A COMPARATIVE ANALYSIS OF RESULTS FROM THREE RECENT NON-SEPARATED CONCURRENT-FLOW HIGH OCCUPANCY FREEWAY LANE PROJECTS: BOSTON, SANTA MONICA AND MIAMI

Howard J. Simkowitz, Transportation Systems Center

Results from three recent non-separated concurrent-flow high occupancy freeway lane projects, Boston's Southeast Expressway, the Santa Monica Freeway in Los Angeles, and Miami's I-95, are compared. The Los Angeles and Miami projects have been terminated, and, in Miami, the carpool definition has been decreased to two or more persons per car. While carpooling and bus ridership increased, other results point out the many generic weaknesses in the concept: the large number of violators and the difficulty of enforcement; the potential for accidents; the inability of the reserved lanes by themselves to attract large numbers of new bus riders and carpoolers; and the political problems associated with removing an already existing lane from general use. A comparison of the performance of these non-separated reserved lane projects with the Shirley Highway reversible lanes and the El Monte busway indicates that when concurrent flow lanes are separated from the general lanes by a concrete barrier or an empty safety lane, the accident and enforcement problems are virtually eliminated and the reserved lanes are better able to perform their function of attracting and carrying high occupancy vehicles.

In order to move more people in fewer vehicles, and with a limited capital investment, a set of priority techniques for high occupancy vehicles (HOV) has been developed and implemented over the past several years. These traffic management options include concurrent-flow, contra-flow, and reversible lanes on arterials and freeways, exclusive lanes that bypass congested areas such as freeway ramps and toll plazas, exclusive access ramps to freeways, bus pre-emption of traffic signals, congestion pricing, transit malls, and auto restricted zones.

This analysis focuses on recent experience with non-separated concurrent-flow high occupancy lanes on freeways. For the remainder of this paper, the term "reserved" will be used to denote these lanes. Reserved lanes exist or have existed on Routes 101 and Route 280 in San Francisco, on the Santa Monica Freeway in Los Angeles, on the Banfield Freeway in Portland, on the Southeast Expressway in Boston, on I-95 in Miami, and on the Moanalua Freeway in Honolulu.

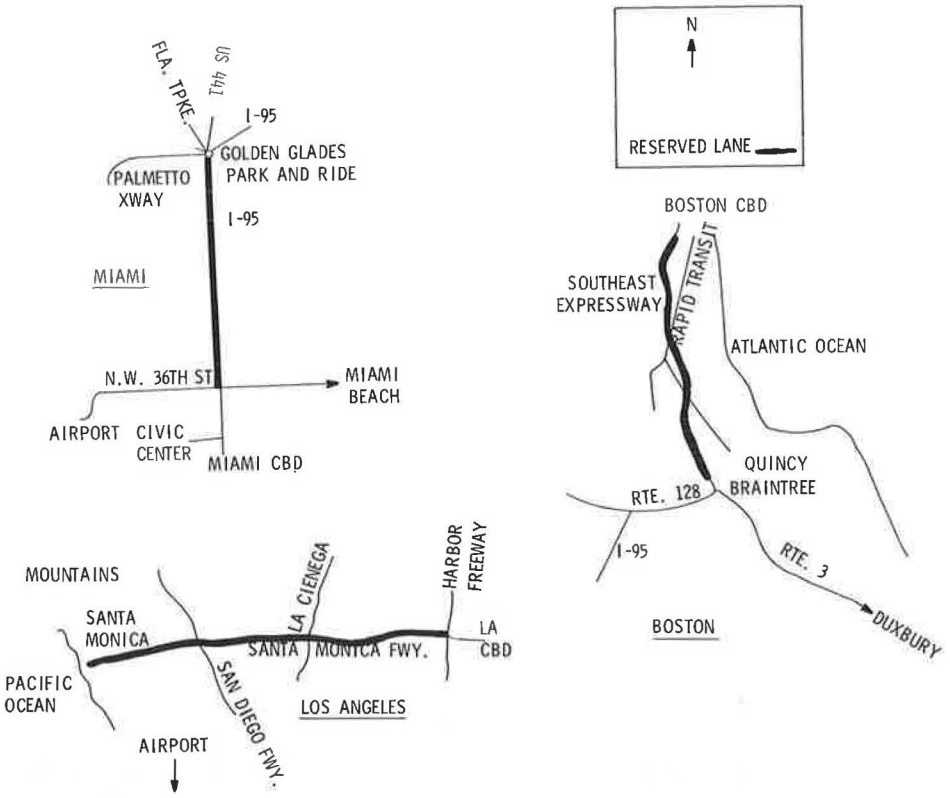
Through a comparative analysis of results of the three most recent concurrent-flow projects, Boston's Southeast Expressway, I-95 in Miami, and the Santa Monica Freeway, this paper attempts to develop a better understanding of the issues surrounding the reserved lane concept. Boston, Miami, and Santa Monica were chosen for comparative analysis for several reasons: all three represent recent experiments with the reserved lane concept; the three projects and project sites exhibit substantial differences; and evaluation efforts were conducted at each site.

Description of Reserved Lane Projects

The three reserved lane projects, even though each involved the concurrent-flow high occupancy vehicle lane concept, differed significantly from each other as to physical design of the freeways, hours of operation, entrance ramp treatment, transit characteristics, and other project related activities (Figure 1 and Table 1).

Boston's Southeast Expressway carries 121,000 vehicles per day, the Santa Monica Freeway carries 240,000 vehicles per day, and Miami's I-95 carries 170,000 vehicles per day. In Miami a lane for high occupancy vehicles was added to I-95 in both directions, completely eliminating the median area. In both Boston and Los Angeles existing lanes were taken away from normal use and dedicated to high occupancy vehicles. In Boston the left lane in the northbound (in-bound) direction only was

Figure 1. Drawings of the three projects.



reserved for buses and carpools of three or more occupants from 6:30 a.m. to 9:30 a.m. during weekdays. In Los Angeles the lanes were reserved for buses and carpools of three or more occupants in both directions from 6:30 a.m. to 9:30 a.m. and 3:00 p.m. to 7:00 p.m. In Miami the southbound (inbound) lane was restricted to buses and carpools of 3 or more occupants from 6:00 a.m. to 10:00 a.m. and the northbound (outbound) lane from 3:00 p.m. to 7:00 p.m. After a year of operations the times were changed to 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. and the restrictions changed to carpools with 2 or more occupants.

Access into and out of the lanes in Los Angeles and Miami was unrestricted. In Boston plastic inserts spaced at 20 or 40 foot intervals separated the lane from the rest of the roadway, and entry to or exit from the lane was allowed only at the beginning and the end. Weaving was prohibited but only sporadically enforced by the police.

Only Los Angeles employed ramp metering. Thirty on-ramps were equipped with meters (these existed before the project), and their timing was adjusted and pre-set to maintain free flow on the Freeway. Twelve of these ramps offered preferential access to buses and vehicles with two or more occupants. During the first three months of operation, the left lane on Boston's Southeast Expressway was blocked just before the beginning of the reserved lane, and all vehicles had to merge into the right lanes. This made it necessary for carpools and buses (and violators) to switch back into the reserved lane. The effect was similar to metering the Expressway. In Miami a flyover providing a direct connection between the major park and ride lot and the reserved lane was opened 12 months after the start of the project.

While all three sites stressed the need to use the existing freeways in a more efficient manner and to reduce energy consumption and air pollution by encouraging the use of high occupancy vehicles, the motivating force behind the reserved lane project in Boston was the need to reconstruct a portion of the roadway that would create a temporary decrease in capacity of up to 25 percent. The potential for serious congestion and the need for preferential treatment for high occupancy vehicles was clearly explained to the public.

The lane restrictions were heavily enforced in Los Angeles and only lightly enforced in Miami. The restrictions were voluntary in Boston during the first five months of operations, after which time enforcement was instituted by sending traffic citations through the mail.

In Boston few changes were made to the existing very extensive public transportation systems. One park and ride route was added, and back-up sections on existing bus and rapid rail routes were provided. Additional fringe parking spaces were made available.

In Los Angeles, up to twelve bus routes used the diamond lane. Five of the routes were new feeder express routes from the Westside area to the Los Angeles CBD. Three new routes provided service to the new park-and-ride lots. In all, the number of morning express bus runs was increased from 18 to 74. Headways on all the routes were 10 to 15 minutes.

Table 1. Comparison of the three preferential lane projects.

PROJECT	FACILITY	LENGTH (miles)	OPERATING DATES	LANE RESTRICTIONS	LANE ORIGIN	HOURS OF OPERATION	SPECIAL FACILITIES
Boston: Southeast Expressway	Freeway, 3 or 4 lanes each direction, including use of shoulder in peak direction during peak period	8	5/04/77-11/02/77	Buses and carpools (3 or more occupants)	1 existing lane reserved (inbound)	6:30-9:30 a.m. inbound only	Plastic inserts space 20-40 feet, freeway "metering" for 3 months
Miami: I-95	Freeway, 4 or 5 lanes each direction	7.5	3/15/76-present	Buses and carpools (3 or more occupants, changed to 2 or more)	2 lanes built in median area	6-10 a.m. (changed to 7-9 a.m.) inbound; 3-7 p.m. (changed to 4-6 p.m.) outbound	Flyover connecting major park and ride lot to I-95 after one year
Los Angeles: Santa Monica Freeway	Freeway, 4 or 5 lanes each direction	12.9	3/15/76-8/09/76	Buses and carpools (3 or more occupants)	2 existing lanes reserved	6-10 a.m. (changed to 6:30-9:30 a.m.) 3-7 p.m. inbound and outbound	Ramp metering, some with preferential bypass
Portland Oregon: Banfield Freeway	Freeway, 3 or 4 lanes each direction	3.3	12/15/75 present	Buses and carpools (3 or more occupants	resurfaced, removed shoulder, narrowed lanes	24 hours/day changed to 6:30-9:30 a.m. inbound and 3:30-6:30 p.m. outbound	

PROJECT	ACCESS/EGRESS	ENFORCEMENT	TRANSIT	EXPRESS BUS AVERAGE FARE
Boston: Southeast Expressway	Only at beginning and end	Voluntary for first 5 months, enforced last 2-1/2 weeks; increase in police	Minor changes to existing express and feeder bus, rapid rail, commuter rail, and commuter boat; new park and ride route	$1.25
Miami: I-95	Unlimited	Little enforcement; no increase in police	Park and ride and feeder/express bus service increased from 18 to 52 trips per day; new large park and ride lot	.60
Los Angeles: Santa Monica Freeway	Unlimited	Fifty percent increase in police, reduced to normal by 12th week	Four existing feeder/express bus routes increased to 9; 3 new park and ride routes and lots	.61

In Miami the express bus service was expanded in 1974. Not only was the express bus service increased to 55 trips per day, but also the size of the market area served was increased: at the northern end of the corridor, express buses provided increased residential coverage to the northwest and northeast of the Golden Glades interchange; at the southern portion of the corridor, the buses served two employment centers (Civic Center and Airport) formerly not served by express buses.

A parking lot with space for 1320 vehicles was constructed at the northern end of the reserved lanes at Golden Glades, the confluence of 5 major highways. The lot was fenced, well lit, and patrolled. Some bus runs originated at this parking lot, while others performed local collection service before converging at the lot to pick up park-and-ride, kiss-and-ride, and transfer passengers. The buses then traveled south along I-95 destined for one of four major employment centers.

The Golden Glades Parking Lot, by acting as a transfer point for the four feeder routes as well as a park-and-ride and kiss-and-ride facility, enabled travel between any point in the residential market area and any employment destination, whereas the former express bus service only operated between selected origins and destinations, with no transfer capability. Furthermore, the four new feeder routes provide far more efficient and direct service in the residential area than the three express bus

routes that they replaced.

In Boston and Los Angeles computer carpool matching, a marketing campaign, and a telephone center were provided to assist and encourage travelers to use the reserved lanes. In Miami only a marketing effort was undertaken.

In Miami the lanes are still in operation although the definition of a carpool has been changed from three to two occupants. In Boston the police began enforcing the lane restriction 5 months after the project began. After two and one half weeks of significant political pressure and unfavorable articles in one of the daily newspapers, the Commissioner of the Massachusetts Department of Public Works suspended the project. In Los Angeles a federal judge ruled that an environmental impact report should have been filed under both federal and state environmental laws. This ended the Santa Monica project after 21 weeks of operation.

Project Results

The three reserved lane projects have met with differing degrees of success and failure. The reserved lane on the Southeast Expressway survived for 6 months only to be cancelled suddenly two and a half weeks after the lane restrictions became mandatory. A federal judge shut down the Santa Monica project after 21 weeks of operation because an environmental impact report had not been filed. In Miami, the inability to enforce the lane restrictions led to a lowering of the lane qualification to two or more persons per car.

The three projects resulted in an increase in the occupancy rate of those vehicles using the facility (Figure 2). However, in both Boston and Los Angeles person throughput on the freeways decreased (Figure 3). A promising trend had developed in Los Angeles, and when the project was terminated the Freeway was carrying only 1.8 percent fewer persons in 9.4 percent fewer vehicles (Figure 4). In Boston, the corresponding figures were 8 percent and 21 percent. In Miami, a rapidly growing area and where new lanes were constructed, person throughput increased by 28 percent while vehicle throughput increased by 20 percent.

Figure 2. Freeway auto occupancy.

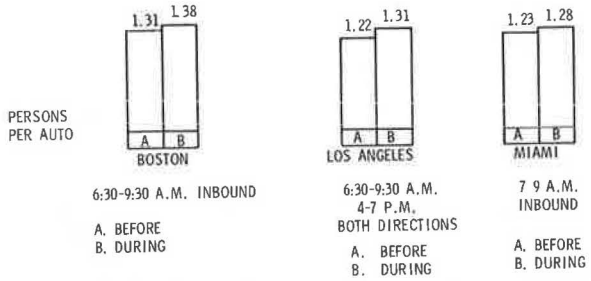


Figure 3. Freeway person throughput.

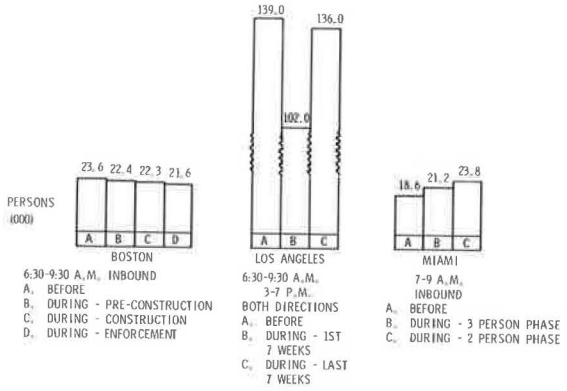
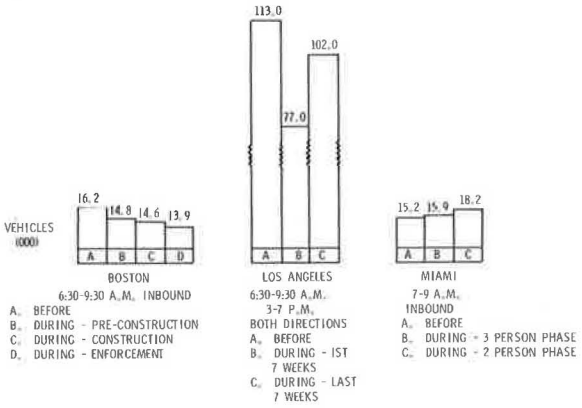


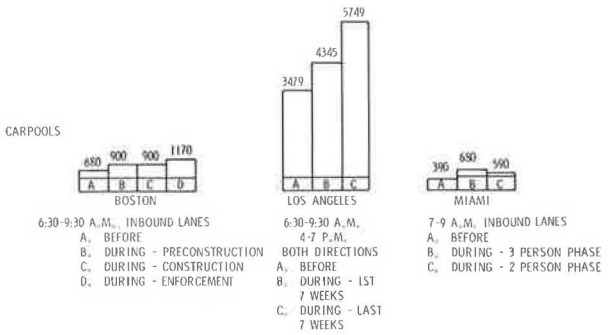
Figure 4. Freeway vehicle throughput.



In Boston, after the reserved lane was instituted but before construction began, the total number of persons carried by the Expressway during the peak period was 22,400, 5 percent less than during the March pre-project period. In June, person throughput declined to 22,300, a decrease of 6 percent from March. This additonal one percent decrease was probably the result of the combination of the construction further north on the Expressway and seasonal factors. During the enforcement period, the total number of persons carried was 21,600, a decrease of 8 percent from March. Since the dominance of Boston's core area as an attraction zone indicated a much greater potential for carpooling and bus ridership than in Los Angeles, it was possible that an increase in person throughput similar to that experienced in Los Angeles would have developed had the enforcement period continued. In fact, it is reasonable to assume that all three projects suffered from the public's perception that the lanes were not permanent. It was less likely for a person to form a carpool or learn about a convenient bus route if he believed that the reserved lane project was to be terminated when construction was completed or if political pressure became too great to maintain it.

At all three sites carpooling increased by about 70 percent (Figure 5). In both Los Angeles and Miami the primary reason given

Figure 5. Freeway carpools.



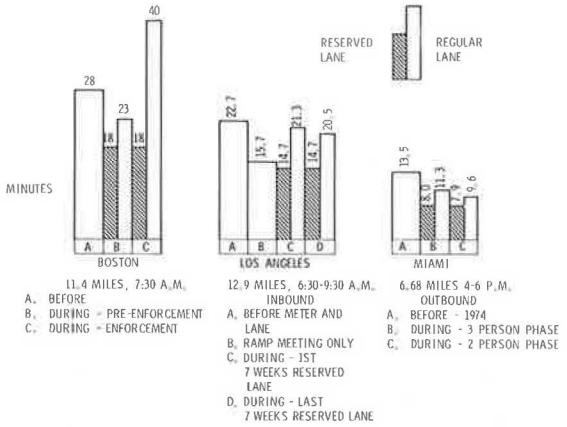
for carpooling was cost and not the time savings from using the lanes. While it was true that the majority of the carpoolers surveyed at each site had formed carpools before the reserved lanes were instituted, and therefore, their primary incentive would have been expected to be time rather than monetary savings, in Los Angeles 35 percent of members of carpools that were formed during the reserved lanes gave cost as the main reason for carpooling while only 30 percent gave time savings. However, the number of carpools fell to within 5 percent of pre-project levels after the project was terminated. It could be that time savings from using the reserved lanes were balanced by the additonal time it took for the collection and distribution portions of the trips.

Not everyone who was eligible for the reserved lanes used them. In Miami less than one-third of the eligible carpools used the reserved lanes. In Santa Monica 22 percent of eligible carpools were in regular lanes. For persons not making long trips it was probably not worth the effort to access the reserved lanes.

At all three sites the greatest benefits accrued to users of the lanes, carpoolers and bus riders, who experienced decreases in travel times and increases in arrival time reliability (Figure 6). In Los Angeles and Boston, these benefits needed to be weighed against any decreases in level of service experienced by non-users of the reserved lanes. In Los Angeles travel times increased for non-diamond lane users. In Boston, users of the regular lanes experienced a decrease in travel times during the pre-enforcement period. This was due to people shifting out of their cars and into carpools and buses on the Expressway and to other modes and routes which resulted in a 5 to 6 percent decrease in vehicles on the southern portion of the Expressway. It was also due to the "metering" of the Expressway just before the start of the express lane. As with ramp metering on the Santa Monica Freeway, this screenline metering worked well in creating free-flow conditions on the roadway. In Miami all users of the facility benefited, but this was a result of the opening of the two additional lanes, at a cost of $19 million, and had little to do with the lane restrictions.

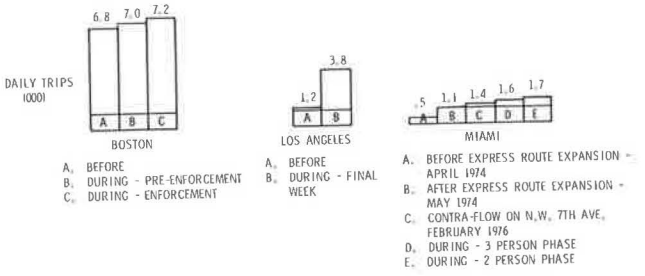
A disappointment with the reserved lane projects was their inability in and of themselves to attract large numbers of new

Figure 6. Freeway travel times.



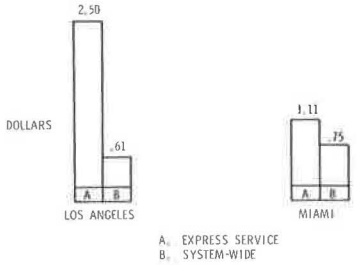
bus riders (Figure 7). In Los Angeles and Miami a large portion of the ridership increases appeared to have been the result of the increase in coverage and schedule frequency and not the travel time savings and increased reliability resulting from the reserved lanes. For most runs, the time spent in the reserved lanes did not represent a major portion of total in-vehicle travel time. However, the reserved lanes were useful in providing a focal point for the transit marketing campaigns and in creating a perceived, as well as a real, time advantage in the minds of the bus passengers. In Boston, where there were almost no transit level of service changes except decreased bus line-haul travel times, express bus ridership increased by only 3 percent. It was interesting to note that ridership on rapid rail and commuter rail increased by about 7 percent, possibly due to the higher visibility and public awareness of these modes.

Figure 7. Daily express bus ridership.



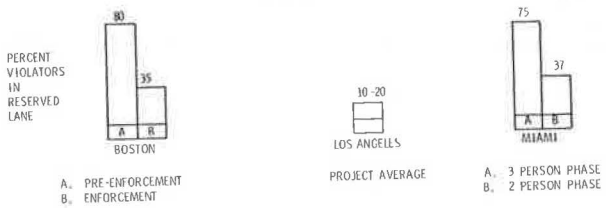
While the feeder/express routes in Miami and Los Angeles proved to be very popular, they also proved to be very costly since few buses could make more than one run during each peak period (Figure 8). Park-and-ride lots at the three sites met with mixed success, and this was a function of where they were situated and the frequency of the bus service. In Miami, the success of the park-and-ride service was due, in part, to the placement of a large parking lot 11 miles from the CBD at the confluence of 5 major highways. Buses travelled to four destinations, and headways were low.

Figure 8. Cost per bus passenger.



Another disappointment with the reserved lane concept was the number of lane violations that occurred and the difficulty of enforcing the lane restrictions (Figure 9). In Boston the plastic inserts did not prevent drivers from weaving in and out of the lanes. A median strip, where police could station themselves and stop violators, helped keep the violation rate in Los Angeles between 10 and 20 percent. Stiffer fines might have proven to be a deterrent, but the probability of being caught was not that great, especially if upon seeing an officer, the illegal driver was able to weave into the adjoining lane. In Boston and Miami a median area was not available. When Boston began enforcing the lane restrictions by sending tickets through the mail, the violation rate fell from 80 to 35 percent.

Figure 9. Violation rate.



One of the most serious problems with the reserved lane projects was the potential for accidents. Accidents were caused by the large speed differential between the reserved lanes and the normal-flow lanes and people making unsafe lane changes, weaving by violators to avoid detection, and by distressed motorists mistaking the reserved lane for a breakdown lane during non-operating hours. Lane changes could be limited by closely spaced plastic inserts, and reserved lane access and egress could be restricted to coincide with major entrances and exits. Boston did this to the extreme by permitting only one entrance and one exit, but motorists still managed to violate the no-weaving restrictions.

Carpool matching programs did not meet with great success. In Miami no carpool matching program was attempted since such a program had been tried on another project and failed. In Los Angeles commuter computer estimated that it was responsible for the formation of only 193 carpools. In Boston about 400 persons filled out carpool matching questionnaries. It was not known how many of these persons actually formed carpools. Most carpools in Los Angeles were formed among co-workers.

Due to the differing nature of the projects, the costs varied significantly (see Figure 2). For example, in Miami almost $19 million was spent just for construction of the two reserved lanes, a parking lot, and a flyover. The entire Santa Monica project cost just over $3 million, with $1.2 million being spent for data collection and evaluation and $886 thousand for bus operations. Boston spent only $245,000 for their entire project.

Recommendations for Future High Occupancy Vehicle Priority Projects

The results of the three non-separated concurrent-flow projects described in this paper point out the many generic weaknesses in this concept: the large number of violators and the difficulty of enforcement; the potential for accidents; the inability of the reserved lanes by themselves to attract large numbers of new bus riders and carpoolers; and the political problems associated with removing an already existing lane from general use.

Based on the Boston and Santa Monica results, it is not recommended that an existing lane be re-dedicated for preferential use unless there is a pressing need such as a reduction in capacity due to freeway reconstruction. If there is to be a decrease in freeway supply available to non-high occupancy vehicles, this decrease should be phased in order to cushion its effects and to encourage single occupant auto drivers to switch early to other modes or routes. A corridor whose transportation facilities are not already saturated will cushion the transition from pre-project to post-project equilibrium by allowing former users of the freeway the option to switch to alternate routes or other modes of transit if these are preferable to carpooling, taking an express bus, or staying on the freeway's normal lanes. These concepts were well-illustrated in Boston.

A comparison of the performance of these non-separated reserved lane projects with the Shirley Highway reversible lanes and the El Monte busway indicates that when concurrent flow lanes are separated from the general lanes by a concrete barrier or an empty safety lane, the accident and enforcement problems are virtually eliminated and the reserved lanes are better able to perform their function of attracting and carrying high occupancy vehicles. The appearance of permanence seems to contribute a great deal to convincing people to switch to HOV's.

Quite often these permanently or semi-permanetly separated configurations are not feasible for economic and/or engineering reasons. Boston attempted the minimum in physical lane separation by installing plastic inserts every 20 or 40 feet between the reserved and regular lanes. Unfortunately, these inserts did not prevent a large amount of illegal weaving between

Table 2. Costs of the three preferential lane projects.

	BOSTON		LOS ANGELES		MIAMI	
	UNIT COST	PROJECT COST ($000)	UNIT COST	PROJECT COST ($000)	UNIT COST	PROJECT COST ($000)
INVESTMENT COSTS						
LANE CONSTRUCTION		-		-		11,656
PARKING LOT(S)		-		199		1,711
FLYOVER TO LOT		-		-		2,981
PLANNING, DESIGN, AND SUPERVISION OF CONSTRUCTION		-		-		2,372
SIGNING		8		163		1,627
BUSES		-		-	20 @ 51,500	1,030
MARKETING		40		358		84
EVALUATION		55		1,232		973
PLASTIC INSERTS	3500 @ $11.	39		-		-
DRILLING HOLES	1500 @ $ 4.	6		-		-
OPERATING COSTS						
BUS OPERATIONS		-	2,588[1]	886[2]	461[1]	211[3]
ROADWAY & SIGNING MAINTENANCE		-		-		88
PARK AND RIDE LOT MAINTENANCE AND SECURITY		-		-		18
INSTALLATION AND REMOVAL OF INSERTS	26 WKS @ $3750	97		-		-
LOCAL AGENCY ADMINISTRATION		-		193		-
COURT COSTS		-		77		-
TOTAL PROJECT COSTS		245		3,108		22,751

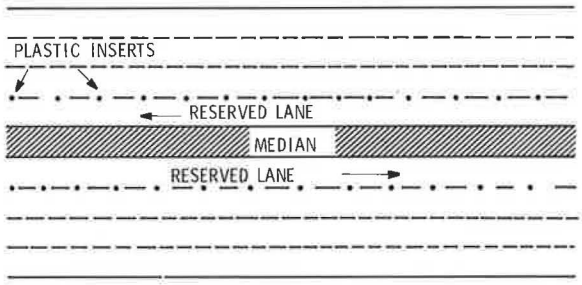
[1] OPERATING COST PER YEAR ($000)
[2] OPERATING DEFICIT FOR 22 WEEKS
[3] OPERATING DEFICIT FOR 1 YEAR

the two lanes. No only did non-carpoolers switch into the reserved lane, but carpoolers illegally left the lane to exit the Expressway.

The evidence indicates that there should be a median strip between the two directions of flow to provide both an area for motorcyle police to station themselves to control the violation rate and a safe area for distressed motorists to stop (Figure 10). To reduce the dangers of lane changing between two lanes travelling at significantly different speeds, the reserved lane entry and exit points should be limited to the beginning and end of the reserved segment and to a few intermediate points. The potentially large speed differential between the reserved lane and the regular lanes could possibly be reduced by electronic signs on the freeway that would limit the speed in the reserved lanes to some amount greater than in the regular lanes. This speed limit could be enforced if bus drivers were instructed to adhere to it. This concept has never been tested.

If the reserved lane configuration calls for inserts and a median, then it must be determined whether or not to leave the inserts in place on a 24 hour basis. It is costly to install and remove the inserts, the operation tends to confuse motorists, and it cannot be performed in the snow or dark. If the inserts were permanent, the lane restrictons would not necessarily have to be in effect or enforced on a 24-hour basis. However, this arrangement could be confusing to motorists as was the case in Miami where the solid striping used to separate the lanes during the early months of the project resulted in the reserved

Figure 10. Concurrent flow reserved lane with inserts and median.



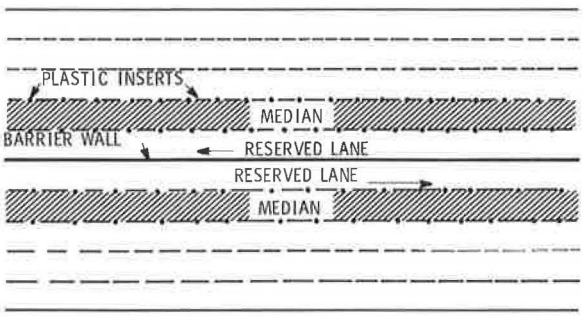
- inserts separate reserved lane from regular lanes
- median for police and distressed motorists
- entry and exit limited to beginning and end and a few intermediate points

lanes being mistaken for breakdown lanes during the non-restricted hours. Other drawbacks are that the inserts could create a safety hazard at night or during slippery conditions and plowing would be extremely difficult.

If space permits, the median could be shifted to the area between the reserved lane and the normal lanes as is the case of the El Monte Busway (Figure 11). Permanent plastic inserts would separate this safety lane from the rest of the roadway. The inserts would be spaced far enough apart so that this empty lane could be accessed by slow moving police and distressed motorists. Carefully designed slip-ramps would provide entry to and exit from the lanes at a few

intermediate points. These ramps would be denoted by inserts, striping, and special pavement treatment so as not to be confusing to motorists.

Figure 11. Concurrent flow reserved lane with safety lane and inserts.



- safety lane between reserved and regular lanes
- safety lane used by police and distressed motorists
- inserts separate safety lanes
- entry and exit limited to beginning and end and a few intermediate points via carefully designed slip-ramps
- barrier wall between two directions of flow

Concurrent-flow lanes are applicable when the flow is balanced in each direction. When there is a large imbalance in peak directional flows, and if sufficient capacity exists in the off-peak direction then contra-flow or reversible lanes would be more appropriate.

In addition to the careful selection of the most appropriate form the HOV lanes will assume, this analysis has revealed factors related to site characteristics, implementation procedures, transit operations, and media treatment that must be considered.

The primary characteristic of the site that defines the market potential for the reserved lanes is a CBD that is the focal point for regional employment. This ensures a ready market for express bus patrons and facilitates the formation of carpools. In order to avoid citizen protest, it is important that the reserved lanes appear to be well-utilized to those travelling in the regular lanes and appear to be permanent.

Any increase in express bus operations should focus on the development of new feeder/express routes with the feeder component used to expand transit coverage, preferably serving more densly populated neighborhoods that currently have poor access to transit. Free and efficient transfer capabilities should be provided at park and ride lots if the buses go to different destinations. However, demand for priority facility bus services has proven to be inelastic with respect to fare; therefore, the fare should reflect the quality of the service being provided.

Park and ride service should be provided only from lots that are distant from the CBD and have good transit and highway access. The lots should be adjacent to the freeway and be large enough to support low headway service to several major destinations. Lots should be guarded, well lit, highly visible to the motorist, and contain amenities such as sheltered waiting areas, telephones, and toilets. The lots should have a convenient and adequate waiting area for afternoon kiss and ride automobiles. The transit operator should be aware of the high cost of operating this express bus service. High occupancy vehicles, such as double deck and articulated buses, could be used on these routes to minimize driver costs.

The public should be made aware of all aspects of the reserved lane project as early as possible. Commuter Computer estimated that carpool formation took an average of one month following a request. All travel options should be clearly described including estimates of level-of-service for each one.

Ramp metering, freeway metering, and pricing can be used along with, or in lieu of, reserved lanes. Ramp metering is relatively inexpensive, easy to install, and acceptable to the public. It worked well on the Santa Monica Freeway, making the average trip time both shorter and less variable. Many of the ramps provided preferential treatment, and the violation rates were low. A form of freeway metering was attempted in Boston and resulted in a decrease in travel time. However, freeway metering does not afford high occupancy vehicles preferential treatment.

The majority of carpoolers in Miami and Los Angeles indicated that their primary reason for carpooling was to save money. Thirty-five percent of members of carpools formed during the Santa Monica project reported cost incentives as the primary reason for carpooling while 30 percent listed the diamond lane. These results indicate that parking or toll policies favorable to carpools, in addition to preferential lanes, would do much to increase carpooling. The revenues generated could be used to expand the express bus service, which would further increase the use of high occupancy vehicles.

Acknowledgements

This work was sponsored by the Office of Service and Methods Demonstrations of the Urban Mass Transportation Administration.

References

Howard J. Simkowitz, Southeast Expressway High Occupancy Vehicle Lane Evaluation Report, U.S. Department of Transportation, Transportation Systems Center, January 1978.

John W. Billheimer, Robert Bullemer, and Carolyn Fratessa, The Santa Monica Freeway Diamond Lanes: An Evaluation, submitted to the U.S. Department of Transportation/Transportation Systems Center by SYSTAN, Inc., Los Angeles, California, April 1977.

Daniel Brand, John Attanucci, Howard Morris, and Charles Kalauskas, Southeast Expressway Reserved Lane for Buses and Carpools, presented at the 57th Annual Meeting of the Transportation Research Board, Washington, DC, January 1978.

Evaluation Study for the I-95/N.W. 7th Avenue Bus/Carpool Systems Demonstration Project in Miami, Florida, Three Quarterly Research Project Progress Reports, July 1, 1975 - March 31, 1976, Appendix D, University of Florida Transportation Research Center, June 1976.

Interstate 95 Exclusive Lanes Demonstration Project, Project Review (Draft), Florida Department of Transportation, Division of Mass Transit Operations District IV, December 1976.

Evaluation Study for the I-95/N.W. 7th Avenue Bus/Carpool Systems Demonstration Project in Miami, Florida, Quarterly Research Progress Report, April 1 - June 30, 1976, University of Florida Transportation Research Center.

I-95/N.W. 7th Avenue Bus/Carpool Systems Monthly Progress Report Summary, Florida Department of Transportation, May 1977.

Evaluation Study for the I-95/N.W. 7th Avenue Bus/Carpool Systems Demonstration Project in Miami, Florida, Quarterly Research Progress Report, October 1 - December 31, 1976, University of Florida Transportation Research Center.

Evaluation Study for the I-95/N.W. 7th Avenue Bus/Carpool Systems Demonstration Project in Miami Florida, Quarterly Research Progress Report, July 1 - September 30, 1976, University of Florida Transportation Research Center.

C.E. Wallace, An Investigation of the Economic Performance of an Express Bus Operation, Transportation Research Center, University of Florida, October, 1976.

Traffic Control of Carpools and Buses on Priority Lanes on Interstate 95 in Miami, final report, University of Florida Transportation Research Center, August 1977.