County road funds, and almost 60 percent of the county's major road funding source for that year was depleted. The heavy losses did not support any of those alternatives that included the beltway.

5. The decision reached definitely indicated support of a strong central business district in Orlando and the need for an improved downtown transit terminal.

6. The I-4 bus and car-pool roadway, although not specifically evaluated for percentage of car pools, is expected to accommodate car pools as well as express buses. Also, the benefit of existing ROW in the I-4 busway concept left open the future possibility of a fixed-guideway system should the densities in the area ever warrant it.

7. The Orlando urban area, similar to other tourist areas, is attempting to solve resident and tourist travel demand with the same system, a difficult if not impossible task. Travel characteristics of tourists are different from those of residents and are sometimes hard to quantify, especially when international markets are involved. We suggest that this problem be further explored by UMTA.

8. Finally, we observed that the adopted plan did not offer the rural areas much transit or highway facilities. This lack was an important flaw in the selected alternative and caused many of the rural areas to support the beltway alternative because they had no other choice.

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Increasing the People-Moving Capability of Shirley Highway

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Because of the dramatic increase in construction costs of rail rapid transit in recent years, the exclusive highway right-of-way for high-occupancy vehicles has emerged as a possible cost-effective alternative for transporting peak-period commuters through congested corridors. The Shirley Highway busway in northern Virginia offered the first such exclusive right-of-way when its first section was opened to buses in 1969. The busway was opened to car pools of four or more riders in December 1973 and became the principal element of the Urban Mass Transportation Administration's Shirley Highway express-bus-on-freeway project, which was conducted for 1 year until December 1974. Priority treatment accorded buses and car pools resulted in a substantial improvement in the corridor's people-moving capability during peak hours. In addition, considerable travel-time savings were realized by all commuters using Shirley Highway. This paper discusses (a) increases in the people-moving capability of Shirley Highway and (b) the reasons for the increases. The increases in the people-moving capability of Shirley Highway can be attributed to increases in commuter use of buses and car pools. Particular attention was given to bus users to determine why a large number of automobile users—many with upper-middle incomes from homes with several automobiles—switched to bus and why some bus users switched to automobiles (driving alone or car pooling).

Because construction costs of rail rapid transit facilities have risen dramatically in recent years, finding less costly means of effectively transporting large numbers of travelers through congested corridors has become necessary. One alternative includes use of exclusive right-of-way lanes for high-occupancy vehicles. Although usually referred to as "busway," many (if not a majority of) exclusive rights-of-way permit use by car pools containing some minimum number of occupants.

In 1969, the first section of the Shirley Highway busway—two reversible lanes in the median of Shirley Highway (I-95)—was opened to buses. This busway, the first in the United States, became the principal element of the Urban Mass Transportation Administration (UMTA) Shirley Highway express-bus-on-freeway project that began April 1971 and ended December 1974. The project provided express-bus service between a portion of northern Virginia and Washington, D.C., shown in Figure 1, and included the following major elements:

1. Two 18-km (11-mile) reversible lanes in the median of the Shirley Highway plus bus-priority lanes in downtown Washington;
2. The addition of 90 new, special-feature buses with new schedules on new, more direct routes; and
3. The coordination of residential fringe parking facilities with express-bus service.

In December 1973 an important new dimension was added to the project when car pools with four or more occupants were permitted to use the busway.

The principal goal of the project was to demonstrate that such priority operations could lead to an improvement in the people-moving capability of a corridor's transportation facilities. People-moving capability is evaluated in terms of both the magnitude of people moved and the effectiveness with which they are moved.

This paper examines the increases in people movement during peak periods on Shirley Highway over the time span of the project as well as the service perceptions of the commuters. The paper includes an estimate of the increase that can be properly attributed to the project and a determination of factors that might have led to the increase. Although these results apply to the Shirley Highway corridor, the experience should be useful to transportation planners in design and implementation of similar efforts.

The Shirley Highway is an eight-lane freeway with two three-lane directional roadways separated by the two-lane reversible express roadway. During the time span of this demonstration project, Shirley Highway was burdened by a major construction program. As the construction program progressed, the capacity of the freeway increased; as the capacity increased, automobile traffic increased. Between April 1970 and November 1974, total morning peak-period person trips (observed between 6:30 and 9:00 a.m.) on Shirley Highway increased from approximately 17 000 to 37 000.

An indication of the increase in people-moving capability attributable to the project can be determined by an analysis of commuter travel on the reversible lanes. Changes in people-moving capability are assessed in terms of project-stimulated changes in

1. The number of person trips per hour carried by the transportation system,
2. The effectiveness of people movement as represented by commuter use of high-occupancy vehicles, and
3. Travel time of commuters using Shirley Highway.

INCREASED PERSON TRIPS PER LANE ON SHIRLEY HIGHWAY

The number of person trips per lane stimulated by the project is estimated as the difference between person trips per lane counted during the hour when the highest number of person trips was counted on the main roadway and on the reversible lanes. Trends in person trips during peak hours are shown in Figure 2. These trends indicate that, between 1971 and 1974, person trips during the peak hour averaged 6100 on the reversible lanes and 2300 on the main roadway.

Thus, the project increased the person trips on Shirley Highway by more than 3500. In calculating person trips during the peak hour, the busway was considered to have been a single-lane facility before May 23, 1973, when eight lanes of highway were completed to a point about 1.6 km (1 mile) south of the Potomac River. Prior to that time, even though the southern part of the busway had two lanes of completed reversible roadway, flow through the northern part of the region narrowed to a single temporary lane. After May 23, 1973, the busway was considered a two-lane facility in the calculations.

As shown in Figure 2, the change in the number of busway lanes from one to two on May 23 reduced the computed person trips per lane by one-half. Car pools of four or more persons, which began using the busway in December 1973, were responsible for the sharp increase in person trips per busway lane during 1974. Regardless of whether the busway was considered a one-lane or two-lane facility, the rate of peak-hour person trips was always much greater than that of the main roadway.

Increase in Bus Ridership and Car Pooling

Between April 1971 and November 1974, peak-period bus ridership (one-way) on the Shirley Highway express-bus routes increased from approximately 5000 to about 16 000. As indicated in Figure 3, bus ridership on other corridor bus routes declined only approximately 1000 during this period. We therefore concluded that more than 10 000 commuters who used the express-bus service were new to the corridor-area system.

This dramatic increase in bus ridership led to a 30 to 41 percent increase in the bus share of the corridor commuter market. An examination of trends in passengers per bus (Figure 4) indicates that the increases in ridership and bus market share were achieved efficiently; i.e., express service averaged 45 passengers/bus. Moreover, Figure 4 suggests that bus ridership might have been even higher had not the limited supply of buses acted as a constraint. Although the bus service was continually expanded, the busway buses always operated at, or above, seating capacity.

Increases in commuter car pooling also increased the highway's people-moving capability. Approximately 4600 car poolers (1050 automobiles) used the reversible lanes each peak period during November 1974 (1 year after they were opened to car pools with four or more riders). These car pools resulted in increases in automobile-occupancy rates both in the corridor area and on Shirley Highway.

Reductions in Line-Haul Travel Times on Shirley Highway

The reversible lanes for buses and car pools have increased the magnitude of people moving on Shirley Highway. The question that arises is whether this priority treatment has affected quality of service. To examine level of service with and without the priority treatment, a computer simulation model was used to estimate the travel times for buses, car pools using the busway, and other automobile users (5). The model estimated these travel times both under the 1974 bus and car-pool priority operations and under those conditions that could have been expected had all lanes (including the reversible lanes) been open to all vehicles. For these calculations, existing conditions under priority operations in 1974 were assumed to be those observed in June 1974 during the morning peak period when 45 percent of the person trips on the Shirley Highway were by bus and automobile occupancy was 1.49. The assumption made was that the total number of peak-period person trips and the total number of bus passengers on Shirley Highway were the same as they would have been had there been no project: that is, 18 500 peak-period person trips, 5000 bus passengers, and automobile occupancy of 1.44.

Travel-time savings were estimated for a 2-km (1.3-mile) length of highway between Glebe Road and Washington Boulevard exits for which data were available. The results showed that the 1974 priority operations for buses and car pools of four or more persons saved over 1400 total person-h daily during the morning peak when compared with travel times under expected mixed traffic conditions on all lanes without the project. A savings of 1400 person-h approximately equals the total time spent on that highway length by all commuters under existing priority conditions. The time savings represents more than a 3-min saving for each bus rider and car-

pool user on the busway plus nearly a 2-min saving for each person traveling by automobile on the main roadway. This large daily time savings still underestimates the benefits of the priority lanes because the time savings refers only to the 2-km (1.3-mile) section (between Glebe Road and Washington Boulevard exits) and also does not include the afternoon peak period. Thus, the model clearly suggests that this priority operation for buses and car pools saved considerable amounts of time not only for bus and car-pool users on the busway, but also for automobile users on the main roadway.

Figure 1. Location of Shirley Highway busway.

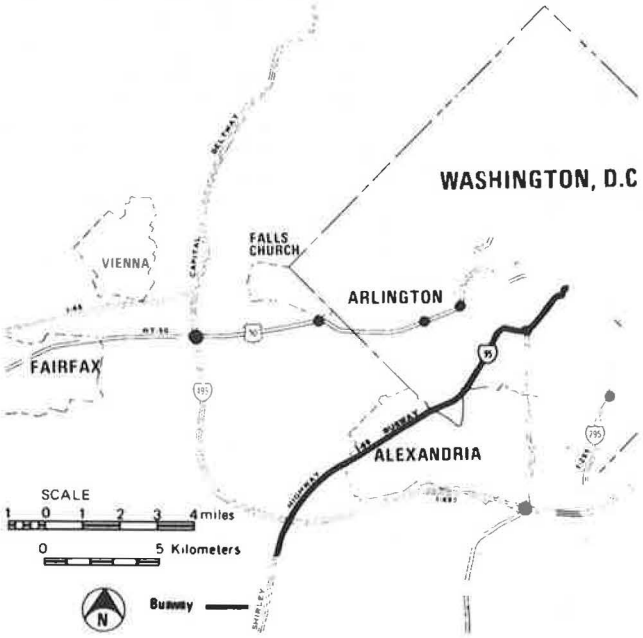
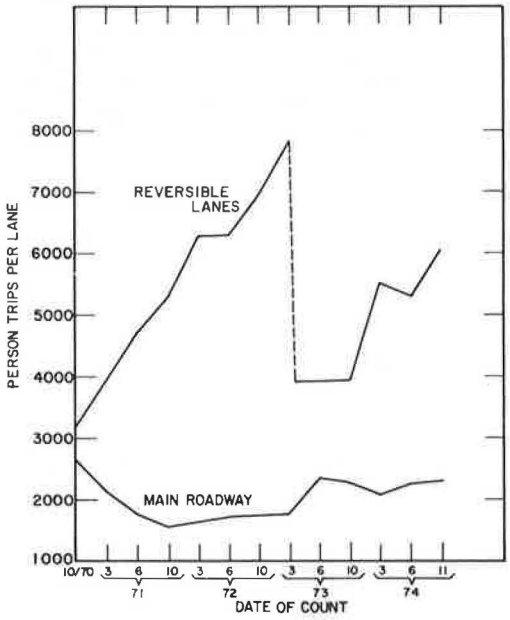


Figure 2. Inbound person trips per lane on busway between 7:00 and 8:00 a.m.



FACTORS CONTRIBUTING TO INCREASE IN BUS AND CAR-POOL USE AMONG CORRIDOR COMMUTERS

Before the busway project, commuter use of buses and car pools had been steadily declining. A major objective of this paper is to identify the reasons for the reversal of this decline.

Figure 3. Inbound bus and automobile person trips on Shirley Highway and other corridor roadways between 6:30 and 9:00 a.m.

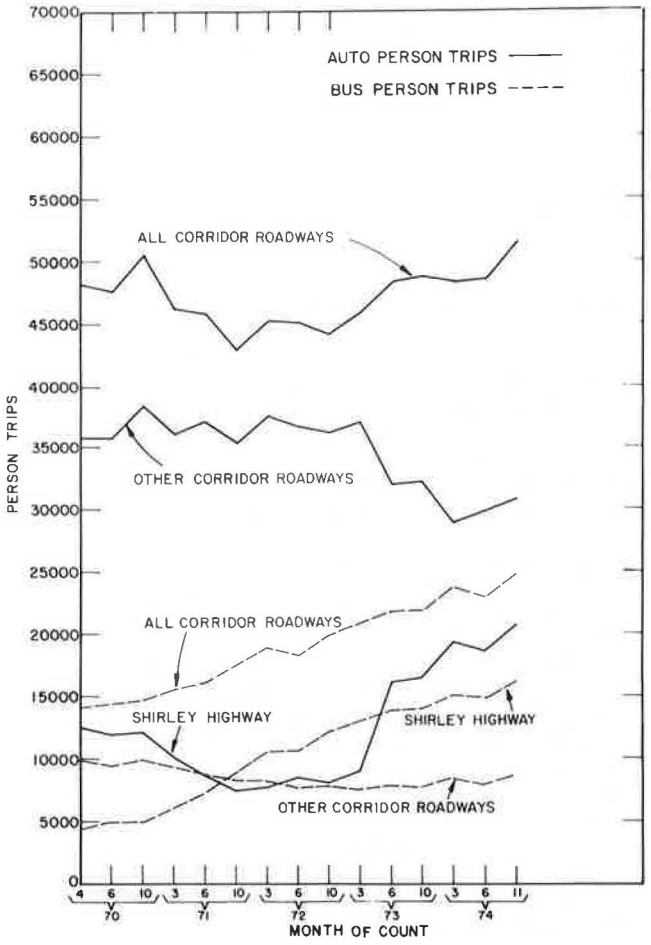


Figure 4. Number of inbound passengers per bus between 6:30 and 9:00 a.m.

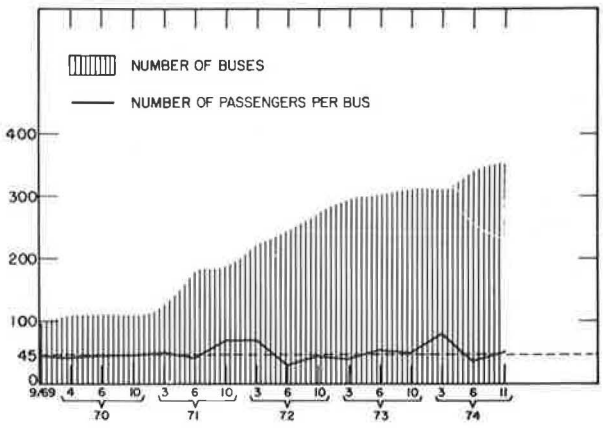


Table 1. Selected demographic characteristics of Shirley Highway commuters in 1974.

Characteristic	Busway		
	Bus Passenger (%)	Car Pooler (%)	Drivers Alone[a] (%)
Household income, $			
<5000	0	0	0
5000 to 15 000	21	7	23
15 000 to 30 000	61	61	45
>30 000	18	32	32
Age, years			
<21	3	1	1
21 to 39	59	46	47
40 to 65	37	53	51
>65	0	0	1
Sex			
Male	62	85	73
Female	38	15	27
Automobile ownership			
0	5	1	0
1	51	30	35
2	37	56	55
3	6	11	9
4	1	2	1

[a] Includes motorists from other corridor arterials.

Corridor-Commuter Surveys

The most recent data on corridor commuters and their modal-choice decisions are provided by surveys conducted during the fall of 1974. The surveys involved different procedures for bus and automobile commuters. For the bus survey, request-return questionnaires were distributed by bus drivers to a sample of passengers on peak-period buses. The automobile survey procedure was more involved. A sample of license plates of automobiles crossing the corridor screen line was recorded, and request-return questionnaires were sent to the owners of automobiles that were registered in Arlington and Fairfax counties.

A 30 percent sample of busway buses resulted in a sampling rate of 34 percent. A 20 percent sample of nonbusway automobiles was attempted. Because of the speeds of the automobiles as they passed the observation stations, this is about the maximum sampling rate. However, the actual sampling rate was 13 percent for drivers alone and 15 percent for car poolers because of observation and recording errors and automobiles with non-Virginia license plates. A 100 percent sample of busway car poolers was attempted, but the actual sample rate was 66 percent, again, because of automobiles registered out of state and observation and recording errors.

Survey-response rates ranged from 45 to 64 percent. Commuters who benefited directly from the busway had the highest response rates. Two short studies were conducted to investigate potential bias due to survey nonrespondents. These investigations, one for the bus survey and the other for the automobile drivers, indicated little statistical difference between respondents and nonrespondents (based on chi-square tests at the 5 percent level). Thus, we concluded that the responding commuters represented a random sample of corridor commuters.

The fall 1974 commuter survey data, given in Table 1, provides the following summary of a corridor commuter. The person came from a family that owned two automobiles, had an annual income between $15 000 and $30 000, and was a male between 21 and 39 years of age. Bus passengers were the youngest and least affluent, were predominantly females, and owned fewer automobiles; busway car poolers were the most affluent, were predominantly male, and owned the most automobiles. The average number of automobiles owned per household was 1.47 for busway bus passengers, 1.83 for busway car poolers, and 1.76 for drivers alone.

Modal-Choice Decisions Involving Bus

After the entire Shirley Highway busway was opened in April 1971 and service was expanded on routes using the busway, daily peak-period patronage on busway buses increased from less than 5000 in October 1970 to 16 000 in November 1974, an increase of nearly 92 percent or 14 700 transit trips from the beginning of the project in April 1971. During the same time period, daily peak-period patronage declined slightly on nonbusway buses from 10 000 to 9000.

Modal-choice decisions of busway bus riders were examined to determine the reasons for this large increase in ridership. Approximately 20 percent of these busway bus riders indicated that they had no alternative to the bus because they did not have an automobile for commuting. These riders are referred to as captive riders and are not included in the examinations of modal choice.

A majority of the noncaptive (choice) busway bus riders had previously commuted by automobile. The table below gives a summary of the responses of the choice bus riders to the survey question: Before you began using this bus, how did you actually commute from home to work? Sixty percent of the choice busway bus riders formerly used automobile transportation. (Of these commuters who had the same trip prior to using bus, 79 percent formerly used automobile transportation.)

Prior Mode	Percent
Did not make this trip, that is, previously resided or worked elsewhere and	
Used automobile	30
Used bus	23
Used other	4
Drove alone	19
Was an alternate driver in a car pool	5
Drove in a car pool	3
Was a passenger in a car pool	3
Used another bus	8
Other	5

To determine why such a large number of bus riders in the area had switched from automobile, responses to the following survey question were examined: If prior to riding this bus you commuted regularly by automobile, why did you switch to bus? As indicated in the table below, "discomfort of driving" was given most often as the reason for switching from automobile. About 28 percent of the busway bus riders indicated that bus operations were the reason for switching, and 26 percent of the busway riders indicated that an income-related feature was the reason.

Reason	Percent	Reason	Percent
Automobile not available	13	Bus faster	2
Automobile too expensive	3	Bus more reliable	2
Parking too expensive	10	Bus express	8
Reduced effect of traffic congestion on bus	20	Time on bus usable	2
Discomfort of driving	34	Other	6

Just as automobile commuters switched to bus, some bus users switched to automobile. A summary is given below of the responses to the question, If you do not now regularly commute from home to work by bus, why not? In the tabulation, A drivers are those drivers alone who had tried regularly commuting by bus in the Shirley Highway corridor since 1970 and B drivers are those drivers

alone who had not done so. The reason given most often is ranked first, and ties are assigned the same ranks.

Reason	A Drivers		B Drivers	
	Percent	Rank	Percent	Rate
Loss of flexibility in working hours	35	3	48	1
Bus takes too long	42	1	40	2
Too much time spent waiting at bus stops	42	1	32	3
Need automobile during workday	29	5	30	4
Bus unreliable	30	4	14	8
Too much walking necessary	20	7	22	5
Bus too expensive	19	8	16	7
No seats available on bus	22	6	8	9
Bus not available	7	9	17	6
No personal privacy	6	10	8	9

The percentages were estimated from survey forms that had "other" checked and a reason specified afterwards. No significant differences were noted in the reasons given for not commuting by bus between those persons who had tried commuting by bus since 1970 and those who had not. Significantly, an analysis of the residences of the diverted bus riders revealed that at least two-thirds lived in areas served by nonbusway routes that provided much slower service than busway routes.

A special category of busway bus riders were those who did not make the same trip prior to using their present bus. These were commuters who began riding the bus after a change in job or residence location. An analysis of their responses revealed that such changes appeared to be a factor in the decisions of many automobile commuters to switch to bus. Responses of current automobile users and of the bus users who formerly had commuted by automobile were compared for the questions: When was the last time you changed your place of residence? and When was the last time you changed your place of work? The automobile users who switched to bus had more recent changes in employment and residence locations then the current automobile users. This switching was further supported by chi-square tests that showed the differences to be significant at the 5 percent level. This analysis indicates that many commuters used a job or residence change to experiment with commuting by bus and suggests that areas of high mobility (such as Washington, D.C.) are also areas of potentially good transit markets.

Modal-Choice Decisions Involving Car Pools

After a long period of decline, late in 1973, car pooling in the Shirley Highway corridor began to increase. Of the car poolers surveyed during October 1974, more than 40 percent began car pooling during 1974. In addition, 37 percent of the car-pool drivers stated that their car pools had increased in size during the energy crisis of the winter of 1973-1974 and after the opening of the busway to car poolers of four or more persons in December 1973.

To gain insight into the reasons for this increase, an examination was made of responses to the survey question that asked car-pool drivers and passengers to identify the importance of several factors to their decisions to join or form their present car pool. Four choices were provided for each factor: very important, moderately important, unimportant or didn't consider it, and not applicable. Tabulated below is a summary of the very important responses. The factor cited most often is ranked first and ties are assigned the same rank. Among both car-pool drivers and passengers, availability of Shirley Highway express lanes for car-pool usage, reduction in commuting cost, special parking privileges, and convenient work locations of other car-pool members were the factors most often reported as "very important."

Factor	Drivers		Passengers	
	Percent	Rank	Percent	Rank
Reduction in commuting cost	71	1	62	2
Special parking privileges	70	2	61	3
Convenient work location of other car-pool members	65	4	59	4
Reduction in gasoline use	53	5	53	5
Availability of Shirley Highway express lanes for car-pool use	69	3	72	1
Reduced stress and frustration in commuting	42	6	46	6
Concern for energy and air-pollution problems	26	7	26	8
Reduced use of an automobile or making the purchase of an automobile unnecessary	21	8	28	7
Availability of good bus service as a backup	15	9	26	8
Characteristics of other car-pool members	12	11	18	10
Comfort of vehicles used by car pool	13	10	13	11
Loss of flexibility in working hours	8	12	7	12
Additional trip time resulting from passenger pickup and discharge	4	15	4	15
Availability of car-pool locator services	5	13	6	13
Additional risk to personal safety	3	17	5	14
Loss of personal privacy	5	13	2	17
Additional automobile insurance required	4	15	3	16

Since there was a sharp increase in car pooling during 1974, the car-pooling factors discussed in the previous paragraph were examined separately for persons who began car pooling during that year and for those who began car pooling earlier. In both groups, the same factors—reduction in commuting cost, special parking privileges, and convenient work locations of other car-pool members—were most often reported as very important.

The availability of Shirley Highway express lanes to car pools was the factor most often cited as very important by busway car poolers who joined their present car pool during 1974. In addition, the express lane factor was ranked fourth in importance by busway car poolers who joined their present car pool before January 1974. Although this ranking was probably an attempt by respondents to ensure that the busway would remain open to car pools, the ranking is also an indication of the importance attached to the busway by car poolers who had established car pools prior to the opening of the busway to them.

An examination of the surveyed transit trips of car poolers and their previous trips by automobile revealed some of the benefits car poolers enjoyed. One was employer-providing parking. Prior to joining their present car pool, approximately 50 percent of the former automobile commuters used employer-provided parking; for their present car pools, this figure rose to 70 percent. Another benefit was travel-time savings; more than 60 percent of busway car poolers reported a door-to-door travel time lower than that of their previous transit trip.

Although a majority of the choice car poolers had commuted by automobile prior to joining their present car pools, a substantial percentage had formerly used the bus. The following table summarizes responses of choice car poolers to the survey question: Before you began using this car pool how did you usually commute from home to work?

Prior Mode	Car-Pool Drivers (%)	Car-Pool Passengers (%)
Did not make this trip, that is, previously resided or worked elsewhere and		
Used automobile	22	18
Used bus	9	9
Used other	1	2
Drove alone	23	16
Was an alternate driver in a car pool	23	20
Drove in a car pool	3	2
Was a passenger in a car pool	4	4
Used bus	12	24
Other	3	5

Former bus users accounted for about 25 percent of all corridor car poolers and about 30 percent of busway car poolers. Significantly, the residences of over 90 percent of the busway car poolers were located in the service area of the busway bus operation. Thus, the busway car-pool operation was in competition with busway bus service, and many of the former bus commuters in these car pools had probably switched from the high-quality express-bus service of the project. Of those who switched from the express-bus service to car pools that used the reversible lanes, approximately 80 percent reported car pooling took less travel time.

As bus riders diverted to driving alone, so did some car poolers switch to driving alone. To investigate why those persons who drove alone and who tried commuting to work by car pool had returned to their automobiles and why the remaining persons who drove alone never car pooled, responses to the following survey question were examined: If you do not now regularly commute from home to work by car pool, why not? The responses are summarized below. A drivers are those who had tried regularly commuting by car pool in the Shirley Highway corridor since December 1973, and B drivers are those who had not.

Reason	A Drivers		B Drivers	
	Percent	Rank	Percent	Rank
Loss of flexibility in working hours	71	1	67	1
Inability to locate others willing to car pool	34	2	21	4
Need automobile during workday	32	3	26	2
Too much time required to pick up and discharge car-pool passengers	9	4	22	3
No personal privacy in car pool	0	7	10	5
Too much automobile insurance required	7	5	4	7
Too much risk to personal safety	5	6	5	6

No significant differences are apparent in the reasons given for not commuting by car pool between those persons who had commuted by car pool in the corridor since December 1973 and those who had not.

CONCLUSIONS

1. This project demonstrated that priority treatment for a comprehensive high-quality bus service and for car pools can lead to a substantial increase in the people-moving capability of a major freeway. Peak-hour person trips per lane of the reversible lanes exceeded those of the main roadway by more than 3500 because many motorists switched to either express-bus service or car pools of four or more members, which could use the reversible lanes.
2. Most of the increase in person trips per hour on the reversible lanes was due to increases in bus ridership. During the time span of the project, daily peak-period, one-way bus trips on the new express-bus service increased by almost 12 000 (from 4200 in April 1971 to 16 000 in November 1974).
3. Many motorists with upper-middle incomes from homes with several automobiles switched to the improved bus service. Faced with expensive parking and frustrating congested roadways, motorists switched to the express-bus operation that provided (a) travel times shorter than preproject travel times by bus, (b) improvements in the reliability of bus service, and (c) expansions in the coverage and frequency of the bus service.
4. Priority treatment on highway facilities and in the assignment of special parking privileges stimulated substantial increases in car pooling. These two incentives plus gasoline shortages during the winter of 1973-1974 were found to be principal reasons for the increase in corridor car pooling. Car-pool locator services and concern for air-pollution problems were not found to be influential to car pooling. Loss of flexibility was found to be the greatest obstacle to car pooling.
5. Most of the increase in car pooling and automobile occupancy can be attributed to motorists; however, former bus users made up approximately 25 percent of the surveyed car poolers. Of commuters diverted to car pooling by the availability of the busway to car pools, nearly one-third had formerly commuted by bus. A large majority of these former bus riders resided in the service area of busway bus routes.
6. The project, which gives priority treatment to buses and car pools of four or more members, resulted in reductions in travel time for all commuters using Shirley Highway, i.e., for those on the main roadway as well as for those on the reversible lanes. Thus, the project not only increased the people-moving capability of Shirley Highway but also improved the level of service for all commuters using the freeway.

ACKNOWLEDGMENTS

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Abridgment

Modal-Choice Analysis of an Exclusive Bus and Car-Pool Lane

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Since the Delaware Valley Regional Planning Commission (DVRPC) adopted its 1985 regional transportation plan in 1969, changes in attitudes and conditions have impeded the implementation of that plan. Neighborhoods have become resistant to major new highway construction. Citizens and legislative bodies have demanded that environmental impacts of plans and projects be fully assessed. Escalated construction costs have made the building of all of the facilities shown on the 1985 plan impossible. Federal ambient air quality standards have required that automobile emissions be reduced. Energy shortages have necessitated complete reevaluation of transportation policies.

Of significant impact to the Delaware Valley region are recent revised regulations of the U.S. Environmental Protection Agency (EPA) concerning air quality and regulations of the U.S. Department of Transportation concerning transportation planning and programming. In 1975 the New Jersey Department of Transportation requested the DVRPC to provide an analysis of modal choice in the US-30, I-676, and Lindenwold High-Speed Line corridor (Pennsauken Township-Camden City). This analysis was part of an assessment of the impact of implementing an exclusive bus and car-pool lane through that corridor. This request was in accordance with the federally mandated New Jersey Transportation Control Plan (NJTCP) that states that each appropriate governmental entity shall establish bus and car-pool lanes on designated traffic flow corridors. One of these designated corridors is the Admiral Wilson Boulevard, a section of US-30 between the Ben Franklin Bridge Plaza and the Camden Airport Circle.

In addition to the NJTCP, EPA also promulgated the Pennsylvania transportation control plan. A section of this plan requires all governmental and public agencies to take the necessary actions to establish a peak-period exclusive bus lane over the Ben Franklin Bridge (US-30) going into Philadelphia in the morning and returning to New Jersey in the evening.

The combination of the two requirements delineates a facility, approximately 6.5 km (4 miles), that during the peak periods would serve primarily those people who reside in South Jersey and work in the Philadelphia central business district (CBD).

The corridor is currently served by the Port Authority Transit Corporation's (PATCO) Lindenwold High-Speed Line, numerous bus routes operated by Transport of New Jersey (TNJ), and four major arterial highways that converge at the Camden Airport Circle. The TNJ bus routes include local service to the city of Camden, feeder service to the PATCO line stations, and express and local service to the Philadelphia CBD.

DELINEATION OF POTENTIAL BUS AND CAR-POOL MARKET

Because the exclusive bus and car-pool lane was nonexistent at the time of this study, its market area was not defined. If a market is to develop, however, it must draw on the users of existing facilities (in the short range), i.e., the high-speed line, existing bus routes, and the highway network. Therefore, the subarea's total travel demand and the interdependence of that demand and the facilities currently offered must be understood before a potential market area for a bus and car-pool lane can be delineated.

The approach for market-area delineation was to overlay maps of the market areas of the existing prime facilities in the study area to form a composite market area. The market area served by the high-speed line was derived from automobile license plate surveys conducted at the train stations by the University of Pennsylvania. The highway network market area was derived by a select-link analysis of the Ben Franklin Bridge and the Admiral Wilson Boulevard. The commuter bus market area was assumed to be the coverage areas of those routes that traverse the general area and provide service to Philadelphia. The resultant composite market area was then modified to conform to DVRPC data collection district boundaries. The Pennsylvania portion was limited to the districts of the Philadelphia CBD because all buses using the facility would be destined for only that area and because the density of destinations there provides the greatest likelihood for car pooling.

Travel-demand matrices were constructed for the market area for the project year 1976. This task involved refining previously derived modal trip tables to agree with current corridor passenger and vehicle flows, demographic data, and employment data. The trip tables were further refined to reflect peak-period travel demand.

MODAL-CHOICE MODELING

In modeling the effect of implementing an exclusive bus and car-pool lane on modal choice in the study corridor, a binary-choice logit model was used. The general form of the model is