 completed surveys back for a 14 percent return

TABLE 1 MODE SPLIT BY SERVICES REQUESTED

MODE	MATCHLIST ONLY	MATCHLIST AND MAP	MAP ONLY	NEITHER	TOTAL
BY TYPE OF REQUEST:					
Walk-bike	0.0	0.1	0.8	0.8	0.7
Drive Alone	42.9	46.5	53.0	53.8	52.0
Carpool	37.1	38.1	29.7	27.6	30.1
Bus	17.7	13.8	16.0	17.6	16.5
Vanpool	2.3	1.4	0.5	0.3	0.6
BY MODE:					
Walk-bike	0.0	3.1	37.5	59.4	100.0
Drive Alone	3.0	13.0	32.6	51.4	100.0
Carpool	4.5	18.5	31.5	45.5	100.0
Bus	3.9	12.2	31.0	52.9	100.0
Vanpool	13.8	34.5	27.6	24.1	100.0
ALL RESPONSES:					
Walk-bike	0.0	0.0	0.3	0.4	0.7
Drive Alone	1.6	6.8	16.9	26.7	52.0
Carpool	1.4	5.6	9.5	13.7	30.1
Bus	0.7	2.0	5.1	8.7	16.5
Vanpool	0.1	0.2	0.2	0.1	0.6

NOTE: All figures represent percentages obtained through employer surveys (4,763 persons).

rate. This precludes us from having a sufficient level of confidence in the results at the map-only versus the map-and-matchlist level.

As shown in the following list of objectives and results, we were successful in terms of our goals of providing a needed commuter transportation service, offering alternatives to driving alone, and enhancing our image:

- OBJECTIVE: Prepare a map of downtown commuter parking lots. RESULT: Within 4 months, 10,000 copies of the downtown parking map and folder were produced.
- OBJECTIVE: Develop and update an inventory of parking costs. RESULT: Within 4 months, an inventory of 95 parking facilities was developed and computerized, which included costs, parking operator, type of parking facility, number of spaces, and information on whether or not a parking attendant was present.
- OBJECTIVE: 6,000 requests for the transportation and parking information packets. RESULT: Ridefinders received nearly 2,500 individual requests for the packets.
- OBJECTIVE: 10 percent of the requests (or 600 persons) will request ridematching assistance. RESULT: 46 percent of the requests for the parking packets also yielded a ridematching request. Therefore, nearly 1,150 persons requested a matchlist.
- OBJECTIVE: Place 60 persons into a ridesharing arrangement. RESULT: Applying Ridefinders' FY 1987 direct placement rate of 13 percent, we estimate approximately 150 persons formed or joined a carpool.
- OBJECTIVE: Develop a more favorable image of Ridefinders. RESULT: The consumer's opinion of Ridefinders improved for 67 percent of the customers.
- OBJECTIVE: Develop a more favorable image of carpooling. RESULT: The consumer's opinion of carpooling improved for 42 percent of the customers.
- OBJECTIVE: Develop a more favorable image of the Greater Richmond Transit Company. RESULT: The opinion of GRTC improved for 20 percent of the customers.
- OBJECTIVE: Develop a more favorable image of transit. RESULT: The opinion of transit improved for 20 percent of the customers.

In addition to the stated goals and objectives, there are several observations that should be made to persons considering such a project. One of the first questions usually asked of Ridefinders is, Why is a ridesharing program providing parking information? Our position has been that transit and ridesharing alternatives have more to gain when placed in comparison to the high cost of parking. It also offers us the opportunity to expose others to our services who would be generally reluctant to apply for ridematching information on their own.

An indication that our premise was correct can be found in what people remember receiving and what action they took after obtaining the information (Figure 1). While the parking map was the prominent piece and the most remembered product, it is interesting to note that the carpool matching application was the second most remembered product, ahead of the parking price list. While 82 percent of the commuters remembered receiving a map showing downtown parking, nearly 68 percent of the commuters remembered receiving a carpool matching application.

Building product recognition is only part of our objective. What the commuter chooses to do with the information is our primary concern. Most people saved the information for future use, but more people used the opportunity to ask for a matchlist or call for transit information than found monthly parking.

Just who used our service is also important to the evaluation of the project. Demographically, the user profile indicates that we are penetrating new markets. While the vast majority (estimated at 75 percent) of the commuters who use Ridefinder's ridematching service are women, there is a fifty-fifty split when parking information is also offered. Another study currently under way will provide us with information on the age, occupation, household size, and vehicle availability data that will enable us to compare this service in more depth with our ridematching data base profile. Figure 1 shows a demographic breakdown of those persons who returned the survey questionnaire.

Finally, no evaluation is complete without a discussion of costs. This project cost less than 60 percent of the budgeted amount. Some of this saving is attributable to lower-than-anticipated demand. However, a significant cost savings was achieved through the use of existing employer distribution channels and a prudent pricing strategy. All labor-related costs associated with this project except for the intern hired to collect the data and draft the business plan were excluded from the costs contained in Table 2. Some items such as the ridematching application and the transit brochure were not billed against this project.

A breakdown of printing and advertising costs follows:

Printing and Advertising	*Costs ($)*
Creative items/functions including copy, layouts, illustrations, type, stats, mechanical art, production, and supervision	3,911.69
Printing of 10,000 two-color folders, with additional pocket flaps	3,315.30
Printing of 10,000 maps, four-color with bleed, including additional negative stripping for color separations by printer	4,771.71
Advertising, including 1 week radio, 11 billboard months, and other	4,122.47
Total	16,121.17

CONCLUSIONS AND RECOMMENDATIONS

- The project has achieved most of its objectives and yielded several additional benefits to the organization.
- The project should be continued and promotion should be focused through employers rather than the general public.
- Low-cost advertising such as the Yellow Pages will provide sufficient coverage for long-term promotional efforts.
- Employers are willing to pay for the product but methods to reduce unit costs should be explored.
- Well-produced materials promote a professional image that can enhance the organization's exposure.
- Market the availability of parking information to employers when soliciting their participation in ridematching surveys.

PROFILE OF SURVEY RESPONDENTS

1. Current mode:

29	Driving alone
20	Carpool
6	Bus
0	Other

2. Materials remembered receiving:

46	Map of downtown
26	Price list of downtown parking
38	Carpool matching application
14	Greater Richmond Transit Company (GRTC) information
11	Estimate of your commuting costs
1	Other

3. How the information was used:

16	Found monthly parking.
17	Requested the names of potential carpool partners.
6	Contacted the bus company for route information.
7	Shared the information with someone else.
31	Saved the information for future reference.
11	Discarded the information.
2	Did not receive any information.
1	Do not remember.

4. How the information affected the commuter's opinion of:

	IMPROVED	NO CHANGE	WORSENED
Ridefinders	33	16	0
Central Richmond Association	3	36	0
Greater Richmond Transit Company	8	32	0
Parking lot operators	2	31	7
Carpooling	20	24	0
Bus service	8	30	1
Parking costs	5	16	21
Parking availability	15	15	15
Public sector's attitude about parking	2	33	6
My employer's attitude about parking	0	37	4

5. Demographics of survey respondents:

Sex	28	Male	28	Female
Age	0	Under 18	4	45 to 49
	2	19 to 24	1	50 to 54
	26	25 to 34	5	55 to 64
	17	35 to 44	1	65 and over
Race	6	Black	46	White
Occupation	33	Professional or Managerial	0	Sales
	20	Administrative or Clerical	2	Production or repair
Number of Employed Persons over 16	4	None	7	3 persons
	12	1 person	1	4 persons
	32	2 persons	0	5 or more persons
Number of Motor Vehicles Per Household	0	None	12	3 vehicles
	8	1 vehicle	2	4 vehicles
	29	2 vehicles	5	5 or more vehicles
Total Annual Household Income	0	Under $10,000	10	$25,000-$34,999
	0	$10,000-$14,999	15	$35,000-$49,999
	4	$15,000-$24,999	27	$50,000 and over

FIGURE 1 Profile of survey respondents.

TABLE 2 PROJECT COSTS VERSUS BUDGET

Description	Budget	Actual	Balance	%
Salaries & Wages	$4,144.00	$2,997.50	$1,146.50	72.3%
Fringes	$368.00	$178.59	$189.41	48.5%
Printing and Advertising	$24,500.00	$16,121.17	$8,378.83	65.8%
Telephone	$250.00	$0.00	$250.00	0.0%
Postage	$5,249.58	$1,650.42	$3,599.16	31.4%
Reproduction	$5,000.00	$1,449.49	$3,550.51	29.0%
Revenue	($200.00)	($125.35)	($74.65)	62.7%
TOTAL	$39,311.58	$22,271.82	$17,039.76	56.7%

- Communications channels within employers' organizations need to be targeted as well as the ETC. Internal electronic bulletin boards through computers may be worth promoting further.
- Consider using the parking information as a revenue-producing service.
- The cooperation of parking operators was good. They receive free marketing of their lots and decks in addition to the data necessary to evaluate market conditions in exchange for keeping Ridefinders' parking information up-to-date.
- With the enhancement of the organization's image often come requests for the management and administration of other transportation services, many of which are unrelated to the commuter market. Caution should be exercised in selecting which, if any, of these potential new services are within the organization's goals.

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Vanpools: Pricing and Market Penetration

DONALD A. TORLUEMKE AND DAVID ROSEMAN

This paper examines the progress of 15 years of formalized vanpooling in developing a market niche. It offers a strategy for achieving vanpooling's market potential through nontraditional financing and fleet management strategies. Two approaches to vanpooling are examined in two case studies: the first using a traditional approach based on capital cost recapture linked to the length of a standard van lease and the second using a capital cost recapture formula based on the actual useful life of a van in mileage. The findings support the premise that capital cost recovery over the useful vehicle life results in significant fare reductions and increased market penetration. The report also concludes that traditional vanpool fleet management approaches frequently result in retiring vans prematurely, leading to higher fares and excluding a large segment of the vanpool market, the 20-to-40 mi per direction commute. It suggests that, where possible, capital cost recovery through fares should be done over the useful van life of from 120,000 to 200,000 mi per unit, or up to 10 years. In addition, the perceived view among vanpool fleet managers that frequent van change-outs are required for customer acceptance, safety, and reliability is unsupported by experience. Although not all programs can use life-cycle capital cost recovery techniques because of the need for capital or borrowing power, those that can will enjoy a significant increase in market share for vanpooling, without subsidization, at reduced rider fares.

Just 15 years ago, in 1973, the concept of "van pooling" originated at the 3-M Company headquarters in Minnesota. Some things have changed since then. The term van pooling has been foreshortened to "vanpooling" and has become part of the transportation lexicon. An entire organization, the National Association of Vanpool Operators, has been created and subsequently subsumed into a yet larger entity known as the Association for Commuter Transportation (ACT).

These are some of the impacts vanpooling has made in its brief tenure—the first truly "new" commute transportation mode of modern times. As with all modes, it has its niche and its limitations. Insurance concerns, unfamiliarity, and financing continue to limit its potential. Yet, it also overcomes many inherent problems of other modes. Its size is ideal for most of the United States' predominant suburban land-use intensities. It overcomes the driver labor cost barrier of transit. It has greater versatility than transit, yet more stability than a carpool. Given these attributes, transportation planners and others have a vested interest in determining and securing the potential for this mode. It can generally be said that a 5 percent peak-period mode split for transit is quite achievable, and higher market share is attainable under favorable conditions. The point must soon come when a "market share" or "mode split" for vanpools can also be determined on a communitywide basis. Vanpools have yet to achieve visibility among mode-split forecasters. It is still not identified as a mode in planning models; rather, it is frequently lumped with carpools, transit, or paratransit.

This lack of identity places severe limitations on the growth and development of vanpooling, for several reasons. First, the contribution of vanpooling toward peak-period traffic congestion cannot be known and recognized unless its mode split is identified. Second, communities lack comparative data to assess their vanpool efforts and make programmatic adjustments. It follows that, for that which cannot be measured or no goals can be set, little will be achieved. This paper asserts two principles: (a) that the market potential for vanpooling is closely related to pricing mechanisms, and (b) that the market penetration potential for vanpooling is significantly beyond present achievements and that a concerted attempt should be made by transportation demand management and planning professionals to define explicit mode split targets for vanpooling and work for their achievement.

VANPOOL MARKET

It has been suggested in many studies and in practice that the primary target market for vanpooling is the over 20-mi one-way commute trip. At trip distances under 20 mi, time incurred in picking up passengers and the cost of operating a commuter van become major barriers to vanpool formation. In a typical company, the over 20-mi one-way trip market segment represents on the order of 25 percent of all employees.

Fares are a major consideration among prospective vanpoolers. In the next section, a comparison of two vanpool programs, one using a conventional lease period capital cost recovery, and the other using vehicle life-cycle cost recovery, are described and compared.

VANPOOL PRICING STRATEGIES

Vanpooling is an extremely cost-effective and energy-efficient mode, yet in the authors' opinion it is significantly underutilized. This is in large part because of conventional pricing techniques rather than technological or other limitations. If

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TABLE 1 VANPOOL LIFE CYCLE COST ANALYSIS, SEPTEMBER 6, 1988

Daily Round Trip Commute Mileage	Annual Vehicle Miles	Useful Life in Years	Annual Depreciation Cost ($)	Capital Cost Recovery ($)	
				Per Month Van	Per Month Rider
20	5,040	24	1,050	88	6
40	10,080	12	2,100	175	13
60	15,120	8	3,150	263	19
80	20,160	6	4,200	350	25
100	25,200	5	5,250	438	31

NOTE: Assumed useful life (miles) = 120,000; assumed unit cost = $25,000; assumed interest = none; depreciation method = straight line; assumed paying passengers = 14.

pricing and cost-recovery techniques are the biggest barrier, and these can be largely overcome, vanpooling can make a more substantial contribution toward relieving traffic congestion. To achieve this, vanpooling must become institutionalized. It deserves to have assigned to it a mode-split target as a discrete mode and a strategy for achieving that mode split. It is in this way that transportation planning goals are achieved.

There are three common approaches to vanpooling today: employee-operated, in which an employee owns or leases a van and provides services for from 6 to 14 others; company-operated; and, finally, commercial vendor-operated. Vanpool mode splits of 15 percent have frequently been achieved in company-sponsored vanpool programs. Yet, vendor-provided vanpools achieve an extremely low market share. For example, in the Southern California market, the average vendor-operated vanpool operates along a 45-mi one-way commute, compared to a 10-mi average commute among all workers. Its market is severely limited by its pricing method. The capital cost of each van is typically recovered from participants over a 3-to-4-year period. In company and employee-operated vanpools, in which the capital cost recovery period can be extended by choice from 4 to as long as 10 years, market penetration soars to 15 percent and greater, with one-way vanpool commutes falling to under 20 mi. It is interesting to note that, under both conditions, full capital cost recovery is achieved. At issue is the length of time allowed for recovery and the length of time a van is maintained in service.

Frequently, attempts to increase vanpool market penetration are made by advancing pricing schemes based on subsidies or less than full capital cost recovery. Such programs are usually severely limited by available funds. Companies are often dissuaded from implementing vanpool programs because of employee resistance to full cost recovery fares based on the customary 3-year vehicle lease. When companies decouple how they choose to pay for a van from how they recover those costs, they can base fares on life-cycle cost recovery principles. Fares can then be brought into a range acceptable to a majority of commuters, and pricing is essentially eliminated as a barrier to capturing full market share.

Life-cycle costing is a principle that considers how long a product will last before it is consumed. Costs are allocated evenly over that "useful life." Among programs using life-cycle costing, evidence indicates that a vanpool has a useful life in excess of 120,000 mi. On this basis, according to Table 1, a vanpool will last for 8 years in a typical 60-mi round-trip commute. At this rate, the monthly per mile depreciation cost of a $25,000 luxury van is just $263, or $19/month for each member of a 14-passenger van (assuming the 15th person, the driver, does not pay, as is typical of a standard vanpool operation).

To implement life-cycle costing, a third party (government agency, company, or individual) purchases a van either as a short-term lease (3 to 5 years) or a cash purchase. Then, the investment is recovered over the "useful life" of the van, depending on its daily mileage, and an assumed mileage life, say 120,000 mi. The cost of funds or interest on funds advanced in this manner is added to the costs recovered. Even with the additional interest, fares are significantly lower than typical vanpool fares, which are based on a loan repayment cycle rather than a vehicle life cycle. In vanpooling, the traditional 3-to-4-year commercial vehicle loan repayment cycle has little correlation to the useful life cycle of the van itself. Life-cycle costing principles for vanpool fleets have been adopted, in whole or in part, by the University of California at Los Angeles, the Aerospace Corporation, and the State of California, among others.

TWO APPROACHES TO VANPOOL SERVICE DELIVERY AND PRICING

The Aerospace Corporation

The Aerospace Corporation is located in the city of El Segundo, California, "aerospace" employment center south of Los Angeles International Airport. The center includes such major firms as GM/Hughes, Northrop, Rockwell, Xerox, TRW, and Aerospace. Total local employment approaches 100,000. The Aerospace Corporation employs approximately 4,000 predominantly professional people. The company maintains a commuter services office staffed by one full-time coordinator. Because of the company's commitment to ridesharing programs and the traffic congestion problem in El Segundo, Aerospace enjoys a 39 percent employee participation rate in ridesharing. The vanpool program operates over 60 vans, reflecting a vanpool market penetration or mode split of about 15 percent. The company provides adequate free parking to meet its needs, although the ridesharing program is currently needed to maintain a balance between demand and supply.

McDonnell Douglas Corporation

The McDonnell Douglas Corporation is located in nearby Long Beach, California. McDonnell Douglas was also fortunate to have ample parking facilities for its employees in the past. Recently, however, McDonnell Douglas has received

new government contracts and has begun construction on a new aircraft. Present employment is around 35,000 and expanding. Approximately 70 percent of the work force is professional. In the past, McDonnell Douglas saw no need for a ridesharing program because of excellent transportation facilities and ample parking. However, with growth, McDonnell Douglas is now awakening to the fact that the transportation facilities its employees rely on are becoming congested, and the once-huge parking lot is no longer adequate. With no prospects for additional parking lots and with the need to expand, McDonnell Douglas has found itself entering the ridesharing arena. Both Aerospace and McDonnell Douglas have recently come under a new 1988 air quality regulation that requires all firms with over 100 employees at a single work site to achieve a 1.5 average commute vehicle ridership between the peak smog production hours of 6 to 10 a.m.

Aerospace Employee Commuter Profile

In early 1988, Los Angeles-based Ekistic Mobility Consultants completed an extensive employee attitudinal and demographic commuter survey of 15 large El Segundo area technical companies, including the Aerospace Corporation. The survey was directed at residents of the South Bay of Los Angeles; however, a picture of the typical aerospace company employee emerges. The typical employee is a married (survey showed 66 percent) professional (62 percent) with an annual household income over $50,000 (50 percent). He or she tends to drive to work alone (83 percent) and is generally satisfied with commuting (84 percent). He or she tends to work in one location (89 percent) with few shift changes (93 percent). However, the overtime picture is not as rosy. The survey showed that 77 percent of the employees surveyed worked overtime, with 28 percent of those staying late 3 or more days a week and 38 percent 1 to 2 days a week. Worse yet is the fact that there seldom is advance notice of overtime (30 percent). Of the employees that stated on the survey that they would be interested in frequently using an alternate commuting mode to work (35 percent), 70 percent were male and most were in the 22 to 35 age group (43 to 36 percent were in the next highest age group, 46 to 65).

Although the survey did not include The McDonnell Douglas Corporation of Long Beach, it can be inferred that the employee demographics of McDonnell Douglas closely mirror those of the survey. Many of McDonnell Douglas's employees have worked for other aerospace firms in El Segundo and elsewhere in the past.

Aerospace Vanpool Program

The Aerospace Corporation has since 1975 operated a vanpool program that is available on a voluntary basis to its employees and those of the adjacent Los Angeles Air Force Station (LAAFS), the firm's major customer. The size of the work force at LAAFS is approximately equal to that of Aerospace. The vanpool program is entirely self-supporting and cannot be subsidized in order to permit Air Force personnel to participate in accordance with federal policies prohibiting participation in contractor-subsidized services.

Vanpool drivers and riders are covered under third-party automobile liability insurance purchased by Aerospace. The company is self-insured for comprehensive and collision. Charges for vanpool collision and comprehensive repairs are recovered from the vanpool program. Indirect staff costs to administer and promote the program are not directly charged to the vanpool program because these staff also promote and support other commute modes.

Van maintenance and fuel are charged to the vanpool program. Aerospace provides a full-service maintenance shop, including paint and body work, and a fueling station. Fuel attendants and maintenance labor are charged against the program. Instead of "running" the company vanpool program, Aerospace has established a method for the employees to run their own program. Because the program is self-supporting, Aerospace feels that riders and drivers know what is best for "their program." The program is governed by a vanpool Operator/Rider Council, a group of elected vanpool participants that provide policy and guidance for the vanpool program. The group is comprised of 11 operators and 11 riders, the term of office is 2 years, and meetings are held monthly. Issues the council discusses include fares, rider and driver policies, maintenance and safety programs, and vehicle purchase and refurbishment.

The success of the 60-plus-van Aerospace vanpool program lies in company sponsorship, employee participation in program direction, and low rider fares. The employees control "their program" and Aerospace supports the environment for success.

A partial listing of Aerospace's commuter van fares appears in Table 2. The fares listed for the shorter range commuter are under $50/month, far below comparable vendor-supplied vans for the same mileage. As is shown in Table 3, the per rider fare on a vendor van ranges from $100 to $120/month. Up to 150 round-trip mi, the Aerospace program has per rider fares below $100. Comparison with the McDonnell Douglas program will illustrate that low fares are key to accessing the 20- to 40-mi one-way commute market.

How has Aerospace been able to reduce per rider fares on its vanpools without subsidy, compared to vendor vans? The principal difference is that vendor vans are generally kept in

TABLE 2 COMMUTER VAN FARE TABLE: AEROSPACE CORPORATION

Daily Round Trip Mileage	Approximate Monthly Per Rider Fare ($)
30	45.00
40	49.50
50	54.50
60	59.00
70	63.50
80	68.00
90	72.50
100	77.00
110	81.50
120	86.00
130	90.50
140	95.00
150	99.50

NOTE: The above fares include lease interest, capital recovery, insurance, maintenance (labor and parts), fuel/oils, and washes. Prices effective September 1987.

TABLE 3 PRICE COMPARISON OF THREE VENDOR VANPOOLS AND THREE OWNER-OPERATED VANPOOLS (MCDONNELL DOUGLAS CORPORATION)

One-Way Commute Distance	Riders	Rider Fare Per Month ($)
40 miles		
Vendor lease	8	100
Owner-operated	7	85
		20/week
70 miles		
Vendor lease	10	117
Owner-operated	9	92
120 miles		
Vendor lease	14	120
Owner-operated	14	148
		35/week

service by the vendor for a maximum of 4 years or 80,000 mi. Once a van reaches either limit, it is replaced with a new van and the old one is sold. In contrast, the Aerospace program keeps vans in service for much longer periods. For example, several 1979-vintage vans were recently "retired" after 250,000 mi and 10 years of revenue service. It is important to note that safety remains a paramount consideration within the Aerospace program. Each van receives frequent safety checks and preventative maintenance. The oldest van currently in the fleet is a 1975 model with over 160,000 revenue service mi At appropriate intervals, usually around 120,000 mi, interiors are refurbished and engines are rebuilt, and the van continues to roll. By keeping older vans on the road through an excellent maintenance program, the capital cost of the vehicle can be amortized over a greater number of years. The single most costly item for a vanpool program is the purchase of new vehicles. Such costs include higher interest rates, more costly units, dealer preparation costs, sales taxes, and increased vehicle registration and insurance fees associated with new vehicles. These costs can be deferred or avoided through an extended vehicle retention program. By delaying the purchase of new vehicles and making old ones last longer, a program can reduce rider fares and penetrate shorter range van commute markets.

It is frequently perceived that older vans are unreliable and that riders insist on riding new vans. Performing routine maintenance and replacing old parts before they break have kept the Aerospace "old" fleet on the road with a minimum of breakdowns. Careful attention is also paid to maintaining appearance, with body work and new paint used to instill pride in the fleet and not draw attention to the age of the units. Van design has changed minimally over the years—a 1979 model in good condition looks similar to a 1989 model. There is little embarrassment in riding in an older van because all vans look similar. Riders also get attached to a van. Once they have ridden in it for a number of months they frequently resist a replacement. They get accustomed to minor imperfections and prefer lower costs to new vans. The frequently-held perception of requiring new vans for customer acceptance, safety, and reliability has not been substantiated by the Aerospace experience.

Impact on fares of additional interest costs with life-cycle costing approach

The additional interest cost between traditional lease cost recovery and life-cycle cost recovery schemes is an important consideration. In the Aerospace case, the traditional lease already includes the normal interest charge for the amortized capital loan and is recovered through fares. Aerospace management has elected not to charge its vanpool program interest for the extended portion of capital cost recovery beyond the lease expiration. However, the potential impact on Aerospace vanpool fares for the additional interest can be estimated. Assuming that Aerospace advances an estimated $10,000 per unit to offset the difference between its monthly lease payments and the amount it collects from riders over that same period, the approximate additional carrying cost in interest cost is $60,000/year for 60 vans at 10 percent per year. Assuming 11 paying riders per vanpool, this amounts to about $1,000 per van annually, or about $8 per rider per month. The median fare is approximately $70. Thus, the interest recovery impact of life-cycle cost recovery would increase average fares by approximately 11 percent. These fares are still substantially lower than those under conventional capital cost recovery schemes.

McDonnell Douglas Vanpool Program

Until November 1986, The McDonnell Douglas Corporation had no official ridesharing program. In November, a new position of employee transportation coordinator (ETC) was created, accompanied by a modest budget. An initial "ride-matching" survey got an encouraging 47 percent return. Obviously, McDonnell Douglas employees were ready for something new. While company management reviews the option of company-sponsored vans, McDonnell Douglas employees, hampered by a modest program budget, currently access vans through two options: vendor vans and owner-operated vans.

McDonnell Douglas's vanpool program now has 19 vans and 6 in the process of forming. One vendor provides a representative on site 2 days a week to help the ETC form vanpools. McDonnell Douglas has made rapid progress in building the young van fleet over a 6-month period. Initially, some employees were turned off by the prospect of dealing with a van vendor and assuming much of the responsibility and administration of a van. Still others attempted forming vans, only to find that the costs per rider were too high to attract riders. One 40-mi one-way van recently disbanded because rider fares were too high to maintain ridership. (Subsequent to this paper, the McDonnell Douglas management approved a company-sponsored vanpool fleet at its Long Beach operations. The company has a long association with vanpooling, dating back to 1980 at its St. Louis, Missouri, area program. The St. Louis operation is the largest in Missouri, with over 100 vans in operation as early as 1981.)

As shown in Table 3, vendor per rider costs including fuel exceed $100/month independent of trip length. With a fare that high, commuters in the shorter-range markets resist the price; the convenience of the personal automobile and free

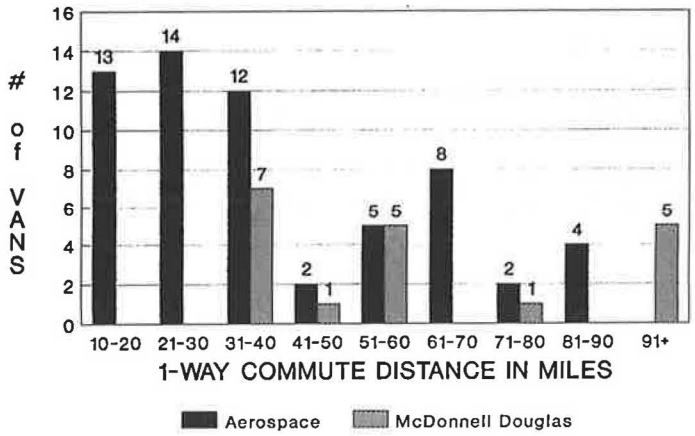

FIGURE 1 Vanpool market penetration.

parking become powerful deterrents. People at greater distances, however, will accept a higher fare because of the mileage involved and the higher costs of solo commuting (physical as well as economical).

The average mileage driven by the McDonnell Douglas vendor vans is 65 mi one-way, or 130 mi round-trip, far in excess of the 20 mi/day driven by the average commuter and far greater than the 35 one-way mileage average for Aerospace vans. As evidenced in this study and confirmed in other company programs, without subsidies the vendor van program has not proven to be able to service the substantial 20-to-40-mi one-way trip market. This means that the 25 percent "vanpool market" of commuters residing over 20 mi as discussed earlier is reduced by per rider fares to perhaps a 5 to 10 percent market. A point of interest is that the shortest van trip for McDonnell Douglas is 40 mi one-way, 80 mi round-trip, whereas the Aerospace Corporation vanpool program has vans traveling as few as 15 mi each way (see Figure 1).

Aerospace is able to penetrate the under-20-mi one-way commuter market by per rider cost reduction. Since neither program is directly company subsidized, the reduction in per rider fares attributable to the Aerospace program is realized primarily by eliminating vendor profit and by longer van retention and extended capital cost recovery.

Another interesting phenomenon is that the McDonnell Douglas program has twice as many owner-operated vans as Aerospace's program, despite its smaller overall fleet size. Over 31 percent of McDonnell Douglas's program is owner operated compared to just 5 percent for Aerospace's program. By comparing per rider costs of owner-operated vans to vendor-supplied vans (Table 3), it can be seen that the owner-operated option can provide lower per rider fares. The reduced per rider cost suggests why there is an abundance of owner-operated vans in the McDonnell Douglas program. However, by comparing the owner-operated fares for each distance to Aerospace's fares in Table 2, the additional savings of longer fleet vehicle retention can be illustrated. For example, for a 40-mi round trip the vendor per rider fare is around $120/month, whereas the owner-operated per rider fare is only $85. The Aerospace fare for that same 80-mi round trip is only $68. The company program has the potential to trim per rider fares further than an owner-operated van program.

CONCLUSIONS

Although The Aerospace Corporation has only 4,000 employees and The McDonnell Douglas Corporation over 35,000, Aerospace has been able to operate over 60 vans, with many penetrating short-distance commute markets of under 20 mi one-way, by reducing its per rider fares. McDonnell Douglas, although serving a potential market four times as large, has been only able to reach the over-40-mi one-way trip market with fewer than 20 vans through a vendor- and owner-operated van program.

Vendor-operated programs result in fares in the $100 to $120 range. A $120/month fare is acceptable in the long-distance commute market (even Aerospace's fare can reach $114/month) but cannot compete in the larger medium- and short-range markets. The McDonnell Douglas program, relying primarily on vendor vans, has been unable to penetrate the under-40-mi market and only a limited portion of the over-40-mi one-way trip market, typical for a vendor program. In response to the high per rider fares of the McDonnell Douglas program, a substantial owner-operated fleet is emerging. Owner-operated vans have the potential to have fares below the $100/month floor of vendor vans and could tap into markets under 40 mi one-way.

A company-sponsored program such as Aerospace's, through fleet purchasing, economies of scale, and extended vehicle life, has the potential to reduce per rider fares to a level of $50/month or lower, and access the 20-to-40-mi one-way trip market. Of Aerospace's 61 operating vans, 18, or 30 percent, serve the below-40-mi one-way market. By maintaining low fares, Aerospace has been able to penetrate additional markets unreachable by unsubsidized vanpool programs.

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Cost-Effectiveness of Private Employer Ridesharing Programs: An Employer's Assessment

FREDERICK J. WEGMANN

The benefits derived from ridesharing are varied and accrue to a variety of individuals and groups. The beneficiaries may be classified into three general groups—employees, employers, and the community. The benefits that accrue to employers are not as well understood, but they are essential to the marketing of ridesharing in times of stable or declining energy prices. Although ridesharing can be accepted as good business practice and as an aid in enhancing the corporate image, to achieve employer support frequently a case needs to be established that ridesharing is not just public relations but returns distinct and tangible benefits to the employer. The objective of this paper is to document the costs and benefits available to private-sector employers through the operation of employer ridesharing programs. Special consideration was given to employers having a direct involvement in operating a corporate ridesharing program. An analysis of the responses from 160 private employers indicates a positive assessment of ridesharing's cost-effectiveness. Respondents were requested to provide specific monetary estimates of the benefits derived from their ridesharing programs. Although the employers did recognize and acknowledge the presence of benefits, most could not quantify the benefits. Most of the benefits cited were of an intangible nature—reduced absenteeism, enhanced corporate image, reduced employee tardiness, and so on. Many employers did not have a specific economic criterion on which to initiate corporate rideshare programs but were more concerned with employee and community benefits. Thus, it is clear that the data base necessary to generate cost-benefit analyses does not exist. Even though the benefits cannot be quantified, they are perceived by employers as being real and present.

The benefits derived from ridesharing are varied and accrue to a variety of individuals and groups. The beneficiaries may be classified into three general groups—employees, employers, and the community. Employee and community benefits have been well documented by numerous studies. The benefits that accrue to employers are not as well understood, but they are essential to the marketing of ridesharing in times of stable or declining energy prices. Although ridesharing can be accepted as good business practice and as an aid in enhancing the corporate image, to achieve employer support frequently a case needs to be established that ridesharing is not just public relations but returns distinct and tangible benefits to the employer. In supporting ridesharing, employers usually absorb some organizational and administrative costs. If the ridesharing program involves operating company-owned vans, the employer is assuming a financial risk in laying out the initial investment. Although actions can be taken to limit risk through abort clauses or leasing, the employer has still committed substantial organizational resources on behalf of ridesharing.

McIntyre and Maxwell (*1*), Commuter Transportation Services (*2*), and Dingle Associates (*3*) have identified the reasons why corporations have become involved in ridesharing and have undertaken the risks of vanpooling without any hopes of turning profits. These studies have indicated that some of the most direct advantages are to (a) reduce parking costs, (b) make parking space available for expansion, (c) reduce congestion, or (d) satisfy zoning or air pollution requirements. Some corporations have noted that ridesharing has favorable impacts on reducing employee tardiness, absenteeism, and turnover rates. Likewise, corporations have been able to retain existing employees through ridesharing. These tangible and intangible benefits must then be compared against program costs.

The objective of this paper is to document the costs and benefits available to private-sector employers through the operation of employer ridesharing programs. Special consideration was given to employers having a direct involvement in operating a corporate ridesharing program. The 1985 nationwide canvass of over 897 employers provided useful information from 230 employers (of which 160 were private) concerning

- Status of ridesharing activities at the employment site;
- Characteristics of the employer—size, location, ridesharing services provided, and so on;
- Parking benefits provided by the employer;
- Cost of ridesharing, parking, and transit incentive programs;
- Employer attitude toward ridesharing; and
- Cost-effectiveness of ridesharing.

DATA COLLECTION PROCEDURES AND CHARACTERISTICS OF RESPONDENTS

Ridesharing effectiveness was assessed through a mail survey of firms with current or past experience with ridesharing. Representatives of these firms were requested to identify the costs and benefits derived for operating the ridesharing pro-

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gram. Special emphasis was placed on corporate ridesharing programs because these employers have corporate resources directly at risk. No attempt was made to structure a scientific sample; rather, the survey attempted to gain insight concerning firms with ridesharing experience. Where a corporate representative was able to provide general estimates of benefits, a follow-up telephone call was instituted in an attempt to define the benefits in monetary terms. The results of the follow-up survey are reported in a case study analysis of 20 companies. Of the 160 respondents from the private sector, 19 were judged to have inactive ridesharing programs, whereas 141 were judged to have active ridesharing programs.

Inactive programs were defined as not having current ridesharing participation, participation limited to a rideshare matching service, or a limited employee-owned and operated vanpool program. Active programs were characterized by employers actively financing and supporting an employer-sponsored vanpool program, a large third-party or employee vanpool or carpool program, or a corporate transit incentive program.

Because the conclusions of this report are based on a sample of 160 employers, it is important to identify the characteristics of the employers responding.

Location

Employers were concentrated in three geographical locations—27.3 percent were in central business districts (CBDs); 25.9 percent were within the city limits, but not downtown; and 36.7 percent were in suburbs. Only 10.1 percent of the respondents were located in rural areas or small towns. Thirty-eight percent of the respondents were located in the Mid-Atlantic and Northeast region, followed by 17 percent in the Northwest and West Coast, 16 percent in the Midwest, 16 percent in the Southeast, and 13 percent in the Southwest.

Industry

The firms included in the survey came from a diversity of industry types (finance, 26 percent; manufacturing, 21 percent; engineering services and research technology, 17 percent; energy, 12 percent; and pharmaceutical, health, and hospitals, 9 percent).

Number of Employees

The survey was designed to obtain information on only one employment site, preferably the site with the greatest ridesharing activities. The distribution of private-sector employers (where n = 160) was noted as follows:

Employees	*Private-Sector Employers (%)*
0–500	25.7
501–1,000	12.6
1,001–2,500	31.8
2,501–5,000	20.0
>5,000	6.8
No response	3.1

The average number of employees per site was 3,000 for the urban and suburban locations and 1,350 for the small town and rural locations.

Parking Shortages

Over 33 percent of the employers indicated that they experienced parking shortages at their employment locations. A cross-tally with size of employer indicated that the parking shortage was most critical with the larger employers. Yet for all employment size classes, at least 20 percent of the respondents indicated parking problems. Only in the case of the CBD employers did the majority of respondents indicate parking problems. Interestingly, 32 percent of the employers in urban non-CBD areas and 18 percent of the employers in rural areas indicated experiencing parking shortages.

Mode Shares

Sixty-eight percent of employees arrived at work by driving alone, less than 1 percent used rail transit, 7.4 percent used bus transit, 16.7 percent used carpools, and 7.2 percent used vanpools. Bus and rail transit accounted for 17 percent of the workers in CBDs. In small town and rural locations, carpooling and vanpooling accounted for over 35 percent of the workers' daily trips to work. Carpooling and vanpooling together represented over 25 percent of the work trips made in suburban as well as CBD locations. Little variation was noted for mode split by size of employer. The percent traveling by vanpooling was higher than the national average, indicating the strong interest in ridesharing by the respondents.

EMPLOYER RIDESHARING AND PARKING COSTS

Assessing ridesharing's cost-effectiveness involves identifying program costs as well as benefits. Discussed in this section are the annual direct costs associated with operating a vanpool program, transit incentive program, or ridesharing matching service. Staff time to oversee and administer a ridesharing program is also reviewed. Because the provision of parking at the employment site is a form of employee transportation subsidy, these costs are also documented and will be compared with ridesharing costs.

Parking Costs

Work Site Parking Policies

Traditionally, it is well accepted that commuting is an individual's responsibility, not of concern to the employer. Yet free parking at the employment site is expected and can represent an extensive expenditure on behalf of the employees. Significantly, 78 percent of the employers participating in this survey provided free parking for their employees. An additional 10 percent charged employees for parking but not enough

TABLE 1 ESTIMATED COST TO EXPAND PARKING

Parking Expansion Cost per Space	No. of Responses	Percent of Responses
$0-$500	6	15.8
$501-$1,000	11	28.9
$1,001-$2,000	6	15.8
$2,001-$5,000	6	15.8
$5,001-$10,000	6	15.8
≥$10,000	3	7.9
	38	100.0

Average = $3,920 per space

to cover costs. Parking then is clearly an employee benefit or transportation subsidy provided by the employer.

All responding employers in rural areas and small towns provided parking at no charge or a partial charge to their employees. Correspondingly, fewer than half of the employers located in CBDs assessed no charge for parking. Over 25 percent of the CBD employers expected employees to cover the full costs of parking. Parking charges showed little variation by employer size. A smaller percentage of large firms (more than 2,500 employees) actually charged full costs for parking than did small firms, although the difference was only a few percentages. Over 50 percent of the employers experiencing parking shortages provided for free parking.

Employer Parking Costs

Employer parking costs varied extensively with the geographical location of the employer, type of parking (structure versus surface lot), and the actual cost items allocated to parking. Some employers indicated that estimates of parking costs were not available because parking costs were not segregated from building lease costs or could not be separated from different functions such as security, building maintenance, and so on. It can be expected that some survey respondents were not aware of the full costs of providing employee parking, including items such as lights, security, traffic control, taxes, land, or depreciation. Typical costs that were identified were yearly striping costs, surface cleaning, and pavement resurfacing every 2 to 3 years. In some climates snow removal was noted as a major expense. The average annual parking cost was estimated to be $64 per space. While modest on a per-space measure, parking can become quite expensive when applied to all the spaces provided. The aggregate free parking costs some large employers $150,000 to $200,000/year. Free parking or reduced cost parking can be considered an employee fringe benefit or subsidy.

For the 72 private firms providing complete data on parking costs, the average total annual financial commitment came to $112,000/year or $73.50 per employee. Over 18 percent of the private firms paid in excess of $200,000/year for employee parking and 11 percent paid over $250 per employee.

Cost of Expanding Parking

The cost to expand parking facilities is a major capital commitment borne by the employer. Thirty-eight respondents estimated the cost to increase the existing supply of parking, as noted by Table 1. The higher cost estimates are associated with constructing garages in areas of high land values such as the CBD. The lower costs are related to expanding surface lots where land has already been purchased. Reduction in parking or possibility of avoiding expanding parking are tangible benefits that an employer can receive from ridesharing. The concept of "free parking" is a misnomer, and "free parking" can represent a sizable annual expenditure for the employer.

Ridesharing Costs

Ridesharing costs can be stratified into a number of different cost categories, including carpool and vanpool operating subsidies, costs associated with administering a ridesharing program, and costs for a transit incentive or priority parking program.

Firms were requested to report the cost of staff time devoted to ridesharing activities. Although the ability to track all relevant activities and to provide a reliable cost estimate will vary between firms, expenditures will be influenced by the actual ridesharing activities provided. Ridesharing coordinators can provide assistance in promoting ridesharing, conducting matching surveys, distributing literature, and contacting individuals to help form ridesharing arrangements. In many communities the employer's rideshare activities are

supplemented by the support of a community ridesharing agency. In these cases the employer's costs can be quite minimal.

As the employer undertakes the responsibility of owning and operating vanpools, relieving the employees or a third party of this responsibility, the employer's administrative commitment becomes more extensive. Many employers operating large employer-based ridesharing programs required the retention of a full-time ridesharing coordinator.

Thirty-two firms with employee-owned or leased or third-party vanpool programs provided estimates of the annual costs involved in administering the ridesharing programs. A full 65 percent stated that there was no measurable staff time or that costs were minimal. The average annual cost for all firms reporting an administrative expense was $4.50 per employee or $3,000/year. From the above analysis it is clear ridesharing activities can be supported at the corporate level with little cost to the firm. As the firm assumes direct responsibility for ownership and operation of the vanpool program, the administrative costs become more substantial. Again, firms with just a few vans frequently report negligible administrative costs. When considering the experience of 58 firms operating employer-owned or leased vanpool programs, 33 percent still reported minimal administrative costs. The average cost was $889 per van per year or $23,000 per firm. These costs will be included as part of the costs to operate a vanpool program and will be discussed in more detail in the vanpool cost subsection.

Employer Vanpooling Costs

Vanpooling can become a major rideshare cost commitment for an employer. Because of the size and nature of these ridesharing activities, the cost estimates need to be discussed in more detail.

Firms providing employer vanpool programs have made a strong commitment to ridesharing. Sixty-seven private firms indicated that they were providing vanpool services for employers either by leasing the vehicles or by outright ownership of the vans. Unlike employee-owned and operated vanpools or third-party leases from an organization other than an employer, the employer is directly at risk for the financial success of the vanpool. In addition to assuming risk, the firm also may elect to subsidize the vanpool program as an employee-assistance benefit. The subsidy can be regulated by adjusting the fares. Any cost-effectiveness equation must consider the extent of the vanpool subsidy. However, through the collection of revenue it is possible for an employer to control the amount of subsidy. In fact, if vanpooling is successful, it is possible for the employer to collect adequate revenue to cover all direct costs and even to reimburse the employer for administrative costs associated with operating the ridesharing program. Although there may be free parking, there is no equivalent free vanpooling.

Vanpool costs include direct operating costs (fuel, maintenance, depreciation, insurance) but exclude administrative costs associated with the program. Another factor to consider on the revenue side of the equation is the availability of tax credits generated through ownership of the vehicles. Tax credits are a return to the firm and can be used to defray part of the expenses of operating the vanpool program. Fourteen percent of the respondents include dollar estimates for tax credits.

Employer Vanpooling Subsidy

Break-Even or Positive Return Programs

Of special interest were the 58 corporations included in the survey operating employer vanpool programs. These firms operated a total of 1,236 vans for an average of 23 vans per firm. Without considering administrative cost, 36 percent of the firms operating vanpool programs indicated that they set riders' fares adequate to cover all operating costs. Interestingly, an additional 5 percent used tax credits to cover operating costs. Twenty-one percent set rider fares high enough to provide a net positive return to the firm. Before including administrative costs, 50 percent of the vanpool programs were operating at a financial break-even point or better.

When administrative costs are included, assuming that all administrative costs are allocated against the vanpool program (excluding other program elements such as transit incentives or ridesharing matching), the number of break-even vanpool programs was reduced to 10. Four programs still realized revenues exceeding costs. Almost one-quarter of the programs then had no direct expenditures in operating employer vanpool programs. Any benefits received by these employers for operating the program will provide a very attractive cost-effectiveness ratio.

Subsidized Vanpool Programs

For the programs not able to break even or provide a positive return, the extent of the rideshare subsidy is of interest. Subsidy levels per van, with and without administrative costs, are shown in Table 2. In addition, total program subsidies are noted in Table 3. When administrative costs are not allocated to vanpooling, the average subsidy is $1,283/year per van. Administrative costs increase the subsidy by approximately $70/year per van. Significantly, even with administrative charges, 60 percent of the firms pay from nothing to less than $10,000/year to support ridesharing programs. The average cost per employee, based on total employment at the work site and not just those employees who vanpool, is only $12.35/year per employee. This per-employee expenditure is only one-sixth what employers spend for free parking per employee ($12.25 versus $73.50 per employee). Although not all employees participate in vanpooling, where such programs can substitute for providing additional "free" parking, they can be cost-effective to the employer. Vanpool commitments can be quite extensive, but program costs are a fraction of an employer's commitment to employee parking.

Assessment

Eighty-four percent of the firms believed ridesharing was cost-effective, and all but four acknowledged a benefit being derived

TABLE 2 ANNUAL SUBSIDY PER VAN FOR EMPLOYER VANPOOLS, SAMPLE OF 58 CORPORATIONS

Excluding Ridesharing Administrative Costs		Including All Ridesharing Administrative Costs	
Subsidy/Program (dollars)	Number of Responses	Subsidy/Program (dollars)	Number of Responses
1-99	0	1-99	1
100-499	6	100-499	11
500-999	7	500-999	10
1,000-1,999	6	1,000-1,999	11
2,000-2,999	4	2,000-2,999	7
3,000-3,999	2	3,000-3,999	1
≥4,000	0	≥4,000	3
None	33	None	14
	58		58
Average Subsidy per Van			
All Programs	$521		$973
Only Programs Subsidized	$1,209		$1,283
No. of Subsidized Programs	25		44

from the firm's involvement in ridesharing. The major benefits identified for the vanpools were as follows:

Benefit	*Percent of Respondents Mentioning*
Good public relations	70
Reduced absenteeism	59
Reduced tardiness	53
Retained valued employees	40

The four firms acknowledging no benefits at all had encountered adverse economic conditions or had recently merged, requiring a reduction in employment.

RIDESHARING COST-EFFECTIVENESS AND BENEFITS

Cost-Effectiveness

The bottom-line question asked of the 141 active private employers with active ridesharing programs was, "Do you feel that your ridesharing and/or priority parking programs are cost-effective?" Fifty-seven percent of the private firms operating active ridesharing programs indicated ridesharing was definitely cost-effective, with an additional 17 percent indicating ridesharing was marginally cost-effective. Only 7 percent responded negatively, and 18 percent stated they did not know. By comparison, 57 percent of the private firms not actively engaged in ridesharing did not know, which could be expected as they had no experience with this form of transportation service. It is impressive that firms with active ridesharing programs thought ridesharing was cost-effective at a ratio of almost 3 to 1 over firms with inactive programs, highlighting the need for those experiencing benefits to communicate the positive attributes of ridesharing to other employers. Responses indicated an overwhelming positive attitude toward ridesharing by private firms with active ridesharing programs.

Benefits

Respondents were requested to indicate if their firms experienced benefits associated with ridesharing. Although the extent of benefits was sought as a dollar value estimate, a positive or negative reply was also requested. Sixty-eight of the private firms responded positively to one or more benefit categories.

TABLE 3 ANNUAL SUBSIDY PER RIDESHARE PROGRAM FOR EMPLOYER VANPOOLS, SAMPLE OF 58 CORPORATIONS

Excluding Ridesharing Administrative Costs		Including All Ridesharing Administrative Costs	
Subsidy/Program (dollars)	Number of Responses	Subsidy/Program (dollars)	Number of Responses
1-4,999	11	1-4,999	14
5,000-9,999	6	5,000-9,999	7
10,000-49,999	5	10,000-49,999	19
50,000-99,999	1	50,000-99,999	1
100,000-199,999	2	100,000-199,999	1
≥200,000	0	≥200,000	2
None	33	None	14
	58		58
Average Subsidy per Program			
All Programs	$14,732		$30,095
Only Programs Subsidized	$34,046		$39,671
No. of Subsidized Programs	25		44

Noted in order are positive responses from private employers operating ridesharing programs.

Benefit	*Percent Noting Favorable Response*
Reduces employee tardiness	49.6
Improves public relations	48.9
Reduces absenteeism	36.2
Helps retain valued employees	29.8
Reduces need to construct parking	22.7
Permits other use of previous parking area	14.2

The intangible benefits prevail with emphasis on tardiness, public relations, and absenteeism. Site-specific benefits were valued less than benefits that can be appreciated by a firm regardless of its site location. Although only one benefit category was selected by over 50 percent of the respondents, the diversity of benefits indicates a broad satisfaction with ridesharing.

CASE STUDIES

Although the respondents to the original survey were requested to provide quantitative estimates of the benefits derived from operating corporate ridesharing programs, few were able to comply. Follow-up telephone contacts were made with 20 employers in order to convert general estimates of benefits into annual monetary values. The follow-up contacts concentrated on private employers who were operating employer vanpool programs.

Generally, the individuals contacted felt the estimated benefits derived from vanpooling were real and tangible values, but they had difficulty in converting benefits into monetary values. In many cases, situations and amplifications were cited to demonstrate that the benefits were actually received. One particular problem is defining monetary benefits derived from reduced absenteeism, tardiness, and employee turnovers. Through conversations, attempts were made to estimate these intangible benefits through an analysis of person-hours saved, under the assumption that the employer suffers a negative consequence if a worker is either late or absent. These estimated benefits are clearly separated from the stated benefits in the ensuing sections of this paper. Absenteeism and tardiness were costed at $5/hr in wages and were based on a 2,000-hr work year per employee. The percent reduction attributed to vanpooling was then applied to the yearly person-hours representing the vanpooling segment of the work force. Tardiness was defined to represent 15 min late. Although approximate, these procedures should reflect the general magnitude of benefits received from corporate rideshare programs and allow comparisons with program costs.

TABLE 4 SUMMARY OF BENEFIT-COST RATIOS, LARGE VANPOOL PROGRAMS 1 THROUGH 4

	1	2	3	4
Employees	12,700	2,200	7,000	14,000
Number of Vanpools	115	20	92	54
Number of Employees	990	180	1,120	518
Reason for Initiating Vanpooling	Need to reduce parking to permit expansion	Need to retain trained employees with a relocation	Energy conservation, and relocation to new site and wanted to retain employees	Lack of transit and improve air quality
Is Ridesharing Cost-Effective?	Definitely	Definitely	Definitely	Definitely
Extent of Benefits				
Reduced Absenteeism	NA --	Yes 10% $180,000[b]	Yes 7.5% $840,000[b]	Yes 15%[a] $2,331,000
Reduced Need to Construct New Parking	Yes $900,000/yr[c]	No	Yes $250,000/yr	No NA
Help Retain Valued Employees	No	Yes NA	Yes NA[d]	Yes NA[e]
Reduced Employee Tardiness	Yes 10% $30,937[b]	Yes 5% $2,812[b]	Yes 7.5% $26,250[b]	Yes 20% $338,500
Permitted Utilization of Previous Parking Area for Other Activity	Yes	No NA	No	No $300,000
Improved Public Relations	NA	Yes NA	Yes NA	NA
Other	--	--	Relieves stress on employees	Employees arrive early
Dollar Value of Benefits Stated/Year	$900,000	NA	$250,000	$2,719,500
Dollar Value of Benefits Estimated/Year	$930,937	$182,812	$1,116,250	--
Vanpool Program Costs per Year (Net Cost)	$77,000	$3,179	$55,100[f]	$220,000
Stated Benefit-Cost Ratio	11.7	NA	4.5[f]	12.4
Estimated Benefit-Cost Ratio	12.1	57.1	20.3[f]	12.4
Aggregated Direct Benefits	$920,000	NA	$194,900	$2,499,500

[a]Estimate of absenteeism and tardiness based on 1976 study. Actual hourly salary of $15-$18/hour.

[b]Estimated value based on percent of vanpoolers at $5/hour and 250 work days per year. Absenteeism assumed 8 hours per work day; tardiness assumed 15 minutes per worker.

[c]Allowed construction of new building on property originally designed for added parking.

[d]Estimated cost to train a new employee is $10,000 per year.

[e]Actual cases have been cited where employees have been offered jobs elsewhere, even at increases in salary, but because of vanpool programs they have stayed with the corporation.

[f]Less tax credit; actually there are no costs to employer.

Estimate of Benefits

Tables 4 through 8 provide a summary of the data and resulting benefit-cost ratios calculated for the 20 employers. Direct benefit-cost ratios are separated from estimated benefit-cost ratios where percent reductions in tardiness and absenteeism were converted to monetary values. Most clearly defined as a benefit from ridesharing was the ability of an employer to use vanpooling to avoid constructing additional parking spaces. This benefit is stated with a high degree of accuracy and confidence. Firms that went through a process of relocation found vanpooling to be valuable in retaining employees. Employee training costs were stated to be in the range of $10,000 per employee. It was suggested by a number of employers that retaining employees is a major contribution offered by vanpooling, which is frequently overlooked. Although only one firm had made a formal study of reduced absenteeism and tardiness attributed to vanpooling, most of the 20 employers reported reductions in absenteeism and tardiness in the range of 5 to 10 percent. Although these benefits are intangible, the respondents felt the benefits were real and had confidence in the percent reduction figure based on actual observations. Only a few employers placed an economic value on improved public relations, although many felt the vanpool program reflected favorably on the corporation. The footnotes to Tables 4 through 8 record comments made during the telephone conversations.

The 20 case studies can be separated into large programs—those with more than eight vans per program—and smaller programs. Of the 12 large programs included in the sample, 10 indicated that the vanpool program was definitely cost-effective. One program involving 37 vans initiated because of relocation to a new site was assessed as not being cost-effective. In fact this program did not achieve sufficient stated benefits to cover costs. However, when estimates were included for absenteeism and tardiness, the program did achieve a positive benefit-cost ratio. The one marginal response involved a program receiving a stream of benefits at no cost for operating the vanpool program.

Representatives for four of the smaller programs stated ridesharing was definitely cost-effective, whereas three programs were assessed as being either marginal or not cost-effective. One response was not provided. The representative of a program involving four vans stated that ridesharing was cost-effective but did not achieve a stated or estimated benefit-cost ratio exceeding 1. Similarly, one of the programs involving four vans and initiated as a program for energy conservation was not cost-effective. An analysis of the stated and estimated benefit-cost ratios verified this contention. The other two small programs for which marginal assessments were stated both had positive benefit-cost ratios. The limited sample indicates that large programs have a closer assessment of the role of an employer vanpool program and the returns it provides for the company. Although small programs are seen as less cost-effective than large ones, cost-effectiveness obviously depends on local circumstances surrounding the program.

Benefit-Cost Ratios

As noted in Table 9, out of the 20 case studies, 14 respondents judged their corporate vanpool programs to be definitely cost-effective. Three smaller programs were felt to be marginally cost-effective, whereas one large and one small program (less than six vans) were evaluated as not being cost-effective. The negative assessments reflected corporations in the energy sector, which had suffered major contractions in employment. Three programs were defined as having a benefit-cost ratio of less than 1, while four programs realized a flow of benefits with the vanpools operating at break-even cost. In all cases these benefit-cost ratios were derived from estimates provided directly by the respondents. When estimates of reductions of tardiness and absenteeism are included, the benefit-cost ratios become more favorable. Only in two cases did the benefit-cost ratio not exceed 1. Both of these programs would be characterized as having a strong management commitment to ridesharing with a substantial employer subsidy. However, because of reduced employment, it has been increasingly difficult for the vanpool program to operate.

The 20 case studies indicate that corporate vanpooling programs can generate benefits exceeding costs. Attractive returns are received by many corporations sponsoring vanpooling programs. It is clear that there are a variety of problems and opportunities stimulating interest in corporate vanpooling.

CONCLUSION

An analysis of the responses from 160 private employers indicates a positive assessment of ridesharing's cost-effectiveness. Respondents were requested to provide specific monetary estimates of the benefits derived from their ridesharing programs. Although the employers did recognize and acknowledge the presence of benefits, most could not quantify the benefits. Most of the benefits cited were of an intangible nature—reduced absenteeism, enhanced corporate image, reduced employee tardiness, and so on. Many employers did not have a specific economic criterion on which to initiate corporate rideshare programs but were more concerned with employee and community benefits. Thus it is clear that the data base necessary to generate cost-benefit analyses does not exist. Even though the benefits cannot be quantified, they are perceived by employers as being real and present.

An important finding is that even in cases where employers took on major commitments for operating corporate vanpooling programs and administrative charges were excluded, 56 percent of the firms were able to operate these programs at a financial break-even point or better. Fares and available tax credits were used effectively by private employers to cover all operating expenditures of corporate vanpool programs. Any positive return in the form of benefits can then provide an effective benefit-cost ratio. This finding needs to be communicated to a maximum number of employers. Even with all rideshare administrative costs being applied against the vanpool program, 25 of the programs will still be able to break even or return a profit.

Free parking is accepted as an employee benefit. Unfortunately, free parking can consume extensive corporate resources. Many employers are not aware of the full cost of providing free parking. Ridesharing, especially corporate vanpooling, can be provided at a fraction of the cost of expanding parking. Thus, vanpooling can be used to avoid the capital and operating costs of expanding parking capacity. In general,

TABLE 5 SUMMARY OF BENEFIT-COST RATIOS, LARGE VANPOOL PROGRAMS 5 THROUGH 8

	5	6	7	8
Employees	3,000	3,500	6,000	200
Number of Vanpools	25	70	54	8
Number of Employees	240	525	750	80
Reason for Initiating Vanpooling	Employee benefit	Employee benefit	Energy conservation	Relocation to new site
Is Ridesharing Cost-Effective?	Definitely	Definitely	Definitely	Definitely
Extent of Benefits				
Reduced Absenteeism	NA	NA	Yes 2% $13,650	Yes 5% $40,000[a]
Reduced Need to Construct New Parking	Yes $50,000	Yes $25,000	No	No
Help Retain Valued Employees	NA	NA	Yes	No
Reduced Employee Tardiness	NA	NA	Yes 2% $1,000	Yes 10% $2,500[a]
Permitted Utilization of Previous Parking Area for Other Activity	NA	NA	No	No
Improved Public Relations	NA	NA	Yes	No
Other	---	Rent out vans during day = $20,000		
Dollar Value of Benefits Stated/Year	$50,000	$45,000[b]	$14,650	---
Dollar Value of Benefits Estimated/Year	---	---	---	$42,500
Vanpool Program Costs per Year (Net Cost)	$17,000	$20,000	Breakeven	$ 2,000
Stated Benefit-Cost Ratio	2.9	2.3	Benefits no cost to employer	---
Estimated Benefit-Cost Ratio	2.9[c]	2.3[c]	NA	21.2
Aggregated Direct Benefits	$33,000	$25,000	NA	NA

[a]Estimated value based on percent of vanpoolers at $5/hour and 250 work days per year. Absenteeism assumed 8 hours per work day; tardiness assumed 15 minutes per worker.

[b]Actual corporate study noted a $100,000 profit from vanpooling in 1985.

[c]Same as stated benefit-cost ratio.

TABLE 6 SUMMARY OF BENEFIT-COST RATIOS, LARGE VANPOOL PROGRAMS 9 THROUGH 12

	9	10	11	12
Employees	1,300	2,000	16,000	4,800
Number of Vanpools	8	38	37	24
Number of Employees	70	400	385	240
Reason for Initiating Vanpooling	Energy conservation	Avoid expanding parking	Relocation to new site	Energy conservation
Is Ridesharing Cost-Effective?	Marginal	Definitely	No	Definitely
Extent of Benefits				
Reduced Absenteeism	No --	Yes 5% $280,000	Yes 25% $962,500[a]	Yes 2% $48,000[a]
Reduced Need to Construct New Parking	No	Yes $146,000	No	NA
Help Retain Valued Employees	No	Yes NA	Yes $100,000	NA
Reduced Employee Tardiness	Yes 5% $1,093[a]	Yes 5% $70,000[a]	Yes 22% $26,468[a]	NA 5% $3,750[a]
Permitted Utilization of Previous Parking Area for Other Activity	No	Yes NA	No	Yes $300,000
Improved Public Relations	No	Yes[b]	No	Yes NA
Other	--	Increases labor market for firm; less stress on employees	Expand recruitment after relocation and maintain employees	
Dollar Value of Benefits Stated/Year	--	$426,560	$100,000	$300,000
Dollar Value of Benefits Estimated/Year	$1,093	$496,560	$1,088,968	$351,750
Vanpool Program Costs per Year (Net Cost)	+	$3,300	$150,946	$24,800
Stated Benefit-Cost Ratio	Benefits at no cost to employer	>100	<1	12.1
Estimated Benefit-Cost Ratio		>100	7.2	14.2
Aggregated Direct Benefits	NA	$423,260	Negative	$275,200

[a]Estimated value based on percent of vanpoolers at $5 per hour and 250 work days per year. Absenteeism assumed 8 hours per work day; tardiness assumed 15 minutes per worker.

[b]Positive public relations was felt to be worth millions of dollars to this company over the past four years. The program received extensive coverage in the national press.

TABLE 7 SUMMARY OF BENEFIT-COST RATIOS, SMALL VANPOOL PROGRAMS 13 THROUGH 16

	13	14	15	16
Employees	250	700	1,000	3,100
Number of Vanpools	4	2	5	4
Number of Employees	30	21	50	62
Reason for Initiating Vanpooling	Energy conservation	Employee assistance program	Energy conservation	Legal requirement
Is Ridesharing Cost-Effective?	No	Marginal	Definitely	Definitely
Extent of Benefits				
Reduced Absenteeism	No	Yes 1% $2,100*	Yes 5% $25,100*	Yes 1% $6,200*
Reduced Need to Construct New Parking	No		NA	No
Help Retain Valued Employees	No	Yes	NA	No
Reduced Employee Tardiness	Yes 10% $938*	Yes 4% $262*	Yes 5% $781*	Yes 5% $969*
Permitted Utilization of Previous Parking Area for Other Activity	No	No	NA	No
Improved Public Relations	Yes $2,000	Yes $2,000	NA	Yes
Other				
Dollar Value of Benefits Stated/Year	$2,000	$2,000	--	NA
Dollar Value of Benefits Estimated/Year	$2,937	$4,362	$25,781	$7,169
Vanpool Program Costs per Year (Net Cost)	$11,500	$300	$2,000	Break-even
Stated Benefit-Cost Ratio	<1	6.7	--	--
Estimated Benefit-Cost Ratio	<1	14.5	12.8	<1
Aggregated Direct Benefits	Negative	$1,700	NA	Negative

*Estimated value based on percent of vanpoolers at $5/hour and 250 work days per year. Absenteeism assumed 8 hours per work day; tardiness assumed 15 minutes per worker.

TABLE 8 SUMMARY OF BENEFIT-COST RATIOS, SMALL VANPOOL PROGRAMS 17 THROUGH 20

	17	18	19	20
Employees	70	180	110	165
Number of Vanpools	1	1	2	1
Number of Employees	9	8	25	15
Reason for Initiating Vanpooling	Relocation to new site	Relocation to new site	Relocation to new site	Lack of transit and to improve air quality
Is Ridesharing Cost-Effective?	Marginal	NA	Definitely	Definitely
Extent of Benefits				
Reduced Absenteeism	Yes 3% $2,700[a]	No	No	Yes 20% $30,000[b]
Reduced Need to Construct New Parking	No	No	No	NA
Help Retain Valued Employees	Yes $5,000	Yes $30,000	Yes $3,000	Yes $27,500/yr.[c]
Reduced Employee Tardiness	Yes 5% $141[a]	No	Yes 20% $1,562[a]	Yes 20% $7,500
Permitted Utilization of Previous Parking Area for Other Activity	No	No	No	NA
Improved Public Relations	No	No	Yes	Yes
Other				
Dollar Value of Benefits Stated/Year	$5,000	$30,000	$3,000	$27,500
Dollar Value of Benefits Estimated/Year	$7,841	--	$4,563	$65,000
Vanpool Program Costs per Year (Net Cost)	$4,000	Break-even	Break-even	$300[d]
Stated Benefit-Cost Ratio	1.3	Benefits at no cost to employer	Benefits at no cost to employer	91.6[d] >100[d]
Estimated Benefit-Cost Ratio	2.0			
Aggregated Direct Benefits	$1,000	$30,000	$3,000	$27,250

[a]Estimated value based on percent of vanpoolers at $5/hour and 250 work days per year. Absenteeism assumed 8 hours per work day; tardiness assumed 15 minutes per worker.

[b]A 10 percent absenteeism per shift means 60-62 people would be off; thus the production line could not function.

[c]Retaining one person saves this corporation $11,000-$12,000 in training costs.

[d]Less tax credit; actually no costs to employer.

TABLE 9 SUMMARY OF BENEFIT-COST RATIOS

	Number of Programs	Benefit-Cost Ratios: Based on Monetary Values Stated by Respondents	Benefit-Cost Ratios: Estimated Values
Cost-Effective			
Definitely	14		
Marginal	3		
No	2		
Not Available	1		
Benefit-Cost Ratios			
Less Than or Equal to 1		2	2
Greater Than 1 and Less Than or Equal to 10		5	4
Greater Than 10 and Less Than or Equal to 20		3	6
Greater Than 20		2	4
Benefits Received at No Direct Program Cost to Employer		4	4
Not Applicable		4	0

ridesharing was perceived by private employers as providing a stream of positive returns to the corporation.

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REFERENCES

1. J. T. McIntyre and D. Maxwell. *Economics of Vanpooling*. Technical Memorandum 1. The Texas Energy and Natural Resources Advisory Council of the Texas Ridesharing Program, Austin, 1980.
2. *The Benefits and Costs of Ridesharing to Employers: Survey Findings*. Commuter Transportation Services, Inc., Los Angeles, Calif., 1985.
3. Dingle Associates, Inc. *Ridesharing Programs of Business and Industry*. FHWA, U.S. Department of Transportation, 1982.

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Temporal Analysis of Handicapped Ridership in Specialized Transportation Service: Lexington/Fayette County Experience

MANOUCHEHR VAZIRI

This paper focuses on modeling of Kentucky's Lexington/Fayette County specialized transportation (WHEELS) monthly ridership. The 1979 through 1985 time-series data suggest an intervention model to replicate monthly ridership. The identified model successfully incorporated the lag structure and functional forms that constitute the relationships between monthly ridership and service changes, such as service area expansion and fare increase. The selected model satisfies all estimation and diagnostic requirements. Model predictions for 1985 were quite reasonable when compared with actual ridership: cyclical patterns were correctly replicated. The supremacy of intervention modeling when compared with multiple linear regression analysis was found to be in capturing ridership seasonality, properly reflecting the impact of changes in service attributes, and displaying uncorrelated residuals.

Specialized transportation services are often provided to persons who do not have the physical or mental ability to use alternative means of transportation. In the last two decades, specialized transportation services have seen a tremendous growth, mostly in the form of paratransit services (*1*,*2*). The development of paratransit systems has been accompanied by the development of mathematical modeling for better planning and management, particularly in routing and scheduling. These models are often designed to determine the delicate balance between supply, demand, and cost of a paratransit system (*2*,*3*). The demand is considered as a whole range of levels of ridership that would eventuate from a variety of different fare levels, different area coverage levels, different times of operation, different months and years, different policies of passenger eligibility, and so forth. The methods used for measuring and forecasting the demand for specialized transportation systems have not adequately taken into account all its major dimensions (*4*–*6*). Nonetheless, in recent years, implementation of microcomputer and data base management software has alleviated many previous problems of trip information gathering and recording (*7*,*8*).

In planning and management of specialized transportation services, major characteristics of ridership that should be considered include spatial and temporal variations. Information about time variation of ridership is essential to determine the level of service that is most appropriate for different points in time. Most of the existing demand models predict trip density, trips per square mile per day or hour (*3*). Although these models are useful in ridership forecasting because of structural changes in users' condition and density, they become problematic and insensitive when generating short-run predictions. A class of models proven to be particularly well suited to short-term forecasting is that often referred to as ARIMA, autoregressive integrated moving average (*9*,*10*). These models replicate past behavior of a univariate time-series rather than determine direct multivariate structural relationships. Such models are particularly useful for short-term forecasting when it is expected that underlying factors determining the level of the variable of interest in the past, herein specialized transportation monthly ridership, will behave the same in the near future. An extension of univariate ARIMA models to the multivariate domain can be presented by intervention modeling. This type of model is specially structured to deal with intervening events affecting the time-series process, herein changes in fare, fleet size, and coverage area affecting ridership. In recent years, there have been several published works related to time-series demand modeling for regular transit systems (*11*–*17*). However, its application has not been sufficiently addressed in paratransit and specialized transportation ridership modeling.

This paper presents an intervention model for modeling and forecasting of Lexington/Fayette County (Kentucky) specialized transportation ridership. Managers and planners of specialized transportation can use the methodology and findings of this study to enhance ridership forecasts and assess the impact of service policy changes.

LEXINGTON/FAYETTE COUNTY SPECIALIZED TRANSPORTATION

The Lexington/Fayette County specialized transportation service, WHEELS, was established in 1978. WHEELS is designed to meet the needs of handicapped persons by overcoming the lack of economical and accessible transportation. The disability of individuals using WHEELS must be documented and a person must fill out an application and be registered in order to become eligible for service. Trip reservations, usually by telephone, are made at least 1 day in advance.

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WHEELS provides service Monday through Friday from 7 a.m. to 6 p.m. and Saturday from 10 a.m. to 4 p.m. Since January 1979, when WHEELS began operation, there have been several modifications of this service. Among these, there were four major events that could be predicted to most profoundly impact system ridership:

- In January 1981, coverage (service) area was expanded from a pilot area in the north end to the whole urban area; simultaneously, fleet size was increased from four to eight vehicles.
- In September 1983, Saturday service was initiated.
- In July 1984, fare was increased from $0.50 to $0.75.
- In July 1985, fare was increased from $0.75 to $1.00.

Monthly ridership during the study period is shown in Figure 1. Figure 1 suggests a general secular increase after expansion of the service area in 1981, seasonal variation involving periodicity over 12-month cycles with a minimum most often occurring during midwinter, and the possible negative impacts of 1984 and 1985 fare increases. The combination of distinct seasonality, secular increase, and four intervening events suggests that the time-series of monthly ridership is a good candidate for intervention modeling.

MODEL STRUCTURE

The intervention model consisted of a mathematical relationship known as a transfer function, which expresses the degree to which intervening events affect the time-series. The model and the method for assessing its parameters as presented in the following section are known as Box-Tiao Intervention Analysis (*19*). This technique is a generalization of the multiple linear regression model with k independent variables:

$$Y_t = b_0 + \sum_{i=1}^{k} b_i X_{it} + e_t \quad (1)$$

where Y_t is the dependent variable at time t, b_0 is a constant, b_i is the coefficient of the ith independent variable X_{it}, k is the number of independent variables, and e_t is the error term. The basic assumption of Equation 1 is that covariance $(e_t, e_{t'}) = 0$ for $t \neq t'$. This presents a serious constraint for application to monthly ridership because of factors such as seasonality. Such a problem does not exist in intervention modeling. The intervention model applied to the 1979 through 1985 monthly time-series for specialized transportation ridership had the following general functional form:

$$Y_t = \sum_{i=1}^{k} \frac{\omega_i(B)}{\delta_i(B)} X_{it} + N_t \quad (2)$$

where Y_t is the time-series dependent variable; B is a backshift operator pertinent to the time index of variables, that is, $BY_t = Y_{t-1}$ and $B^2Y_t = Y_{t-2}$; ω_i and δ_i are polynomial operators for ith intervention variable, that is, $\omega_i(B) = \omega_{0i} - \omega_{1i}B - \ldots - \omega_{gi}B^{gi}$ for polynomial operator of order gi, where $\omega_{0i}, \ldots, \omega_{gi}$ are coefficients and $\delta_i(B) = 1 - \delta_{1i}B - \ldots - \delta_{hi}B^{hi}$ for polynomial operator of order hi, where $\delta_{1i}, \ldots, \delta_{hi}$ are coefficients; X_{it} is the ith intervention variable and $X_{it} = 1$ for month t, wherein the ith intervening event is taking place and $X_{it} = 0$ otherwise; and N_t is the noise that can be presented by an ARIMA process such as $N_t = (\theta(B)/\phi(B))a_t$, where θ and ϕ are polynomial operators and a_t is the white noise variable for month t, independent and normally distributed with mean of zero and variance of σ^2. The advan-

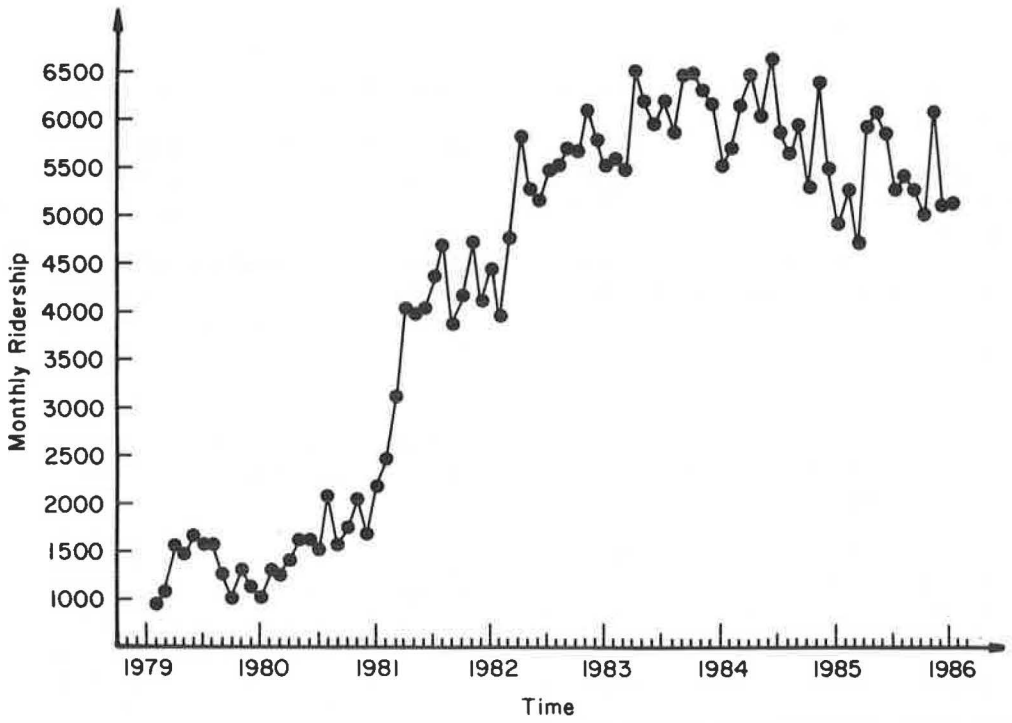

FIGURE 1 Monthly ridership for the period 1979–1985.

tage of Equation 2 is that it allows estimates of Y_t to reflect prior levels of Y, prior levels of X_i's, and prior levels of white noise. This is not feasible for Equation 1 when Y_t is only dependent on current levels of the X_i's.

MODEL BUILDING

The selection of a model for any time-series data from the family of intervention models presented by Equation 2 is in large part a matter of judgment. Nevertheless, a generally accepted model building strategy includes iterative identification, estimation, and diagnosis stages (*9,10,20*). The identification stage is often accomplished on the basis of (a) prior knowledge of the data pattern, (b) evaluation of the plotted time-series, (c) evaluation of the sample autocorrelation coefficients (ACFs), and (d) evaluation of the sample partial autocorrelation coefficients (PACFs). The identification often starts with initial noise modeling, the ARIMA modeling for N_t, based on (a) the portion of the data containing no unusual events or (b) all the data by using robust estimation to reduce the effect of unusual events. Once components of the ARIMA model are identified, the information is used to identify the transfer function components. Once a tentative model is identified, its parameters are estimated and tested for statistical significance. In addition, parameter estimates must meet stationarity-invertability requirements (*9,10,20*). If either criterion is not met, a new model must be identified and its parameters estimated and tested. After successful estimation and testing, the model is finally diagnosed. To pass diagnosis, the autocorrelation of the residuals (RACFs) from the estimated model should be sufficiently small and should resemble white noise. If the residuals remain significantly correlated among themselves, a new model should be identified.

After several trials, following basically the aforesaid stages of modeling and using the Time Series Program of the Biomedical Package (School of Public Health, UCLA), the selected intervention model with the smallest residual mean square (RMS) was found to have the following form (*21*):

$$Y_t = \frac{\omega_{01}}{1 - \delta_{11}B} X_{1t} + \omega_{02}X_{2t} + \omega_{03}X_{3t} + \omega_{04}X_{4t} + \frac{(1 - \theta_1 B - \theta_4 B^4 - \theta_5 B^5)(1 - \theta_{12}B^{12})}{(1 - B)(1 - B^{12})} a_t \qquad (3)$$

where Y_t is monthly ridership for month t; X_{1t} is a dummy variable reflecting the intervening event of fleet and service area expansion, $X_{1t} = 0$ for months of 1979 through 1980 and $X_{1t} = 1$ thereafter; X_{2t} is a dummy variable reflecting the intervening event of Saturday service, $X_{2t} = 0$ for months before September 1983 and $X_{2t} = 1$ thereafter; X_{3t} is a dummy variable reflecting the fare increase from \$0.50 to \$0.75, $X_{3t} = 0$ for months before July 1984 and $X_{3t} = 1$ thereafter; X_{4t} is a dummy variable reflecting the intervening event of fare increase from \$0.75 to \$1.00, $X_{4t} = 0$ for months before July 1985 and $X_{4t} = 1$ thereafter; a_t is the white noise variable for month t, independent and normally distributed with mean of zero and variance of σ^2; ω_{01}, δ_{11}, ω_{02}, ω_{03}, ω_{04}, θ_1, θ_4, θ_5, and θ_{12} are parameters and B is the backshift operator.

Based on Equation 3, the estimated intervention model for 1979 through 1985 monthly ridership has the following form:

$$Y_t = \frac{601.8}{1 - 0.712B} X_{1t} + 82.23X_{2t} - 512.9X_{3t} - 152.5X_{4t} + \frac{(1 - 0.584B - 0.290B^4 + 0.506B^5)(1 - 0.811B^{12})}{(1 - B)(1 - B^{12})} a_t \qquad (4)$$

where notations are the same as in Equation 3, t statistics for parameter estimates are all greater than 2 except 0.35 for X_{2t} and 0.63 for X_{4t}, and RMS is 97,579. The autocorrelations of the residuals—shown in Figure 2—are inside the range of 95 percent confidence interval and therefore not significant. To check whether the entire residual autocorrelation is different from what could be expected of white noise, the Portmanteau test was performed (*9*). Following is a summary of the test results.

K	Q	*Degree of Freedom*	*Level of Significance*
6	4.33	2	0.123
12	8.20	8	0.425
18	15.31	14	0.370
24	19.98	20	0.464

The Q statistic is the sum of the first K residual autocorrelations multiplied by the number of observations minus the maximum back order for the period of time-series study. The Q values are distributed approximately chi-square with the degree of freedom equal to K minus the number of estimated parameters. The data show that the results are not significant at the 0.05 level. For Equation 4, the roots of $\theta(B)$ lie outside and those of $\phi(B)$ lie on the unit circle, thus meeting stationarity and invertability requirements (*9*).

The parameter estimates for X_{1t} suggest that monthly ridership increased by roughly 2,090 because of the service expansion of January 1981. Nevertheless, the response was not immediate but rather a first-order dynamic response like that in Figure 3. The parameter estimate for X_{2t} suggests that Saturday service increased monthly ridership by roughly 82. The parameter estimate for X_{3t} suggests that the fare increase

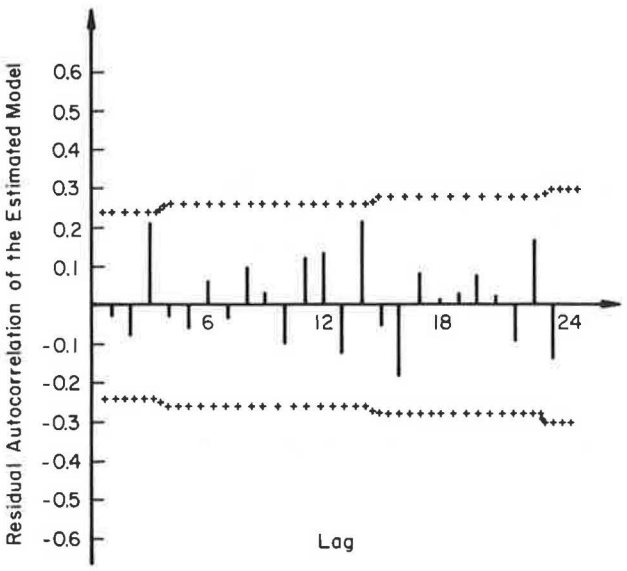

FIGURE 2 Residual autocorrelation function of the estimated intervention model.

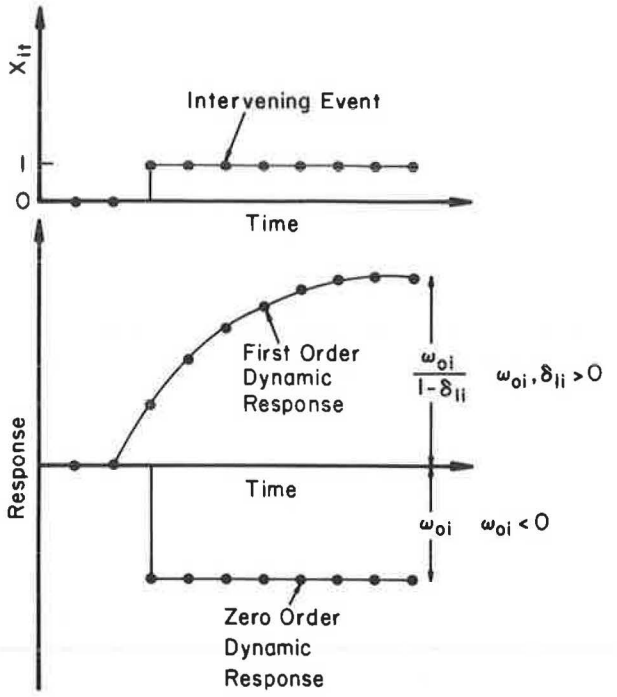

FIGURE 3 Response to a step-intervening event.

from \$0.50 to \$0.75 resulted in a monthly ridership decrease of roughly 513. The parameter estimate for X_{4t} suggests that the fare increase from \$0.75 to \$1.00 resulted in a monthly ridership decline of roughly 152. The intervention events, X_{2t}, X_{3t}, and X_{4t} produced immediate responses, the zero order dynamic response type of Figure 3 (*19*). In view of statistical significance at a level of 0.05, X_{2t} and X_{4t} should be excluded from the model because their parameter estimates have t statistics smaller than 2. Exclusion of X_{2t} and X_{4t} from the model resulted in the following intervention model:

$$Y_t = \frac{582.6}{1 - 0.725B} X_{1t} - 464.1X_{3t} + \frac{(1 - 0.563B - 0.296B^4 + 0.514B^5)(1 - 0.806B^{12})}{(1 - B)(1 - B^{12})} a_t \quad (5)$$

where the notations are the same as in Equation 4, t statistics for parameter estimates are greater than 2, and RMS is 96,018. Equation 5 meets stationarity and invertability requirements and passes all checks of diagnosis. The parameter estimates for X_{1t} suggest that monthly ridership increased by roughly 2,119 because of the service expansion of January 1981. The parameter estimate for X_{3t} suggests that the fare increase from 50 cents to 75 cents in July 1984 resulted in a monthly ridership decrease of roughly 464.

MODEL EVALUATION AND PREDICTION

To demonstrate the advantage of intervention modeling, the same time-series data were used to calibrate two regression models. The first is the simpler version that assumes time as the only independent variable:

$$Y_t = 1392.1 + 67.073t + e_t \quad (6)$$

where Y_t is monthly ridership for month t ($t = 1, \ldots, 84$). The coefficient of t has a t statistic greater than 2. The RMS of Equation 6 is 991,151, which is 10 times larger than the RMS of Equations 4 and 5. The parameter estimate for time variable t suggests that monthly ridership increased by roughly 67 per month. Introduction of intervention variables as further independent variables resulted in the second regression model:

$$Y_t = 589.4 + 71.874t + 1525.8X_{1t} - 414.3X_{2t} - 1354.7X_{3t} - 881.4X_{4t} + e_t \quad (7)$$

where the notations are as defined before and the t statistics for parameter estimates are all greater than 2 except 1.8 for X_{2t}. The RMS of Equation 7 is 222,479, which is 2.3 times larger than the RMS of Equation 5. Although Equation 7 is superior to Equation 6 because of its smaller RMS, the negative coefficient of X_{2t}, introduction of Saturday service, is not logical. One should expect an increase in total monthly ridership as a result of Saturday service, as Equation 4 correctly predicted. Nevertheless, the parameter estimate for the time variable suggests a monthly ridership increase of roughly 72 per month. The parameter estimate for X_{1t} suggests that monthly ridership increased by roughly 1,526 because of service expansion. The parameter estimate for X_{2t} suggests that the Saturday service decreased monthly ridership by roughly 414. The parameter estimate for X_{3t} suggests that the fare increase from \$0.50 to \$0.75 resulted in a monthly ridership decrease of roughly 1,355. The parameter estimate for X_{4t} suggests that the fare increase from \$0.75 to \$1.00 resulted in a monthly ridership decrease of roughly 881. In view of statistical significance at the 0.05 level, X_{2t} should be excluded from the model. Exclusion of X_{2t} from the model resulted in the following equation:

$$Y_t = 700.2 + 63.014t + 1719.6X_{1t} - 1431.1X_{3t} - 801.7X_{4t} + e_t \quad (8)$$

where the notations are the same as in Equation 7, t statistics for parameter estimates are greater than 2, and RMS is 228,780. The parameter estimate for the time variable suggests that monthly ridership increased by roughly 63. The parameter estimate for X_{1t} suggests that monthly ridership increased by roughly 1,720 because of service expansion. The parameter estimate for X_{3t} suggests that monthly ridership decreased by roughly 1,431 because of the fare increase from \$0.50 to \$0.75. The parameter estimate for X_{4t} suggests that the fare increase from \$0.75 to \$1.00 resulted in a monthly ridership decline of roughly 802.

The major drawback of Equations 6, 7, and 8 is the assumption of residual independency. Indeed, residual autocorrelations of Equations 6, 7, and 8 showed several statistical significances, especially for Lag 1 and Lag 12. However, such a problem does not exist for the intervention models, Equations 4 and 5.

The calibrated regression and intervention models were used to predict the monthly ridership of WHEELS for the 12-month period beginning in January 1985. Figure 4 presents the 12-month predictions for Equations 5, 6, and 8. It also shows the actual values and 95 percent confidence interval for the predicted values from the intervention model, Equation 5. The intervention model extends the seasonality throughout 1985, whereas the regression models are insen-

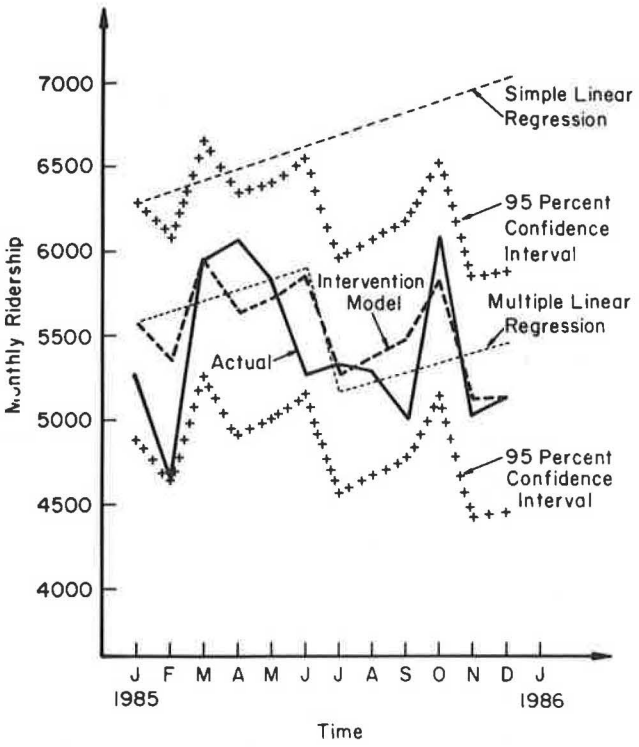

FIGURE 4 Comparison of actual and predicted monthly ridership.

sitive to such seasonal behavior. Parameter estimates for the time variable t from the developed regression models are positive. It is noteworthy that in the least square method of regression modeling with time as a monotonically increasing independent variable, the first and the last observations of the time-series usually make the greatest contribution to the sum of squares (*20*). Thus, the coefficients are derived so that the trend line passes close to the first and last data points. This would suggest that predictions by such regression models are inferior for mid-periods. Because of the statistical significance of the coefficient of X_{4t}, Equation 8 has apparently reflected the impact of the second fare increase. However, this to a great extent could have been because of the aforesaid characteristic of the least square method. This has not been the case for Equation 5, which was developed excluding X_{4t}. Availability of 1986 data for the time-series will eventually allow clarification of the assumption with respect to X_{4t} for the intervention model. Implementation of the second fare increase was in July 1985 and the impact was reflected in only six monthly ridership data points. This is usually considered to be an insufficient number of data points for an intervention model to show the impact of an intervening event. Indeed, it would have been desirable to develop models for the 1979 through 1984 period, and then for model evaluation, predict 1985 monthly ridership. Unfortunately, because of the second fare increase in July 1985, this was an unsuitable basis for evaluation.

Ridership predictions for 1985 are summarized in Table 1. The superiority of the intervention model is evident because of smaller RMS and more accurate prediction of both average monthly ridership and yearly ridership.

CONCLUSIONS

Intervention modeling applied herein to time-series monthly ridership was based on Box-Tiao Intervention Analysis. The applied intervention modeling for Lexington/Fayette County specialized transportation (WHEELS) monthly ridership consisted of iterative stages of identification, estimation, and diagnosis. The selected model for 1979 through 1985 time-series data showed that monthly ridership has a seasonality of 12 months and depends on the past month's ridership as well as Lag 1, Lag 4, Lag 5, and Lag 12 white noises. Furthermore, the monthly ridership was found to be affected by changes in service attributes, such as fare increase and service expansion. With 0.05 as a level of significance criterion for parameter estimates in the intervention model, it was found that service expansion in January 1981 resulted in a monthly ridership increase of roughly 2,119 and the fare increase from 50 cents to 75 cents in July 1984 resulted in a monthly ridership decline of roughly 464.

For specialized transportation service of the type analyzed, intervention modeling is more appropriate and powerful than traditional multiple linear regression in evaluating and predicting time-series data with intervening events. Although requiring somewhat more historical data points, intervention analysis successfully treated time lag structure and interrelations of the time-series data. The superiority of intervention modeling lies in the ability to capture seasonality in the time-series and properly reflect the impact of changes in service attributes. Unlike traditional multiple linear regression models, the residual autocorrelations of the estimated intervention models were found to be uncorrelated. Although the selected intervention model is dependent on 1979 through 1985 WHEELS ridership data, the same methodology can be applied to study any specialized transportation or paratransit system with time-series nonstationary behavior characteristics that have been affected by service policy changes or other intervening events.

TABLE 1 COMPARISON OF PREDICTED AND ACTUAL 1985 RIDERSHIP

Variable	Actual	Regression		Intervention Model
		Simple	Multiple	
Monthly avg.	5,415	6,657	5,535	5,524
Yearly total	64,981	79,883	66,408	66,291
RMS	0	1,809,664	208,925	111,450

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REFERENCES

1. W. G. Bell and J. S. Revis. *Transportation for Older Americans, Issues and Options for the Decade of the 1980s*. Report DOT-I-83-42. Office of Technology and Planning Assistance, U.S. Department of Transportation, 1983.
2. J. W. Billheimer, G. R. Lucas, and R. W. Wilmuth. Review and Assessment of Paratransit Models. In *Transportation Research Record 724*, TRB, National Research Council, Washington, D.C., 1979, pp. 29–35.
3. S. Kikuchi. Dispatching of Specialized Transportation Vehicles: Problems and Methods. Presented at 10th National Conference on Specialized Transportation, Florida State University, Sarasota, 1985.
4. *NCHRP Synthesis of Highway Practice 39: Transportation Requirements for the Handicapped, Elderly, and Economically Disadvantaged*. TRB, National Research Council, Washington, D.C., 1976, 54 pp.
5. *NCHRP Synthesis of Highway Practice 209: Market Opportunity Analysis for Short-Range Public Transportation Planning, Transportation Services for the Transportation Disadvantaged*. TRB, National Research Council, Washington, D.C., 1979, 52 pp.
6. *NCHRP Synthesis of Highway Practice 262: Planning Transportation Services for Handicapped Persons, User's Guide*. TRB, National Research Council, Washington, D.C., 1983, 74 pp.
7. D. Dornan and D. Middendorf. *Planning Services for Transportation Handicapped People, Data Collection Manual*. Report DOT-I-83-40R. Technology Sharing Program, U.S. Department of Transportation, 1985.
8. N. Hamer. Implementation of Computer Systems for Specialized Transit: Three Case Studies. Presented at 10th National Conference on Specialized Transportation, Florida State University, Sarasota, 1985.
9. G. E. P. Box and G. M. Jenkins. *Time Series Analysis: Forecasting and Control*. Holden-Day, Inc., Oakland, Calif., 1976.
10. J. P. Cleary and H. Levenbach. *The Professional Forecaster: The Forecasting Process Through Data Analysis*. Lifetime Learning Publications, Belmont, Calif., 1982.
11. M. Gaudry. An Aggregate Time Series Analysis of Urban Transit Demand: The Montreal Case. *Transportation Research*, Vol. 9, 1975, pp. 249–258.
12. M. Gaudry. Seemingly Unrelated Static and Dynamic Urban Travel Demand Models. *Transportation Research*, Vol. 12, 1978, pp. 195–212.
13. M. Kemp. *Bus Service in San Diego: A Study of Patronage Growth in the Mid-1970s*. Working Paper 1470-1. The Urban Institute, Washington, D.C., 1981.
14. M. Kemp. *A Simultaneous Equations Analysis of Route Demand and Supply, and Its Application to the San Diego Bus System*. Working Paper 1470-2. The Urban Institute, Washington, D.C., 1981.
15. M. Kyte, J. Stoner, and J. Cryer. Development and Application of Time-Series Transit Ridership Models for Portland, Oregon. In *Transportation Research Record 1036*, TRB, National Research Council, Washington, D.C., 1985, pp. 9–18.
16. G. H. Wang. An Intervention Analysis of Interrupted Urban Transit Time Series Data: Two Case Studies. *Proc., American Statistical Association, Business and Economic Section*, Washington, D.C., 1981, pp. 424–429.
17. G. H. Wang, W. Maling, and D. Skinner. *Modeling Monthly Ridership for Seven U.S. Transit Authorities*. Transportation System Center, U.S. Department of Transportation, Cambridge, Mass., 1982.
18. N. Barker. *WHEELS Monthly Report*. WHEELS, Lexington, Ky., Jan. 1979 through Dec. 1985.
19. G. E. P. Box and G. C. Tiao. Intervention Analysis with Application to Economic and Environmental Problems. *Journal of the American Statistical Association*, Vol. 70, 1975, pp. 70–79.
20. R. McCleary and R. A. Hay. *Applied Time Series Analysis for the Social Sciences*. Sage Publications, Inc., Newbury Park, Calif., 1980.
21. *BMDP Statistical Software*. (W. J. Dixon, ed.) University of California Press, Berkeley, 1983.

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Characterization of the "Público" System of Puerto Rico

FELIPE LUYANDA AND PODURU GANDHI

The "público" system of Puerto Rico is a privately operated government-regulated transportation service to the general public ranging from small urban routes to long intercity routes. This service is normally operated on fixed routes and fixed fares with low-capacity automobiles and passenger vans. The principal objective of this paper is to present a summary of a recent study that provided a description of the "público" system as it operates in Puerto Rico. Data for the study were obtained from previous "público" system studies and from government agencies that regulate the system. The paper presents for the "público" system its general and specific characteristics and qualitative attributes and discusses its advantages and limitations.

The inability to solve urban transportation problems, despite the infusion of billions of dollars in public subsidies during the past two decades, demonstrates the need for private-sector participation in urban and rural transportation systems and experimentation with innovative forms of transportation investments. Researchers and transportation planners have recognized that an ideal urban transportation system is a cooperative mix of paratransit and conventional transit with highly coordinated and varied ownership and with active involvement of private paratransit providers in planning and operation of the service (*1*).

A paratransit system, locally known as "públicos," has been successfully operating in Puerto Rico for several decades. This paper summarizes a study that provided a description of the "público" system as it operates in Puerto Rico (*2*).

STUDY ORGANIZATION

Because the principal objective of the study was to present a complete description of the "público" system, considerable data on its general and specific characteristics were gathered from previous studies and from government agencies that regulate the system (*3–14*). These studies have been performed throughout Puerto Rico to evaluate potential sites for "público" terminals, consider the effect of these terminals on the transportation system, and recommend public policies regarding the "público" system. Based on the availability of these studies, four municipalities, Bayamón, Arecibo, Mayagüez, and Aguadilla (see Figure 1), were selected to analyze the "público" system. These municipalities represent different types of conditions and thus different operating characteristics for their respective "público" systems. In each municipality a data base that integrated "público" service characteristics and socioeconomic information was constructed to obtain specific characteristics of the system.

This paper also presents general characteristics of the "público" system and qualitative information on several attributes mostly related to the level of service provided, and it discusses the system's advantages and limitations.

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"PÚBLICO" SYSTEM—GENERAL CHARACTERISTICS

Historical Review

The "público" operation in Puerto Rico dates back to the beginning of this century. However, little information is available before the 1970s. An intercity public transportation study performed in 1972 recommended development of intermodal terminal facilities to consolidate "público" operations and increase system efficiency and attractiveness (*4*). This recommendation has had a major impact on the operation of the "público" system. Several terminals have been built throughout the island and several others are being planned. Recent studies in various cities including Río Piedras, Bayamón, Arecibo, and Aguadilla mainly have been emphasizing the planning and evaluation for potential sites for the terminal facilities (*5–9*).

In 1980, an evaluation was made of a demonstration trunk and feeder system in which the "públicos" served as feeder to several bus routes in portions of the San Juan Metropolitan Area (SJMA) (*10*). The main conclusion of the study was that the experiment had failed primarily because of a lack of coordination between the "público" feeders and the trunk bus routes.

During 1983, the Transportation Institute of the University of Puerto Rico performed an evaluation of the impact of a "público" terminal facility on the Mayagüez urban area and its transportation system (*11*). In the study, it was determined that the new centralized terminal facility contributed significantly to improve the "público" system and the central business district (CBD). The new facility increased conveniences to users and operators, facilitated transfers between routes, provided protection from weather, provided security for drivers and users, and eliminated parking from the CBD.

A policy study dealing with public transit alternatives was completed in 1985 in which the role of the "público" system was analyzed with respect to the current and future transit needs in the SJMA (*12*). The main conclusions of that study were that the "público" system is an effective transit mode

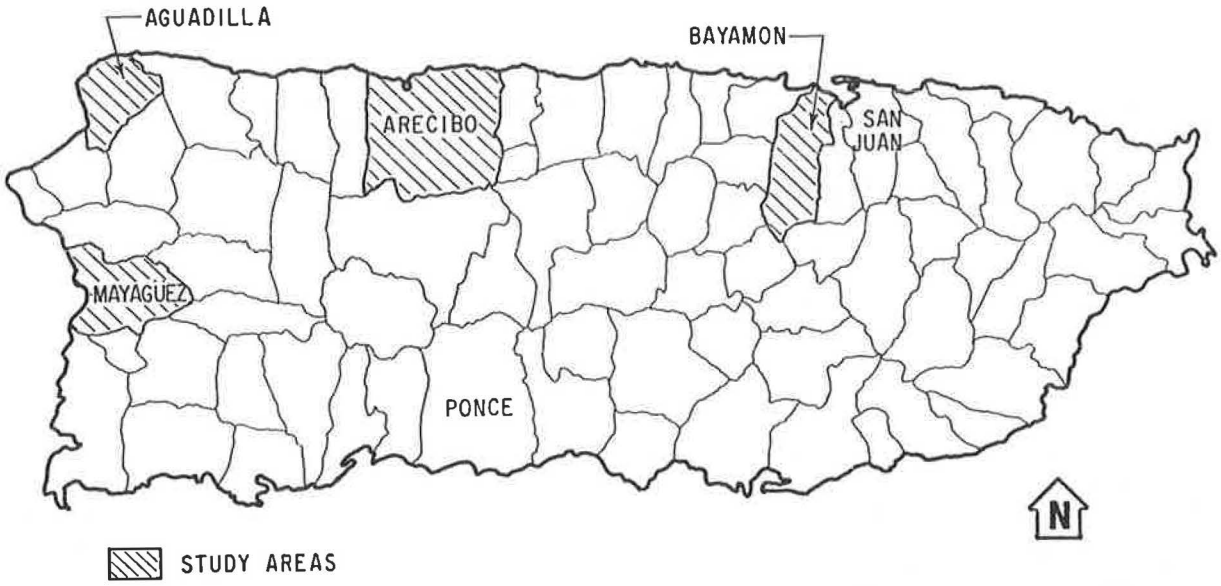

FIGURE 1 Location of study areas.

alternative and emphasis should be placed on its continued development; "públicos" should be given priority in those low-to-medium-density urban and rural sectors where the "público" service is the principal mode of transit travel; and "públicos" should be allowed to operate in high-density areas only if they form a beneficial complementary service or where there is sufficient demand for two or more modes of public transit.

Operating Characteristics

The "público" system provides a family of services to the general public (see Table 1) with different operating characteristics. Islandwide there are approximately 12,000 vehicles distributed over about 900 routes, which serve both urban and rural areas. The operators determine the hours of operation mainly based on the availability of passengers, but other factors such as the type of route, the type of route organization, distance traveled, and vehicles available also influence the number of hours of operation. Other decisions regarding the service such as the route alignments, fares, operators' licensing, vehicle requirements, and locations of terminal facilities are regulated by different government agencies.

In terms of service characteristics the "público" service is normally provided from Monday through Friday from 6:00 a.m. to 6:00 p.m. and Saturdays from 6:00 a.m. to 5:00 p.m. There is hardly any service at night or on Sundays. Outside the operating hours, the "público" vehicles are often used as personal vehicles by the operators.

Regulatory Controls

The "público" system is regulated by the Public Service Commission (PSC), the Department of Transportation and Public Works (DTPW), and the municipal governments. The PSC controls entry into service, licensing, transfers, suspensions, fares, and other issues. The operators are regulated through the licensing procedure. A 5-year renewable authorization to operate a specific route is provided only after the operator meets licensing requirements (age, good conduct, medical certificate, driver training, and so on), a needs and convenience study of the route for which the candidate is soliciting is conducted, and public hearings are held. Once licensed, the PSC can impose sanctions for route violations, such as invading another route, discipline, unsafe vehicles, illegal fares, and so on.

Fares are determined by the PSC through similar procedures as for licensing and route establishment. New fares or modifications to existing fares are established after special fare studies are conducted. These studies consider the route

TABLE 1 SERVICES PROVIDED BY THE "PÚBLICOS"

Type of Service	Characteristic
1. Local Routes	Unscheduled municipal level coverage connecting town center to residential areas, office complexes, commercial areas, schools and suburbs or barrios. General fares range from $0.50 to $1.00.
2. Intercity Routes	Unscheduled service along primary state highways between municipalities and some deviation from routes to serve major communities or institutions. Fares range from $1.00 to $5.00.
3. "Líneas" (Line Service)	Scheduled door to door service between major cities with phone reservations. Also package delivery. Typical fares $3.00 to $10.00.
4. "Urbano" (Urban Routes)	Special service in Mayagüez area with and without door to door service within city limits with no fixed routes or fixed stops. General fares $0.50 to $1.00.

operating costs plus its supply and demand patterns. The PSC also regulates the vehicles by establishing minimum and maximum vehicle and safety requirements.

The DTPW regulates operator licensing, vehicle registration, terminals and stops within the right-of-way of state roads, and traffic control on state roads. The municipal governments regulate the location and design of curb-side and off-street terminals and stops along the right-of-way of municipal roads and control traffic operations along municipal roadways.

Vehicle Types

The vehicles used for "público" service include sedans, checkers, vans, and minibuses. Sedans, which constitute about half of the "público" system fleet, have a seating capacity of five or six passengers and are the preferred vehicle type in areas in which the passenger demand is not sufficient to justify larger vehicles. Vans, which have capacities that vary from 14 to 17 passengers, are being used in high-demand intercity and local routes. The minibus has a capacity of 17 passengers and is more comfortable than the regular vans, but because of its high price its use has been limited. The operators do not receive any direct subsidies for the purchase of their vehicles but do obtain excise tax exemptions and low-interest loans through a government agency.

Organization of "Público" Operators

The operators can either work independently or join to form route associations or cooperatives. Route associations are organizations of operators who serve the same area and want to centralize their operations to function as a unit. They share a common place at the terminal, rotate service between vehicles, and buy parts and tires wholesale to save on operating expenses. These route associations tend to improve the service because controls can be implemented regarding minimum headways, passenger quotas, and route distributions by sectors.

Cooperatives are more formal arrangements usually made up of various route associations. They are often used to create benefit programs for the operators, such as low-interest loans, and are active in lobbying with governmental agencies and commercial concerns to obtain special rates from gasoline stations, automobile parts stores, and other related establishments.

Governmental Support and Incentives

Although the "público" operators do not receive any direct governmental subsidies, either local or federal, the government does provide several supportive actions and incentives. These incentives include lower vehicle registration fees, excise tax exemption on the purchase of vehicles, low-interest loans, and terminal facilities. "Público" operators who own and operate their vehicles as their sole source of income pay only a $1 annual vehicle registration fee (Puerto Rico's current fee is $40) and are allowed full excise tax exemption on the purchase of vehicles.

"Público" operators can also obtain a franchise certificate through the PSC and then use it as collateral for low-interest loans obtained through the Commercial Development Corporation (a government agency). The loans can be used toward the purchase of a new vehicle or for the repair of an existing unit.

The provision of terminal facilities is the most significant form of aid provided by the government. Municipal governments have taken advantage of several programs under the Urban Mass Transportation Administration to obtain funding for the planning, design, and construction of major off-street terminal facilities. These terminals have provided better facilities for operators and users and have contributed to improving traffic and parking conditions near the towns' plazas.

"Público" Users

Information on the characteristics of the "público" users was obtained from various surveys conducted in earlier studies. Table 2 summarizes the occupations of different groups of "público" users. The table indicates that students and housewives represent a significant portion of the "público" users.

The average family income of "público" users is difficult to obtain since many are not willing to answer and the various surveys use different ranges for the income. Of those willing to answer, approximately 38 percent indicated an income of less than $3,600/year, approximately 38 percent between $3,600 and $7,200, and 24 percent indicated greater than $7,200.

The majority of "público" users can be considered as captive to the system because, in all the studies, from 75 to 90 percent of the users indicated that the reason for using the system was that they did not have other alternatives.

The trip purpose of users is fairly evenly divided between work, school, shopping, visits to government agencies and medical services, and personal trips.

TABLE 2 OCCUPATIONS OF "PÚBLICO" USERS

	Aguadilla	Arecibo	Bayamón	Mayagüez	SJMA
Student	46.20	26.60	52.10	34.60	27.80
Employees	18.10	19.60	18.30	23.90	35.60
Housewife	20.20	29.00	18.70	21.70	18.10
Unemployed	7.10	13.40	5.30	9.10	9.50
Other	8.40	11.40	5.70	10.70	9.30

Averages from various surveys in earlier studies

"PÚBLICO" SYSTEM—SPECIFIC CHARACTERISTICS

This section complements the general "público" information provided earlier with a detailed description of the level of service and socioeconomic characteristics of the population served in the four study areas (Aguadilla, Arecibo, Bayamón, and Mayagüez).

Demographic Characteristics

According to the 1980 Bureau of Census statistics (*14–18*), Puerto Rico has a population density of 361 persons per square kilometer. The population is distributed mostly in urban areas (urban/rural ratio is approximately 2 to 1). The demographic characteristics of the four study areas are shown in Table 3.

Bayamón represents a densely populated urban area, which is part of a major metropolitan area, with extensive development (commercial, industrial, and residential) and in which the "público" system provides the majority of transit trips to the urban residential developments and wards.

Arecibo represents a regional center with a considerable rural population and which has an extensive "público" system providing service within the urban area, regional intercity coverage, and service to a large number of rural wards.

Mayagüez serves as the regional center for trade, commerce, industry, and public health and is also an important educational center. Mayagüez has a balanced combination of urban, suburban, and rural wards. It has a fairly extensive "público" system that ranges from urban service (called the "urbano," which operates as a shared taxi within the urban area) to a door-to-door service to the capital city of San Juan.

Aguadilla, located less than 20 mi to the north of Mayagüez, is a small regional center, within the area of influence of the Mayagüez region. It represents a small regional center with a well-developed "público" system that provides service within the urban area, regional intercity coverage, and door-to-door service to San Juan.

Table 3 also indicates several aspects related to commuting to work and the use of public transportation in the four study areas. The majority of workers use their private vehicles to travel to work, drive alone, and have a mean travel time to work of less than 25 min. In all of the municipalities the percentage of workers using public transportation (bus and "públicos") to work was less than 20 percent, and the "público" system constitutes the principal means of public transportation.

Route and Vehicle Information

As shown earlier in Table 1, the "público" system has three basic types of routes: local, intercity, and line service. Besides the three basic route types, in Mayagüez there is an "urbano" route that provides door-to-door service within the city limits but does not have terminals, fixed routes, or fixed stops.

In the United States, "públicos" are often described as a jitney system, which is not entirely correct. "Públicos" provide a wide range of service types, including the one similar to jitneys provided by the local system, the door-to-door scheduled service of the line system, and the shared-ride taxi system represented by the Mayagüez "urbanos." The fundamental characteristic of the "públicos" is the institutional arrangement that includes the government incentives and regulations, the route associations, and the high percentage of owner operators with significant flexibility in the way they operate their businesses.

In terms of vehicle types, sedans and vans are the vehicles used most in the four study areas. but the vehicle mix varies

TABLE 3 DEMOGRAPHIC INFORMATION FOR THE STUDY AREAS

	Puerto Rico	Aguadilla	Arecibo	Bayamón	Mayagüez
1. Population (1980)	3,196,520	54,606	86,766	196,206	96,193
2. Area (sq. km.)	8,855	95	330	116	200
3. Pop. Density (persons/sq. km.)	361.00	574.80	262.90	1691.40	481.00
4. Urban Population	2,134,365	48,613	52,457	189,753	85,714
5. Urban/Rural Ratio	67/33	89/11	60/40	97/3	89/11
6. Percent of Total Population enrolled in school	30.40	28.30	29.10	32.70	31.00
7. % Unemployed	15.20	22.30	17.10	11.50	14.90
8. Mean Income per Household ($)	7,738	6,406	6,532	9,769	7,946
9. Means of Transportation to Work (%)					
a) Private Vehicle	68.3	64.90	68.50	77.20	65.70
b) Bus	4.5	0.80	1.20	2.80	0.60
c) "Públicos"	12.4	18.10	16.40	11.60	14.60
10. Travel Time to Work -Mean (minutes)	25.8	18.90	23.50	29.70	19.50

TABLE 4 ROUTE DISTRIBUTION AND NUMBER OF VEHICLES FOR EACH TYPE OF ROUTE FOR THE STUDY AREAS

	Total	Intercity	Local	Line	"Urbano"
Arecibo					
# of routes	45	14	29	2	- - -
# of vehicles	778	224	450	104	- - -
Aguadilla					
# of routes	15	8	5	2	- - -
# of vehicles	513	256	222	35	- - -
Bayamón					
# of routes	36	15	21	- - -	- - -
# of vehicles	1,068	529	539	- - -	- - -
Mayagüez					
# of routes	24	12	10	1	1
# of vehicles	642	246	118	20	258

from area to area. The tendency has been to replace sedans with higher capacity vehicles in those routes that have a higher passenger demand. Table 4 shows the distribution of routes and the number of vehicles for each type of route in each of the study areas. In all the study areas, the "público" system is fairly extensive, with more than 500 vehicles providing good local and intercity coverage.

To provide a better idea of the magnitude of the "público" service in each of the study areas, four commonly used statistics were computed and are presented in Table 5. In all of the study areas there are at least 20 authorized vehicles per 1,000 households and at least an average of 17 vehicles per route. Aguadilla, although the smallest of the study areas in terms of the size of the municipality, has the highest rate of authorized vehicles per household, per person, and per route. This may reflect a problem of oversupply, which was indicated in a recent study (*9*). Bayamón, being the most densely populated of the study areas, has the lowest rate of authorized vehicles per household and per person, but it has the highest rate per square kilometer. Arecibo, being the largest of the municipalities in terms of size, has high rates per household and per person but the lowest rates per square kilometer and per route.

The study areas are also served by other modes of public transportation. Arecibo is served by four private bus companies that have 13 buses distributed over six routes connecting to nearby municipalities and to the eastern rural communities. In Bayamón there are also eight private bus routes with approximately 33 buses that use Bayamón as a stopover and provide regional intercity service. It is also served by five routes of the Metropolitan Bus Authority. Aguadilla and Mayagüez had, until recently, a very limited bus service to San Juan. Taxi service is also available in all the study areas but only to a minor degree.

Passenger and Revenue Data

The passenger and revenue data for the four study areas are summarized in Tables 6 through 9. The information about passengers and vehicle trips was based on cordon counts conducted between 6:00 a.m. and 6:00 p.m., on a typical weekday, and information about weekends and night service was not included. Also, because of the lack of information about trips starting outside of the cordon line, certain correction factors, based on interviews with the operators and spot checks along the routes (*20*), had to be applied.

Revenue was computed based on the official fare of the route and the estimation of the cost of providing "público" service. The principal source of data for this purpose is the PSC. The cost estimates developed by the PSC consist of two components, one fixed, the other variable. The fixed costs of the PSC's methodology include depreciation, tires, repairs, maintenance, insurance, and registration. The total fixed costs per vehicle per day vary from $15.38 for a six-passenger vehicle to $27.68 for a 20-passenger van. The variable cost component includes fuel cost per mile based on average fuel efficiency ratings for the fleet by vehicle type. The efficiency ratings used are 13 mi/gallon for the six-passenger sedans, 10 mi/gallon for 12-to-15 passenger vans, and 8 mi/gallon for the 17-to-22 passenger minibuses. These ratings, together with the fleet composition by route and the average fuel cost (assumed $1.39/gallon), are used to obtain the fuel cost by route.

The PSC cost methodology does not include labor costs. The reason for this is that the principal labor cost of the "público" system is that of the driver and, because a large percentage of the drivers are vehicle owners, a salary per se was not considered appropriate. Thus, the net revenue obtained from the gross revenue and cost estimates based on this methodology include the income of the driver.

The information in Tables 6 through 9 can be used to compare the "público" systems of the study areas and the different types of routes. While comparing, one should remember that the four study areas represent different types of environments. Bayamón has the "público" system with the most vehicle trips and passenger trips. In addition, its system has the shortest headways, the highest vehicle occupancy, and the highest rev-

TABLE 5 STATISTICS ON AUTHORIZED "PÚBLICO" VEHICLES

	Veh.\1,000h.h.	Veh.\1000pop.	Veh./sq.km.	Veh./Route
Arecibo	31.63	8.97	2.36	17.29
Aguadilla	33.34	9.39	5.35	34.20
Bayamón	20.60	5.44	9.16	29.67
Mayagüez	23.05	6.67	3.22	26.75

TABLE 6 AGUADILLA "PÚBLICO" SYSTEMWIDE INFORMATION

Variable Name	Total	Intercity	Local	"Línea"
Vehicle Trips Per Day	1,715	663	1,025	27
Passenger trips per day (outbound-thru cordon)	5,952	2,223	3,647	82
Passenger trips per day (total trip adjusted)	18,271	6,652	11,349	270
Headways (minutes)	0.42	1.09	0.70	26.67
Two-way route length (km)	812.60	211.20	97.40	504.00
Average Occupancy (One-way trip adjusted)	5.33	5.02	5.54	5.00
Round trips/veh.	4.14	3.27	5.57	1.00
Revenue per day ($)	15,775	5,800	8,355	1,620
Revenue/veh. per day ($)	38.10	28.57	45.41	60.00
Cost/veh. per day ($)	20.24	18.31	20.79	30.98
Profit/veh. per day ($)	17.86	10.26	24.62	29.02
Fare/km (cents)	5.35	5.97	7.08	4.76
Revenue/km ($)	0.40	0.32	0.58	0.24
Cost/km ($)	0.21	0.20	0.27	0.12
Profit/km ($)	0.19	0.12	0.31	0.12

"Público" data based on a study performed in 1984

enues and profits per vehicle. But even in Bayamón, the average revenues and profits per vehicle are relatively low. The Arecibo system also has a significant number of vehicle trips and passenger trips per day and has similar economic characteristics as the Aguadilla "público" system. Both of these systems have less revenues and lower profits than the Bayamón system. The Mayagüez system shows the least vehicle trips and passenger trips per day, longer headways, and lower revenues and profits. A variable that is fairly consistent in all of the study areas is the fare per kilometer, being an average of 5 to 6 cents in all of the systems.

A comparison between the different types of "público" routes indicates that the local routes are characterized by more passenger trips per day and higher vehicle occupancy, more frequent service, more trips per vehicle, shorter headways, higher revenues, and higher profits. The line service is characterized by a fewer number of trips, longer trips, longer headways, and higher revenues and profits per vehicle but low profits per kilometer.

"PÚBLICO" SYSTEM—QUALITATIVE INFORMATION

Several attributes, mostly related to the level of service provided by the "público" system for which lack of data prevented numerical comparisons, are discussed in a qualitative manner. These attributes include privacy and general comfort, average speed and directness of travel, waiting time, service coverage, safety and insurance, and organizational and labor issues.

Privacy and General Comfort

The "público" vehicles are, on the average, 6-year-old sedans, and, given their high occupancy, the privacy and comfort provided are low.

Average Speed and Directness of Travel

The average speed and directness of travel of "públicos" are highly dependent on the type of route. In the case of the intercity "públicos," which operate between terminals at the towns' plazas, the alignment is usually that followed by private automobiles in similar journeys. For this reason, the in-vehicle travel time of this service is similar to that of private automobiles.

The journey of the line service can be divided into three separate components: collection, distribution, and linehaul. The linehaul segment of this service operates similarly to the other intercity "públicos" with travel time almost equal to that of private automobiles. The collection and distribution legs of this service are along residential streets with low speeds.

Local "público" routes operate along major arteries and roads with lower average speeds because of the frequent stops they make along the route to pick up and deliver passengers.

TABLE 7 ARECIBO "PÚBLICO" SYSTEMWIDE INFORMATION

Variable Name	Total	Intercity	Local
Vehicle trips per day	2,119	366	1,753
Passenger trips per day (outbound-thru cordon)	9,391	1,053	8,338
Passenger trips per day (total trip adjusted)	29,962	3,776	2,618
Headways (minutes)	0.34	1.97	0.41
Two-way route length (km)	1018.7	265.8	752.9
Average Occupancy (One-way trip adjusted)	7.07	5.16	7.47
Round trips/veh.	4.38	2.70	4.97
Revenue per day ($)	19,628	4,230	15,398
Revenue\veh. per day ($)	40.55	32.29	43.62
Cost/veh. per day ($)	22.15	20.62	22.72
Profit/veh. per day ($)	18.4	11.6	20.9
Fare/km (cents)	5.02	6.09	4.65
Revenue/km ($)	0.36	0.27	0.39
Cost/km ($)	0.19	0.17	0.21
Profit/km ($)	0.17	0.10	0.18

"Público" data based on a study performed in 1983.

Waiting Time

The frequencies of local "públicos" are determined dynamically by the demand of travel; for this reason, although they provide frequent service, they can be highly unreliable, particularly at periods of low demand. Many intercity "público" routes also set their frequencies dynamically in response to the demand. In this case, the service is less frequent and its variability can be quite high because of the lower demand rates.

For both the local and intercity "públicos," there is a large variation in the route headways within a route type. For example, in Aguadilla, the average route headway of intercity routes was 17.65 min, but it ranged from 3.2 to 65.5 min. The routes serving rural areas have longer headways because their demand rates may be relatively low. Line service, on the other hand, provides reliable door-to-door service but with less frequency. The latter does not affect the wait time because passengers adapt their trips to this schedule; however, this may be inconvenient if travel is required at specific times of day.

Service Coverage

The service coverage of a system refers to its availability to offer service to different origins and destinations (spatial component), at different times of day (temporal component), and the ability to complete the trip in as short a time as feasible. In terms of the spatial and temporal coverage, the private automobile or a taxi can be considered the best mode. The different components of the "público" system can be considered at a second level in terms of spatial coverage because they are dense regional systems.

"Públicos" are also usually available for emergency trips in their neighborhoods and for special trips during nonworking hours to airports, sporting events, or political activities. This adds to the temporal coverage of this mode, providing much-needed service for the transit dependent.

Safety and Insurance

The accident records in Puerto Rico do not categorize "público" accidents and, thus, there is no published information. "Públicos," however, are not considered a safety hazard for passengers, but many drivers create traffic problems because they frequently stop at any point, for passenger pickup and delivery, without regard to the rest of the driving population.

Organizational and Labor Issues

The "público" system is not well organized, and a loose organizational structure exists only at the route level, mostly to ensure vehicle loading priorities at the terminals and to take phone calls for the line service. The drivers are free with respect to schedules and operation of vehicles. All this leads to inefficient operations and affects reliability of service. The

TABLE 8 BAYAMÓN "PÚBLICO" SYSTEMWIDE INFORMATION

Variable Name	Total	Intercity	Local
Vehicle trips per day	3,586	1,106	2,480
Passenger trips per day (outbound-thru cordon)	33,165	9,680	23,485
Passenger trips per day (total trip adjusted)	95,165	28,756	66,409
Headways (minutes)	0.20	0.65	0.29
Two-way route length (km)	1266.56	790.88	475.68
Average Occupancy (One-way trip adjusted)	13.27	13.00	13.39
Round trips/veh.	4.16	2.70	5.47
Revenue per day ($)	51,112	20,930	30,182
Revenue\veh. per day ($)	59.23	51.05	66.63
Cost/veh. per day($)	25.42	24.32	26.41
Profit/veh. per day ($)	33.81	26.73	40.22
Fare/km (cents)	4.67	4.68	4.67
Revenue/km ($)	0.60	0.57	0.63
Cost/km ($)	0.26	0.27	0.25
Profit/km ($)	0.34	0.30	0.38

"Público" data based on a study performed in 1982.

TABLE 9 MAYAGÜEZ "PÚBLICO" SYSTEMWIDE INFORMATION

Variable Name	Total	Total (without "Urbano)	Intercity	Local	"Línea"	"Urbano"
Vehicle trips per day	3,760	418	182	224	12	3,342
Passenger trips per day (outbound-thru cordon)	6,233	1,459	540	859	60	4,774
Passenger trips per day (total trip adjusted)	*	4,194	1,820	2,254	120	*
Headways (minutes)	0.19	1.72	3.96	3.21	60.00	0.22
Two-way route length (km)	*	975.80	337.10	325.10	313.60	*
Average Occupancy (One-way trip adjusted)	*	5.02	5.00	5.03	5.00	*
Round trips/veh.	8.02	1.98	1.60	2.64	1.00	12.95
Revenue per day ($)	*	5,943	2,384	2,600	960	*
Revenue\veh. per day ($)	*	28.16	20.93	30.58	80.00	*
Cost/veh. per day ($)	*	18.25	16.61	17.97	35.80	*
Profit/veh. per day ($)	*	9.91	4.32	12.61	44.20	*
Fare/km (cents)	*	5.91	5.75	6.86	5.10	*
Revenue/km ($)	*	0.32	0.31	0.36	0.26	*
Cost/km ($)	*	0.21	0.24	0.21	0.11	*
Profit/km ($)	*	0.11	0.07	0.15	0.15	*

"Público" data based on a study performed in 1983.
* Data not available.

only advantage is that overhead costs of operation are minimized. Controls exist only with respect to fares and licensing to operate on a route. Labor problems are practically nonexistent because of the individual private operations. No major conflicts are reported between the "público" system and other modes, such as taxis and public transit.

ADVANTAGES AND LIMITATIONS

The "público" system, as mentioned earlier, is the principal mode of public transportation in Puerto Rico providing a family of transportation services in urban, suburban, and rural areas. Certain socioeconomic characteristics of Puerto Rico help create an environment, in terms of both supply and demand, under which "públicos" result in an adequate transportation mode. These include the high level of unemployment, the relatively low income of the population, and the high percentage of households without phones or vehicles. These phenomena result in both a large captive "público" market and a large pool of potential operators willing to offer service at relatively low profit margins. In addition, in Puerto Rico both private and public investments in public transportation have been limited, so the "públicos" serve a useful function for school, shopping, and other types of trips.

Other significant aspects of the system are that it is self-supporting, operating without any direct government subsidies and with a minimum amount of government interference. It has low startup and overhead costs because of its simple organization but contributes to the economic sector by providing a source of self-employment to a largely uneducated, unskilled middle-age labor force and by generating economic activity in local markets. It is adaptable to narrow and crowded streets where large buses cannot operate easily.

However, Puerto Rico's "público" system has its share of problems that affect the operation. These include an oversupply of vehicles in some routes, inefficient or inadequately served routes, difficulty in transfers resulting in inadequate cross-town service, slow response to changes in passenger preferences or travel patterns, limited service during periods of low demand, low operator incomes, absence of planning and scheduling information, and absence of proper insurance for both drivers and passengers.

CONCLUSIONS

The "público" system provides an acceptable and widely used service for a mostly captive market in Puerto Rico. The success is mainly because of the acceptance of low profit levels by the operators. Although other areas may have different environments compared to Puerto Rico, many of the principal characteristics of the "público" system could be used as a basis for consideration in transportation improvements by

diverse federal, state, and local transit authorities. A service based on the characteristics of the "público" system may be suitable for feeder routes to major transportation systems or as the principal mode of service in low-density and low-income areas.

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REFERENCES

1. *Special Report 164: Paratransit*. TRB, National Research Council, Washington, D.C., 1976.
2. F. Luyanda, P. Gandhi, and S. González. *Evaluation of the Transferability of the "Público" System of Puerto Rico to Other Areas*. Report PR-11-004. School of Engineering, University of Puerto Rico, Mayagüez; UMTA, U.S. Department of Transportation, Sept. 1986.
3. *Transportation Studies for the Metropolitan Areas of San Juan, Ponce, and Mayagüez*. Wilbur Smith and Associates, Inc., San Juan, Puerto Rico, 1967.
4. R. Garcia, A. Riesco, E. Aldarondo, F. El Gammal, and M. Padrón. *Público Study*. Report PR-URT-1-71. Transportation Research Institute, University of Puerto Rico, Mayagüez; UMTA, U.S. Department of Transportation, June 1972.
5. CLM Systems, Inc. *Intercity Highway Public Transportation Plan*. Final Report. Puerto Rico Highway Authority, San Juan, Aug. 1972.
6. Consultores Técnicos Asociados, Inc. *Río Piedras "Público"—Car Terminal Location Alternative Analysis*. Final Report. Planning and Budget Office, Municipality of Río Piedras, Puerto Rico, April 1981.
7. Consultores Técnicos Asociados, Inc. *Bayamón Public Transportation Terminal Alternative Location Analysis*. Final Report. Planning Office, Municipality of Bayamón, Puerto Rico, July 1982.
8. Management & Technical Consulting Group, Inc. *Arecibo Public Transportation Terminal Needs and Location Study*. Municipality of Arecibo, Puerto Rico, Aug. 1983.
9. Noel Añeses and Associates, Inc. *Feasibility Study for the Location of a Mass Transportation Terminal in the Aguadilla Urban Commercial District*. Municipality of Aguadilla, Puerto Rico, Feb. 1985.
10. Engineering Management and Information Systems of Puerto Rico. *Evaluation of the Carolina Transportation Corridor Trunk and Feeder System*. Final Report. Metropolitan Bus Authority, San Juan, Puerto Rico, 1980.
11. F. Luyanda and J. F. Lluch. *Evaluation of the Impact of a "Público" Terminal Facility on Urban Transportation*. Report PR-11-003. Transportation Research Institute, University of Puerto Rico, Mayagüez; UMTA, U.S. Department of Transportation, May 1984.
12. Consultores Técnicos y Asociados, Inc. *Público-Car Policy Analysis*. Final Report. Department of Transportation and Public Works, San Juan, Puerto Rico, March 1985.
13. F. Luyanda and J. L. Rodríguez. Public/Private Partnership in the Operation of the "Público" System of Puerto Rico. Presented at the Annual Meeting of the Institute of Transportation Engineers, San Francisco, Calif., ITE, Washington, D.C., 1984.
14. Synectics. *Level of Service Rendered by "Público" Cars for the Metropolitan Area of Mayagüez*. Final Report. Department of Transportation and Public Works, San Juan, Puerto Rico, Oct. 1982.
15. *1980 Census of Characteristics of the Population, Number of Inhabitants, Puerto Rico*. Report PC 80-1-A53. U.S. Department of Commerce, Bureau of the Census, June 1982.
16. *1980 Census of Population and Housing, San Juan, Puerto Rico*. Report PHC 80-2-323. U.S. Department of Commerce, Bureau of the Census, Feb. 1984.
17. *1980 Census of Population and Housing, Arecibo, Puerto Rico*. Report PHC 80-2-74. U.S. Department of Commerce, Bureau of the Census, Feb. 1984.
18. *1980 Census of Population and Housing, Puerto Rico, Selected Areas*. Report PHC 80-2-53. U.S. Department of Commerce, Bureau of the Census, Feb. 1984.
19. *1980 Census of Population and Housing, Mayagüez, Puerto Rico*. Report PHC 80-2-235. U.S. Department of Commerce, Bureau of the Census, Feb. 1984.
20. E. Arroyo Mora. *Público Cost and Revenue Estimation*. Draft of M.S. thesis. Department of Civil Engineering, University of Puerto Rico, Mayagüez, June 1988.

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