AN ANALYSIS OF THE SHIRLEY HIGHWAY EXPRESS-BUS-ON-FREEWAY DEMONSTRATION PROJECT

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ABRIDGMENT

•FOR MANY YEARS one of the most critical problems in urban areas has been the supply of transportation facilities. As the automobile has become the predominant mode of transportation, planners and traffic engineers have attacked this problem by increasing the number of lanes of streets and highways in urban areas. Now it is realized that a single mode of transportation cannot fulfill the demands, and a balanced system is required. One concept for alleviating the transportation problem is the use of freeway lanes for express bus service. Several studies have revealed that this concept is feasible; however, governing bodies have been reluctant to implement it. An exception is the 9-mile exclusive bus lane on Shirley Highway, Interstate 95, in northern Virginia just outside Washington, D. C.

The Shirley Highway Express-Bus-on-Freeway Demonstration Project was sponsored by the U.S. Department of Transportation, the Metropolitan Washington Council of Governments, and the Virginia Department of Highways. The principal objective was to test the hypothesis that the provision of rapid and improved bus service over an exclusive bus lane would attract a significant number of passengers formerly commuting by automobiles. The diversions from automobiles to buses would increase the "people utilization" of the facility and should enable all commuters to travel more quickly and conveniently.

The project consisted of three elements: the busway, including the exclusive lane on Shirley Highway and the bus priority lanes in the Nation's Capital; bus transit operation, involving new buses and services; and residential fringe parking where existing shopping centers and new lots provide free parking for bus riders.

The exclusive lane was opened in three sections. The first segment, approximately 5 miles long, utilized the completed reversible lanes on Shirley Highway and was designated for exclusive bus service in September 1969. The second section, opened in September 1970, was a temporary facility that connected the permanent lanes and extended northward 1.6 miles. In April 1971, the temporary lane was extended to the newly constructed center-span bridge across the Potomac River between the two older 14th Street bridges.

The feasibility study report estimated that 90 additional buses would be required during the peak periods to handle the ridership by the time the demonstration project was concluded. This expansion in service would result in a major increase in the bus company's capital requirements, and, in September 1970, the Urban Mass Transportation Administration approved a grant to the Northern Virginia Transportation Commission that provided the funding for the required buses. These buses were purchased and placed into service as the demand increased.

The availability of free fringe parking was one of the keys to market expansion. Park-and-ride and kiss-and-ride facilities were provided near the residential areas of the Shirley Highway corridor. These included parking facilities in existing shopping centers as well as new parking lots that will later serve the rail rapid system.

STUDY OBJECTIVES

This investigation was conducted to determine the effectiveness of the express bus service in relieving the congestion on Shirley Highway, thus improving the level of

service for the automobile commuter using the conventional lanes of the facility. The major objectives of this study were

1. To determine the effects of the busway on bus patronage and automobile travel trends,
2. To analyze sources of bus patrons and determine the reduction in automobiles, and
3. To use the automobile reduction to compare the level of service of the existing facility with that of the freeway without the exclusive busway.

The bus system provided similar services to the commuters during both daily peak periods; however, the scope of this study was limited to the inbound flow during the morning peak period to eliminate duplication of data collection and analysis.

STUDY LOCATION

Because the effectiveness of the busway varied over its entire length, a site that represented typical operations was chosen. This site is in the segment opening in September 1970. The geometrics of the inbound facility at this location consist of two 12-ft lanes with a 10-ft shoulder on the right and a wooden barrier guardrail, which separates the conventional lanes and the busway, located within 6 in. of the left edge of the pavement. It is a half-mile segment in level terrain, and the restricted average highway speed is approximately 50 mph.

ANALYSIS OF TRAVEL DATA

To achieve the objectives of the study, we identified and evaluated parameters such as travel times, passenger trends, commuter profiles, traffic volumes, automobile occupancy, and reductions in automobiles on Shirley Highway.

Bus travel times were based on actual scheduled runs, whereas automobile travel times were recorded by a license-plate survey. The results indicated that many of the buses saved 20 to 25 min over the automobile for the same trip.

To properly evaluate the passenger trends on Shirley Highway required that adjacent facilities in the Shirley Highway corridor be reviewed. The annual growth in travel in the 6 years prior to the initiation of the demonstration project was 4 percent, with only ½ percent being bus patronage. Since that time, travel in the corridor has decreased and for the past 2 years has experienced a decline of 1 percent each year.

The increase in bus patronage was determined from the travel counts made by the transit company. The counts included only the local buses and not special buses, many of which operated on a chartered or nonscheduled basis. At the initiation of the project, approximately 3,800 bus passengers traveled through the study site each day, but, at the end of the 31-month study period, patronage had increased to 9,200 persons or 142 percent. That is, an additional 5,400 passengers (gross increase) started riding the express bus during the study period. At the beginning of the project, approximately 25 percent of the commuters on Shirley Highway traveled by bus, whereas 54 percent of all commuters rode the bus during the peak periods in April 1972. In other words, more people were then commuting by bus than by automobile on Shirley Highway during the rush hours.

The gross increase in bus patronage was subjected to adjustments and assumptions in making the estimate of the number of commuters diverted from automobiles to buses on Shirley Highway. The adjustments included historical passenger trends in the Shirley Highway corridor, diversion from non-Shirley Highway bus routes, and transient population in the Shirley Highway corridor.

Of the adjustments evaluated, the only one that affected the number of riders significantly was the passenger diversion (6 percent) from non-Shirley buses. A 6 percent reduction of the busway's gross passenger growth (5,400) results in a net increase in patronage of 5,076 passengers. The net increase or growth represented the number of persons who formerly commuted on Shirley Highway and were attracted to the express bus system.

The demonstration project would not have been effective if only captive riders had been attracted, inasmuch as the project objective depended on a diversion from the

automobile commuter population. An on-board bus survey provided data on the sources of bus patronage. The results indicated that two-thirds of the new bus riders had a choice between the express system and their automobiles, and they freely stated that the contributing factor in their taking the bus was the fast service provided by the exclusive lanes, which avoided the conventional traffic congestion.

The bus system attracted the young working male with a good income who lived and worked within walking distance of the bus route. The majority of the bus users had annual family incomes in excess of $15,000, whereas only 1 percent had incomes of less than $5,000. Only 6 percent reported that they did not own an automobile, and the average number of automobiles per household was 1.32. It was concluded that the bus users were choice riders and were diverted from automobiles.

In the method of computation used in the study, the number of automobiles removed from Shirley Highway depended on automobile occupancy rate. As one would expect, the number of automobiles using Shirley Highway decreased as bus patronage increased. In September 1970, automobile trips reached a peak of 9,300 vehicles; in March 1972, the trips had decreased to approximately 5,600. With the number of passengers and vehicles known, the automobile occupancy rate at the study site was calculated, and there was a variation during the early months of the project before the rate leveled off at approximately 1.4 passengers per vehicle. The average automobile occupancy rate for Shirley Highway during the study period was 1.43. A review of the other major facilities in the corridor, as well as other roads leading into Washington, indicated that the 1.43 occupancy rate was within the proper range, and therefore it was used in the analysis.

Dividing the occupancy rate into the increase in bus patronage revealed that 3,550 vehicles per peak period were removed from the conventional traffic lanes. A review of the automobile travel trends substantiated this estimate, and when the decrease in automobile travel along with the annual decrease of travel in the corridor was considered, the analysis revealed that the estimate was realistic.

Classification traffic counts secured during the peak period revealed that the "vehicle-moving" peak hour occurred between 6:30 and 7:30 a.m. and the "people-moving" peak hour between 7:15 and 8:15 a.m. During the peak period, 192 buses used the busway, and 131 trips were during the "people-moving" peak hour. Because the objective of the reserved-lane concept was to increase the "people-moving" capability of the facility, the "people-moving" peak hour was selected for the level-of-service analysis.

LEVEL-OF-SERVICE ANALYSIS

In evaluating the level of service, the Highway Capacity Manual technique (4) was used inasmuch as it is the most effective means available for this purpose. The major factors used in the technique are the operating speed and volume-capacity ratios.

Speed studies taken at the study site during the "people-moving" peak hour revealed an operating speed of approximately 30 mph. Computations revealed that the service, or demand volume, was 2,210 vehicles per hour, whereas the capacity of the conventional lanes was 3,420 vehicles per hour. The resultant volume-capacity ratio was 0.65. Utilizing this ratio, the 30-mph operating speed, and a peak-hour factor of 0.79, the Highway Capacity Manual technique revealed that the subject section of Shirley Highway was operating at level of service E. The characteristics of level of service E include unstable flow, stoppage of momentary duration, operating speeds in the vicinity of 30 mph, and volumes approaching the capacity of the roadway. On a field trip to the study site during the "people-moving" peak hour, all of these characteristics were observed.

To measure the effect of the busway on the level of service for the conventional traffic required that an analysis assuming that the busway was not in operation be made. In this analysis automobiles eliminated from Shirley Highway were placed back into the conventional traffic stream. The geometrics of the roadway and the peak-hour factor were assumed to remain unchanged. It was also assumed that the "people-moving" peak hour occurred at the same time as experienced on the existing

facility, although it was surmised that this would change in a real world situation. Travel time on Shirley Highway by automobile is greater than by bus; therefore, theoretically, if the buses were removed, the commuters would be forced to travel by automobiles and thus would have to make their trips at an earlier time when the traffic flow was greater.

There was no way of predicting the operating speed on this hypothetical roadway. However, the anticipated volume-capacity ratio was 1.34. Under these conditions, the demand volumes would far exceed the capacity of the facility, and the facility would break down. The result would be low, if not zero, speeds; extremely high density; and very low volumes. A comparison with the standards established in the Highway Capacity Manual indicates a forced flow in traffic jams and an unacceptable level of service.

CONCLUSIONS

The foregoing analysis concluded that a significant number of commuters were diverted from automobiles onto the buses. This diversion reduced the number of automobiles on Shirley Highway, and consequently the level of service in the conventional lanes was improved. It is even conceivable that the busway has alleviated or at least not worsened the congestion on other facilities in the corridor. If the busway had not been provided, the number of automobiles using Shirley Highway would have increased until intolerable service levels were reached, and then motorists would have sought other routes. Thus, it is reasonable to assume that the volumes on other arterials would have been higher if the busway had not been implemented.

Apparently, the bus riders were receiving many benefits and were pleased with the service inasmuch as the patronage continued to increase even though a good majority of the riders never had a seat available for the trip. When the length of the trip is considered, much comfort must have been sacrificed for the other benefits received.

It must be concluded that the project is effective and successful inasmuch as a large number of automobile commuters have started using the attractive, rapid express bus system, and as a result the level of service for all commuters has improved. More importantly the project demonstrates the potential of the bus system as a method of public mass transportation. It appears to be feasible, practical, workable, and acceptable to the public.

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