HOV Facility Development: A Review of National Trends

by

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ABSTRACT

High-Occupancy Vehicle (HOV) Lanes have been in existence for over 30 years. As a congestion management strategy, HOV lanes have been widely applied in the U.S. to preserve mobility, maintain trip reliability, and improve the person moving capability within a corridor or metropolitan area. While there are many examples of successful HOV lanes that carry large numbers of commuters and buses, criticism has been levied toward HOV lanes in some metropolitan areas.

A lack of information and data as to the benefits of HOV lanes, the nationwide trend toward lower carpool utilization, and the closure of two projects in New Jersey in 1998 has resulted in some metropolitan areas or agencies re-assessing the purpose, role, and benefits of HOV lanes. This has lead some to postulate that the HOV lane concept may no longer be viable. In response to these perceptions, this paper reviews available data and provides some perspectives on the recent past and possible future of HOV lanes, particularly those treatments applied on urban freeways that represent the majority of such applications.

This paper presents a summary of recent experiences, growth, type, and changes that have occurred with HOV lane operational policies. Many of these trends have been influenced by federal legislation over the past 15 years, specifically the Clean Air Act and operational policies related to the development of HOV lanes as a congestion management strategy. Based on the current roadway improvement plans of various states, the trends in future HOV lane development are also presented to provide a prospective for future policy and programming considerations.

INTRODUCTION

Based on thirty years of experience from across the country, HOV lanes are a proven, viable, and effective alternative to mitigate the impacts of traffic congestion in urban and suburban areas. As a part of an overall approach to address travel demand and mitigate the impacts of congestion in a region, HOV lanes have the potential to move more people in fewer vehicles, improve the person moving capability and reliability, and efficiently utilize the available roadway infrastructure and transit fleet. Based on the increased level of service and reliability that is provided to HOV lanes, will result in driver frustration among users of congested general purpose lanes, due to the perception that HOV lanes are being operated inefficiently.

As the severity of congestion experienced by the general purpose lanes increases, the potential for the general public to develop a negative sentiment toward HOV lanes may also increase. This sentiment may over time lead to the generation of requests or proposals to alter the operation of HOV lanes or to convert them to general purpose lanes. Due to changing attitudes toward effective use and potential benefits of HOV lanes, on November 30, 1998, the State of New Jersey removed HOV lane designations on I-287 and I-80. This New Jersey action resulted in the generation of a number of reports and articles in various news media, incorrectly suggesting or implying that a change had occurred in public opinion and public agency support against HOV lanes. These reports have to some degree adversely impacted the planning, development, management, or operation of HOV lanes within the United States and Canada.

The purpose of this paper is to identify the current and anticipated future trends associated with the state of deployment, operating characteristics, and benefits of HOV lanes. This paper also provides information that addresses some of the concerns that have been raised nationally as to the viability and public support for HOV lanes. The information to support this paper and trends identified in various figures were compiled from a variety of sources including TRB HOV Committee meeting minutes dating from 1990 (*1*) unpublished HOV lane status reports *(2)* and published reports (*3, 4*) sponsored by the Transportation Research Board (TRB), and National Cooperative Highway Research Board (NCHRP). Various unreferenced material was also supplied from local and state agencies sponsoring HOV lanes.

INITIAL HOV FACILITIES

Perhaps the best means to understand the current and anticipated future trends in HOV lane development is to briefly review several of the first HOV facilities that were implemented over 30 years ago.

New Jersey's Experience

HOV lanes were first introduced as demonstrations to promote and sustain transit ridership. Beginning in 1969 with the Exclusive Bus Lane (XBL) on the Route 495 approach to the Lincoln Tunnel in New Jersey, the HOV concept was tested to determine if providing a dedicated lane free of congestion, could sustain and perhaps reverse declining transit ridership. This short 2.5-mile lane borrowed from the off-peak direction, initially implemented at a cost of less than $200,000, served in excess of 700 buses and over 30,000 passengers during the peak hour. The project continues to prove its worth by moving roughly this same number of commuters into Manhattan each weekday morning, which are more people than observed on any other HOV project in North America. Various studies have attempted to define alternatives to moving commuters along this route, including busways along nearby parallel routes or adding an additional HOV lane. High costs associated with any replacement facility, along with the potential controversy associated with these alternatives, have made reliance on the existing HOV lane an invaluable and irreplaceable feature of the region's transit system and surface transportation system infrastructure.

Virginia's Experience

Simultaneous to the New Jersey project's opening in 1969, reconstruction of the I-395 Shirley Highway corridor in suburban northern Virginia offered an opportunity to test whether mobility for existing transit patrons could be preserved during these construction activities. A temporary bus-only lane was created through the construction work zone utilizing wooden barricades. This reversible lane which operated during peak commute periods proved that transit ridership could be not only preserved, but enhanced and travel speeds increased, by taking these actions. Initial transit patrons numbered in excess of 6,000 per hour. Experiences learned during this reconstruction project suggested that the temporary bus lane could serve a more important purpose if they were made a permanent operational feature of the roadway. The final roadway alignment, initially intended as express lanes for long distance commuters, was opened as two reversible lanes for HOVs with 4 or more persons per vehicle.

Over time, the occupancy rules and hours of operation have been altered, but today the Shirley Highway continues to be a key HOV link in the region's growing network of HOV lanes, even after extensions of both the Washington D.C. subway and Northern Virginia commuter rail service penetrated the same commuting markets within this corridor. Currently the 28-mile reversible HOV lanes carry an average of 10,400 person trips and 2,800 vehicles in the AM peak hour. This facility provides an average travel time savings of 31 and 36 minutes for the Am and Pm peak travel periods. Future plans include extensions of the Shirley Highway HOV lane system further south along the I-95 corridor toward Richmond and along the I-95/I-495 circumferential Capital Beltway *(5)*.

Los Angeles' Experience

In 1976 the Los Angeles area was about to be placed under mandatory trip reduction restrictions and curtailment of gasoline supplies if the region did not aggressively impose congestion management measures. These actions were required because of the region's poor air quality and inability to meet air quality goals established by the US Environmental Protection Agency. These mandates, resulting from federal legislation that was intended to improve the nation's air quality, resulted in several ill-fated regional policies to rapidly change driving behavior, including proposals to convert general purpose lanes to HOV lanes.

One of the early strategies tested included converting general purpose left-side travel lanes to 3+ high occupancy carpool lanes on the Santa Monica Freeway. This approach proved too unpopular to sustain support, and the project was terminated by court action after 21 weeks of operation. This experience adversely affected the consideration of HOV lanes in California and around the nation. After this event agencies have implemented HOV lanes as new lane additions, rather than converting existing general purpose travel lanes into HOV lanes. The basic planning precepts that are used today for HOV lanes were also founded based on this experience, where the adequate utilization and perception of users was felt necessary to both implement and sustain a project's viability over time.

Just prior to the Santa Monica experience, the first major investment for a major busway facility was simultaneously being implemented in Los Angeles on the El Monte Freeway . An 11-mile portion of this corridor was rebuilt with a barrier-protected two-lane, two-way busway with on-line stations and park-and-ride lots. The busway was considered a preeminent example of a bus rapid transit guideway when the first segment was opened to traffic in 1973. Following a bus drivers strike in 1976, the project was opened up to limited use for 3+occupant carpools.

In these early years the El Monte Busway moved more than 800 vehicles and 15,000 commuters per hour. Currently approximately 1,200 vehicles carrying approximately 5,700 people use this facility in the AM and PM peak commuting hours when the occupancy requirement is 3+ *(6)*. However, the El Monte experience was tempered by the after effects of the Santa Monica project termination, resulting in area agencies waiting almost a decade before reconsidering HOV lane treatments. By the mid 1980s, HOV lane treatments were tested as demonstrations on State Routes 55 and 91.

The longevity of El Monte, SR 55 and SR 91 successes, coupled with a growing dependence on mass transit throughout the LA basin, helped pave the way for a substantial investment in all forms of transit, including a greatly expanded HOV network that now represents the largest system in the world. There are now more than 300 route-miles in operation and about 300 route-miles planned. The Southern California Association of Governments estimates that in Los Angeles County alone, more than half a million commuters use the HOV lane on any given day, each averaging about one half minute per mile in travel time savings *(6)*. As many as one million trips per day appear to be made on all of the HOV lanes in the four-county area that comprises the Los Angeles basin.

Seattle's Experience

Another region where a demonstration project utilizing occupancy to restrict access to a lane or facility, has ultimately led to the development of a comprehensive HOV lane system throughout the Puget Sound region. Shortly after I-5 north was completed with an express median reversible roadway, a multi-agency test was launched to initiate express bus service into the central business district (CBD) of Seattle via dedicated bus ramps and lane treatments. Patronage of the service generated a large number of bus commute trips. The service helped launch an ever increasing number of similar bus improvements along freeways throughout the region, including in-line stations, bus flyer stops designed as right side bus ramps and stations adjacent the right shoulders, park and ride lots, and ultimately, bus ramps connecting to a bus subway constructed through the heart of the CBD.

Today Seattle continues to expand and enhance its HOV lane system, both for the benefit of carpoolers and transit markets. Various examples of the Seattle system success are borne out in the relatively high bus volumes using HOV lanes. Seattle's transit mode split, which has grown to more than 45 percent, is one of the highest for a western city. On one HOV lane along SR 520, buses carry more people than are moved on all the adjacent freeway lanes combined. Seattle's HOV lane treatments began in the early 1970s, and today the region includes more than 191 route-miles in operation out of a total 297 mile HOV system that has been planned for completion in 2018. The system moves more than 100,000 commuters daily. The commitment to a regional HOV system, along with providing the necessary resources to manage and operate this system 24 hours – 7 days a week, has generated broad public support for HOV lanes. A recent survey of randomly selected drivers in the Seattle area found that 72% of single occupant drivers (SOV) and 95% of HOV drivers indicated that "HOV lanes are a good idea" *(7)*.

PAST EXPERIENCE & CURRENT TRENDS

This section reviews past experience and current trends in HOV lane planning, deployment, design, and operation *(1, 3, 4)*. Although no national inventory or database for HOV facilities exists, various published and unpublished reports have periodically documented these experiences. Additionally, the TRB HOV Systems Committee periodically reports on the number of projects that are operating and planned for implementation along with their general operating characteristics *(2)*. Based on the information available from these resources, key trends in HOV lane development and operating characteristics have been compiled for the last 30 years.

Planning and HOV Project Development

Many of the early HOV lanes began as demonstrations. These projects and many others were pursued because bus service or HOV lanes provided an opportunity to meet the needs and improved the operational effectiveness of mass transit. Most were found successful. These metropolitan areas did not initially study or adopt HOV lanes as a system-wide strategy. Rather, many of the demonstrations were extended or expanded to other routes, and in some places region wide plans and systems have evolved over time.

In various locales specific standards of practice have evolved based on how HOV lanes have been designed, implemented and operated. Many projects have become part of a broader array of services and investments made in transportation demand management, transit services, and congestion management and mitigation programs. The early lessons gained were that such strategies have played a collective role in helping promote better management of the transportation system, and not a as a means of eliminating congestion or as a means of circumventing the need to add general roadway capacity where such action was more appropriate.

Over 130 HOV lane facilities are operating on freeways within 23 metropolitan areas. The greatest concentration of these projects is located in the largest metropolitan areas and within freeway corridors where traffic congestion is typically more severe. Figure 1 graphically illustrates where freeway HOV lane projects are located. HOV lanes exist on a number of arterials in many cities, and most of these lane treatments are designed to facilitate bus movements, typically in the vicinity of CBDs. Information has not been collected, analysis performed, or deployment trends developed for arterial HOV lanes. This information need has been identified and recommended as a research topic in the NCHRP HOV Systems Manual *(3).*

Figures 2 and 3 provide route-miles and lane-miles of operating HOV facilities in the U.S. and Canada since 1969. These trends are tracked in both lane-miles and route-miles. Route miles represent the centerline distance along any highway that provides a full or part-time HOV treatment. Lane-miles reflect this mileage by the number of lanes designated along highways. In most cases where one HOV lane is provided in each direction of travel, cumulative lane-mileage is double the total route mileage. Figure 2 also illustrates what orientations these projects provided. The following trends were identified based on this information:

- Most initial HOV lanes were limited in length and installed where HOV demand was the highest within freeway corridors that served the CBDs of major metropolitan areas. Practically all projects in the 1970s were implemented in radial corridors, where the greatest potential for transit service existed.

- As congestion expanded into the suburbs, and increasingly into non-radial routes that connected suburb to suburb, an increasing number of HOV lane projects were implemented to serve carpool markets in these suburban settings (top shaded area of each bar).
- The greatest number of these non-radial corridors (i.e., corridors not oriented to a traditional central business district), exist in the Los Angeles, Seattle and San Francisco Bay areas, where the greatest concentration of HOV mileage has been implemented.
- The planning and deployment of HOV lanes in metropolitan areas typically evolved around the completion of regional system-wide HOV plans or freeway improvement plans within specific corridors.

Figure 3 also illustrates likely trends in future HOV lane deployment on freeways, based on current roadway improvement program plans identified by various regions and agencies. If these plans are implemented, the number of HOV lane-miles in existence in 2001 will climb almost 50 percent by the end of this decade. Some of these proposed projects are examining the feasibility of using strategies other than occupancy (e.g., access management and value pricing) to optimize the use of these “managed use” lanes by a larger group of eligible users.

The concept of managed lanes are just now emerging as a topic in a number of major metropolitan areas where significant roadway improvements are being planned within major freeway corridors. Several of these studies are expected to result in the use of a number of different operational strategies to proactively manage travel demand and control traffic on several multi-lane treatments. In such a roadway setting, HOVs may be only one of many user groups who are being considered for preferential treatment.

A majority of the planned future HOV lanes will be implemented as extensions to current lanes, with a heavy concentration of projects slated for cities along the West coast, particularly in California. Other areas likely to see new or additional HOV lanes this decade will include Atlanta, Charlotte, Dallas, Austin, Denver, New York, Portland, Salt Lake City, Seattle, and Washington D.C. metropolitan areas.

Perhaps most prominently, based on the information that was collected and trend analysis that was performed, the data does not suggest that there has been any consistent backlash throughout the country to terminate existing or proposed HOV lane projects. To the contrary, the last HOV lane to be terminated in the U.S. occurred on I-80 and I-287 in New Jersey in 1998. Prior to this the last HOV lane that was terminated was in 1991 on the Dulles Toll Road in Northern Virginia, where a lane was constructed and initially opened to general purpose traffic, and then it was converted into an HOV lane. The Dulles project was terminated because it reclaimed newly constructed lanes opened to general traffic for HOV use, creating a backlash among commuters. The Dulles HOV lanes have since been re-implemented along this entire facility after the additional roadway capacity was constructed to accommodate HOV lanes.

The total number of HOV lanes that have been terminated since 1969 represent less than 5 percent of all HOV lane route-miles. FHWA issued program guidance in 1999 (revised in March of 2001) on the Federal interests and some of the possible actions that are required with proposals to significantly change the operation of existing HOV lanes *(8)*. While some HOV lanes will likely be terminated in future years, nothing suggests a substantial lack of support by the general public or change in public policy that would influence the increases that are predicted in the deployment of future HOV lanes.

Types of HOV Facilities Lanes and Design Considerations

Figure 4 provides a comparison of the types of HOV lanes that are commonly implemented. The NCHRP HOV Systems Manual #414 provides more information on the relative differences, advantages, and disadvantages with each these types of treatments. Based on the experiences documented to date and current agency practices: *(1, 3, 4)*

- Concurrent flow HOV lanes operating in both directions of travel--listed as "buffer" and "no-buffer" separated-- are the most common form of HOV lane,
- HOV lanes with barriers provide a physical separation with adjacent traffic, usually employing a concrete barrier. HOV lanes with barriers are occasionally reversible in radial corridors with high directional demand,
- Contraflow HOV lanes borrow an off-peak direction lane only during rush hours for peak direction HOV traffic and usually employ moveable concrete barrier or pylons for separation,
- Queue bypasses for high occupant vehicles are isolated treatments to allow eligible traffic to circumvent a traffic bottlenecks, such as a ramp meters, ferry queues, or toll plazas, and
- Busways are HOV lanes dedicated to bus-only "BRT-type" of operation and is located in separate rights-of-way.

While concurrent-flow HOV lanes are the most popular type of HOV lane design, practice has gradually shifted since 1993. Currently 48 percent of all the HOV route mileage is buffer separated concurrent flow lanes, while only 28 percent are non-buffered. When HOV lanes are in operation on a part-time basis, restricting access is seldom practiced because motorists can become confused when the lanes are eligible to be used by all traffic. Concurrent flow HOV lanes appear like general purpose lanes, except where a different pavement marking stripe or spacing may be used along with the corresponding signing, to indicate to motorists the part-time occupancy restriction requirement.

Buffer separated HOV lanes have a designated separation between the HOV and general purpose lanes. This facility type restricts access to the HOV lane at designated locations where gaps in the buffer are marked and signed as ingress and egress points. As a result, buffer separated HOV lanes exist when occupancy restrictions are in place 24 hours a day.

The use of a wide buffer separation was initially employed on the El Monte Busway in 1976. The California DOT design standards requires a four-feet wide buffer separating the HOV lane and the adjoining general purpose lane. This width has now become a defacto standard that is applied or has been adopted as a standard in other states.

As shown in Figure 4, the most predominant type of HOV lanes are concurrent-flow lanes. Three factors seem to play a role in this trend, including:

- Implementing HOV lanes in constrained corridors,
- Congestion and demand exists that justifies the need for HOV lanes in both directions, and
- Preferences with a particular type of HOV lane where HOV lane development has already occurred within a freeway corridor or entire region. Planning trends suggest that

since 1993 there has been an even greater proportional shift to more concurrent-flow lane treatments, representing about 80 percent of all recent projects implemented.

Another trend affecting contraflow HOV lanes is the gradual but steady transformation of contraflow lane separation from reliance on manually placed traffic cones or pylons to the use of moveable barrier. As of 2002, all but one contraflow operation will have shifted to the use of moveable barrier separation. The remaining project—Route 495 in New Jersey—is too narrow to incorporate moveable barriers.

HOV Operating Policies

This section addresses trends in HOV operational policies and practices that have occurred since the early 1970s. Initially, HOV lanes were envisioned to serve only buses and carpools with very high occupancy requirements (those carrying three or more persons per vehicle). Trends in the 1970s were heavily influenced by federal legislation that established the minimum allowable occupancy level which was 3+ persons per vehicle if an agency chose to implement and operate an HOV lane on a facility that would use federal-aid funding.

Other factors influencing national legislation that established a minimum occupancy rate included high levels of observed average vehicle occupancies during peak commute periods when compared to average vehicle occupancies that exist today; an energy crisis and federal legislation that encouraged the formation of carpools and ridesharing; and a greater prevalence of employer-sponsored programs (e.g., vanpooling, carpooling). A number of exceptions to the federal legislation were granted in the early and mid-1980s which allowed a number of projects to begin operating with a 2+ occupancy requirement.

In 1987 federal legislation was changed to allow local agencies greater flexibility in establishing the actual occupancy requirements for HOV lanes. Subsequently, a majority of then-operating and soon to open HOV lanes adopted a 2+ occupancy policy (Figures 5 and 6).

Today, a vast majority of freeway-based HOV lanes apply a 2+ occupancy requirement. Exceptions include a few projects (e.g., Bay Area and Houston) where occupancy requirements were raised to a 3+ minimum occupancy due to excessive demand during selected peak hours. In most cases the change to a 2+ occupancy policy has worked well, in terms of generating a level of demand that justifies the HOV lane without it becoming overloaded or congested.

Two predominant philosophies -- part-time operation and full-time or 24-hour operation -- have influenced when the occupancy requirements are in effect. For part-time HOV lanes, the lane is almost always returned to general purpose use outside the restricted periods of operation. No HOV lane borrows an emergency shoulder for part-time operation. More than 95% of all HOV lanes are located in the median next to the center barrier.

Both of these HOV operational philosophies have distinct advantages and drawbacks. In general, full-time operation is typically consistent within a given city or geographic area, but not necessarily consistent on a statewide or regional basis. Most locations have implemented HOV lanes on a part-time basis and altered the actual hours of operation as demand warranted. As noted in Figure 7, about half the nation's HOV projects operate part-time, and about half operate on a full-time or 24-hour basis. Because operation philosophies have become institutionalized in many areas, future trends will likely show a similar pattern with both of these policies being accepted in practice.

While the period from 1980 to 1995 was marked with significant changes in operating policies among various HOV lanes and metropolitan areas, few operational changes have taken place in recent years. The operational changes that have occurred have involved revising the hours of operation, raising or lower the occupancy requirement to accommodate demand, and adding pricing along with occupancy requirements.

The viability and operational benefits of HOV lanes will continue to come under greater and greater scrutiny from various advocacy groups, general public and elected officials as the severity of congestion grows in metropolitan areas. While public perceptions from recent unpublished surveys in Seattle and Los Angeles (2001) still strongly support a commitment to HOV lanes, these same surveys also report that individuals feel that HOV lanes are not adequately used. This finding suggests that operating agencies will need to expend greater effort in attempting to both promote awareness and continuously improve the operation of each HOV lane and its related system *(6,7)*.

HOV lanes are appropriate throughout the day and not just during peak travel periods when congestion may be the most severe. During off-peak periods, the Washington DOT found that the HOV lanes are well used when congestion exists, which increasingly extends beyond the traditional peak travel periods. They found that the average number of people in each car is higher that what was expected during non-peak periods, especially on weekends. A study performed in the Seattle area on weekend freeway use found that between 30 to 60% of the traffic was eligible to use the HOV lanes, and when congestion did occur (e.g., work zones, traffic incidents, adverse weather, special events), these vehicles used the HOV lanes *(7)*.

Enforcement continues to be a challenging issue with all HOV systems. Without the proper enforcement of the HOV lane occupancy requirements, the operational effectiveness and efficiency, along with public acceptance suffer. This requires an ongoing commitment of resources, cooperation, and coordination between the many interests involved with managing, enforcing, and providing information to the public.

Another emerging approach to HOV lane operation is augmenting the use of occupancy restriction with pricing, where vehicles are allowed to travel in the HOV lane for a fee, if they do not satisfy the minimum occupancy requirement established for a particular time period for an HOV lane. While this approach has been encouraged for study and implementation by FHWA and various interest groups only three projects have been implemented since 1995 that are using pricing and occupancy. They include I-15 in San Diego, SR 91 Express Lanes in Orange County, California (specifically a private toll road embedded in an HOV corridor rather than HOV lane treatment), and I-10 in Houston.

These projects have demonstrated that pricing can be combined with occupancy as an effective means for agencies to proactively manage travel demand. It also provides agencies with the flexibility to allow single occupant vehicles (SOVs) to use an HOV lane where there may not be sufficient demand or capacity to accommodate an occupancy level of 2+ or 3+. Since 1995, approximately 20 studies have been or are being conducted on existing and proposed HOV lanes. These studies will likely generate several new pricing demonstrations in the coming years.

FUTURE DIRECTIONS

Based on past experience and issues raised in the course of HOV project development and operation, the following is a summary of the emerging issues and future directions that were identified at recent TRB HOV conferences, TRB HOV Committee meetings, and HOV and managed lane workshops held in Pittsburgh, Orange County (CA), Seattle, Austin, and San Diego. *(1, 3, 4)*

Planning and Implementation

- The focus on planning is continuing to expand. Some locales are engaged in:
  - Evaluating the merits of HOV feasibility at the corridor level,
  - Exploring ways to improve the operation of existing HOV lanes,
  - Studying existing HOV lanes to enhance their existing investment, and
  - Planning ultimate HOV system expansion and enhancements to allow greater benefits to be realized .
- Few pure "HOV feasibility" studies are now being pursued. Increasingly, a complete array of congestion management strategies are being explored which include:
  - Traditional capacity expansion,
  - Improved incident management programs,
  - ITS treatments and traffic monitoring,
  - Expanded transit services and transit guideway treatments,
  - Operational strategies (e.g., access, vehicle types (e.g., trucks), hours), and
  - Transportation demand management programs.
- To accommodate the current and projected future growth in HOV lane demand, the construction of additional HOV lane capacity is being explored when roadway improvement projects are considered. The operational strategies have been considered by agencies to optimize the use of these special "managed lanes" include:

  - Occupancy,
  - Vehicle type (e.g., trucks, clean fuel vehicles),
  - Pricing, and
  - Access.
- The planning and implementation timetable for HOV lane extensions or new facilities typically extends beyond original estimates due to: .
  - Increasingly complex environment issues,
  - New HOV lanes and major projects that involve the reconstruction of existing freeway facilities, and
  - Easiest HOV projects have already been implemented along corridors where fewer physical constraints existed.
- The number of agencies involved in HOV planning has grown to include the users of a facility as well as agencies involved in the roadway infrastructure.
- State DOTs and local transportation authorities are the primary project sponsors based on their traditional mission of providing and maintaining the roadway infrastructure. This role is currently changing to one that includes a focus on proactively managing travel and operating the surface transportation system, to optimize its performance for all users, and for the investment that have, and will continue to be made in the roadway.
- Agencies continue to move toward completion of a regional HOV system plan, and integration of this plan and identification of HOV lanes as a key strategy in the region's long range transportation plans.

Design

- Design practices are becoming more consistent with:
  - HOV systems where a substantial investment has already been made,

    - Fewer "interim" projects being implemented which require substantial deviation from accepted design practice,
    - Direct access ramps and dedicated enforcement areas, and
    - Buffer-separated concurrent flow lanes.
- HOV system continuity (e.g. linking separate HOV lanes together and adding direct access provisions between or to these facilities) is an emerging issue in areas with a significant number of HOV lanes on intersecting freeway corridors.
    - Improving access between HOV lanes, transit stations, and park and ride lots,
    - Providing direct access between arterial and freeway HOV lanes, and
    - Connecting HOV lanes through interchanges.
- A significant amount of transferability in accepted design practice has occurred where particular types of HOV facilities, such as buffer-separated concurrent flow lanes, are appearing in an ever larger number of states and locations.
- Current HOV lanes will likely be converted to multi-lane HOV or managed lane facilities when roadway improvements are made, to accommodate:
    - Express users, those who are traveling longer distances and less reliant on frequent access,
    - "Managed lane" facilities will drive the need for a higher level facility design and access features that can facilitate a greater number of users and operate using a number of different operational strategies, and
    - New design standards may emerge from the managed lane projects currently being planned around the country (e.g., San Diego, Houston, Dallas, Seattle).
- Research is needed to monitor and document the impacts of specific HOV lane and access design treatments on safety and performance.

Management and Operation

- Localized decisions in setting and changing operation policies currently exist. Consistency will continue to exist largely at the regional level. Based on past trends, part-time and full-time operation options will continue to be equally popular.
- Monitoring, evaluating, and reporting of HOV lane performance will play a greater importance in the operation, planning, decision making, provision of travel condition, and benefit information to the general public.
- Planning studies are exploring new ways to manage and operate both freeways or designated special use or managed lanes using operational strategies that may include:
    - Access control and ramp metering,
    - Pricing,
    - Vehicle type (e.g., trucks, clean fuel vehicles), and
    - Transit.
- As travel demand and congestion increase, the frequency and impacts resulting from incidents will play a more important role in the overall performance and reliability of HOV lanes. The performance of some HOV lanes are already facing reliability problems resulting from even minor incidents that disrupt flow.
- No means of automating the occupancy enforcement of HOV lane occupancy requirements has emerged, or seems likely to be accepted, so enforcement presence will continue to require a continued commitment of the necessary staff and resources.

CONCLUSIONS

HOV lane experience suggests that while the total number of HOV lane-miles will continue to grow, albeit at a slower pace than experienced in the 1990s, greater public and political scrutiny will be placed on all of these treatments. The recognized role, value, and benefit of HOV lane operation must grow accordingly. If greater emphasis is not placed on performance monitoring, reporting, and the proactive management and operation of HOV lanes to make adjustments in the operating policies in some locales, the viability of the concept of HOV lanes as a whole could continue to be eroded. If these conditions are not addressed or changes made, legislation imposing changes in HOV lane operating policies will continue to be attempted in a number of states.

An example of this proactive management and operation could involve working with transit service providers, adjusting the hours of operation, and combining operational strategies with occupancy (e.g., pricing, vehicle type). This could involve the need to reinforce the role, support, and commitment of transit interests within a metropolitan area. Other changes that may be appropriate could involve significantly altering or terminating the operation of some poorly performing HOV lanes. In some locations the demand to use HOV lanes exceeds the capacity requiring either the need for additional lanes, raising the occupancy requirement, or pursuing the use of other additional operational strategies.

The role of the HOV concept is broadening. Occupancy is one of a number of operational strategies that could be applied in a managed lane application and it will continue to be explored in more freeway corridors and metropolitan areas around the country. Some agencies are now considering operational strategies that serve express traffic, trucks, inherent low emission vehicles, and pricing as a means of managing demand. The concept of managed lanes and the proactive use of multiple operational strategies is not well understood. Few experiences exist and no standards have been developed.

The profession is just now coming to terms with the implications of a separate roadway system within existing freeway corridors that may provide preferential treatment and serve different user groups by time of day and day of week. Currently envisioned projects will pave the way for these experiences to set the course of whether widespread implementation of managed lanes are a passing trend or foundation for the natural growth and evolution of HOV lanes. Busways and bus rapid transit (BRT) are also emerging as viable guideway strategies in constrained and congested corridors, and lessons learned from these experiences will also set forth a recognized standard of practice that will influence HOV lanes.

The importance and role of research needs to be reinforced to provide planners, designers, operators and policy makers with information that they need to assess the impacts, consider the alternatives, and make intelligent choices related to HOV lanes. The significant investment that has and will continue to be made in HOV lanes provides an opportunity for a wide-ranging list of experiences to be documented, technical guidance to be prepared, and training to be developed. Tough questions related to safety and operating effectiveness of HOV lanes will need answers that are best addressed with findings gained from the wide array of projects that have been implemented.

LIST OF FIGURES

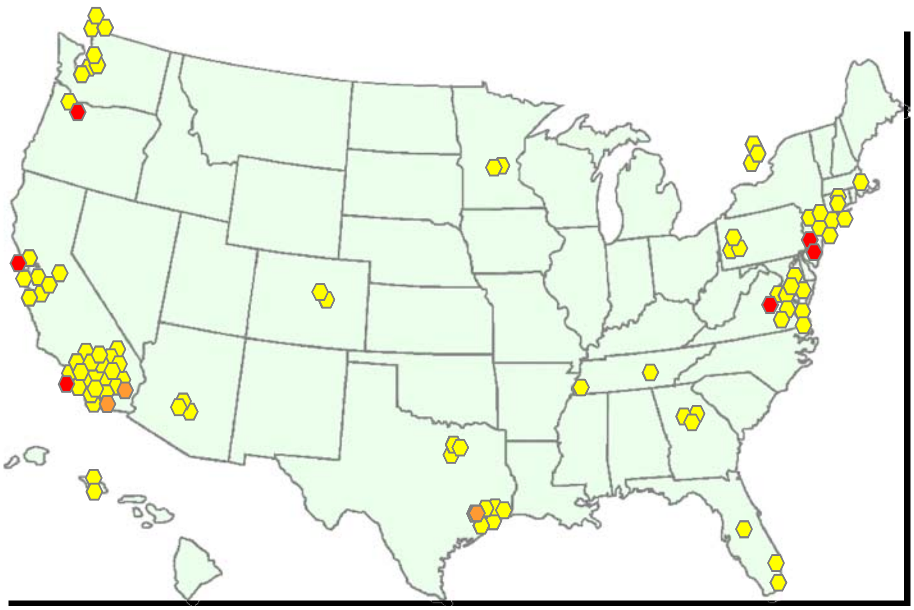

Figure 1: Locations of Freeway HOV Lanes in North America

Note: Dark dots are projects that have been terminated since 1970.

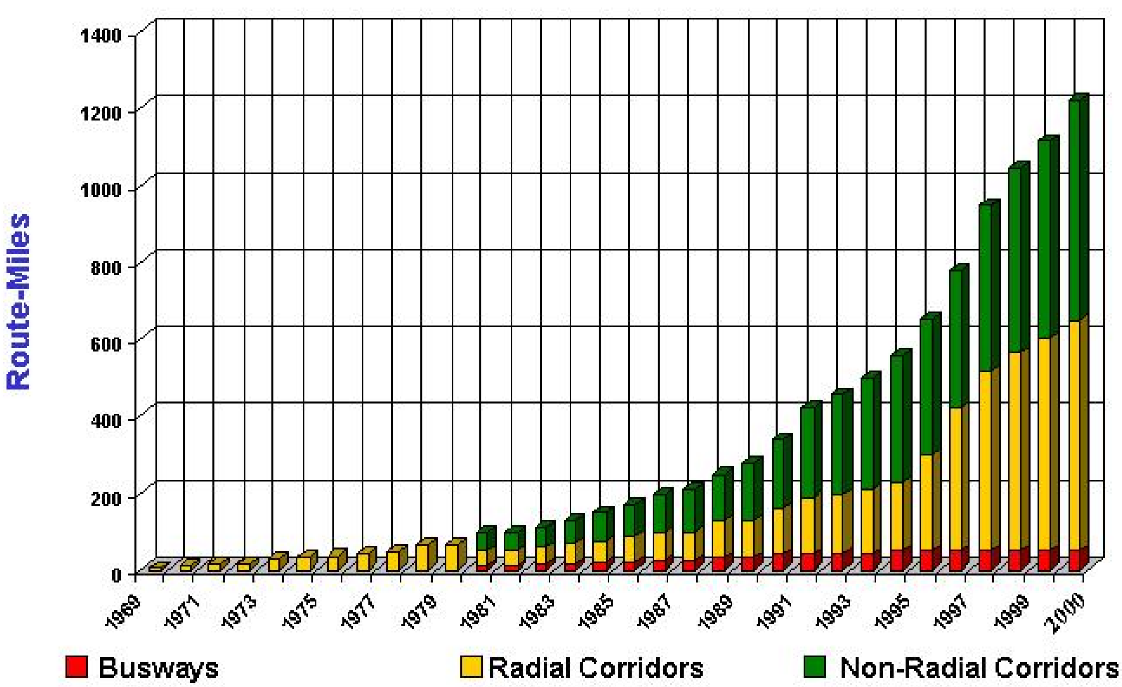

Figure 2: Route-Miles* of Freeway HOV Facilities in the U.S.
Note: Most projects contain two lane miles for each route mile, since HOV lanes exist in both directions in most locales. No data source was available for determining the magnitude of arterial HOV lanes.

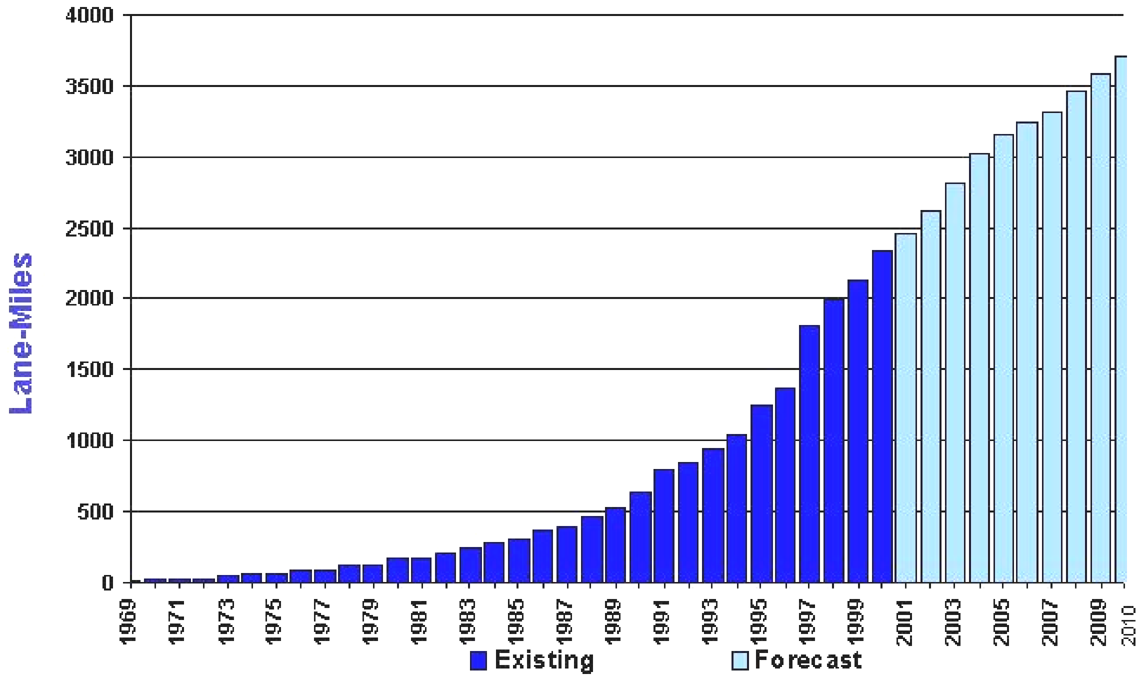

Figure 3: Current and Planned Freeway Lane-Miles of HOV Facilities in the U.S.

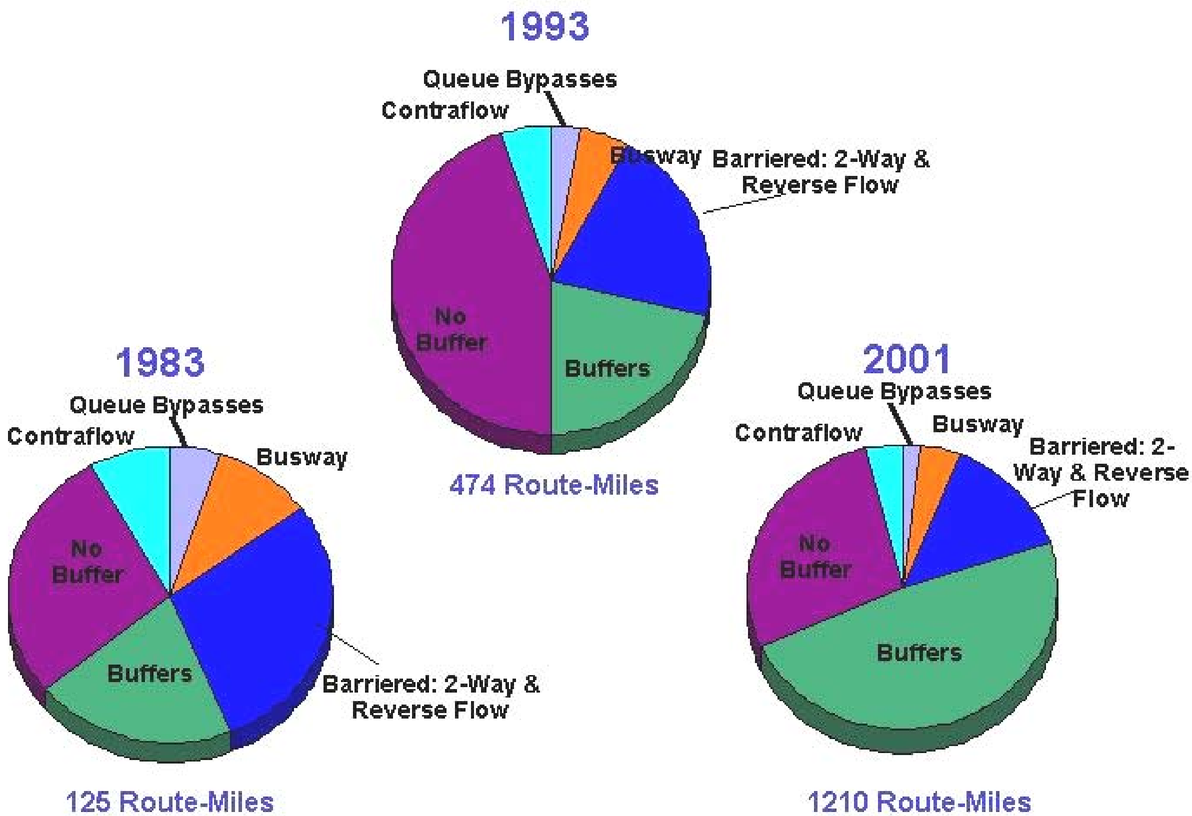

Figure 4: Trends in Types of Freeway HOV Lanes, 1983 to 2001

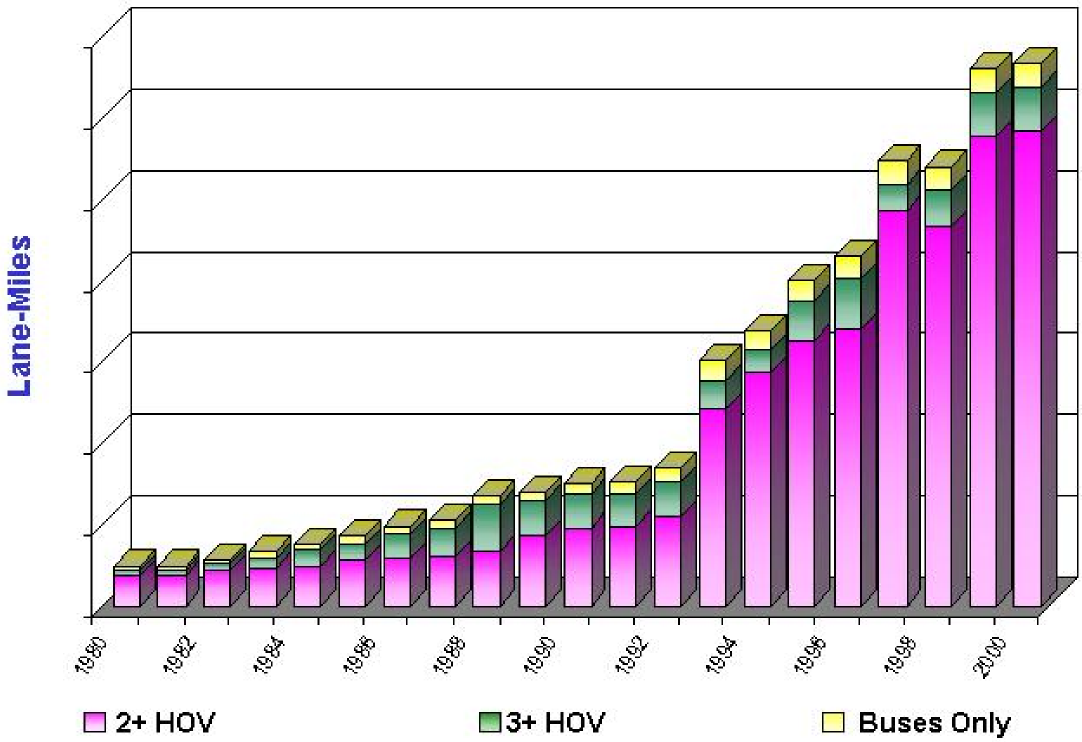

Figure 5: Trends in Freeway HOV Lane Occupancy Requirements

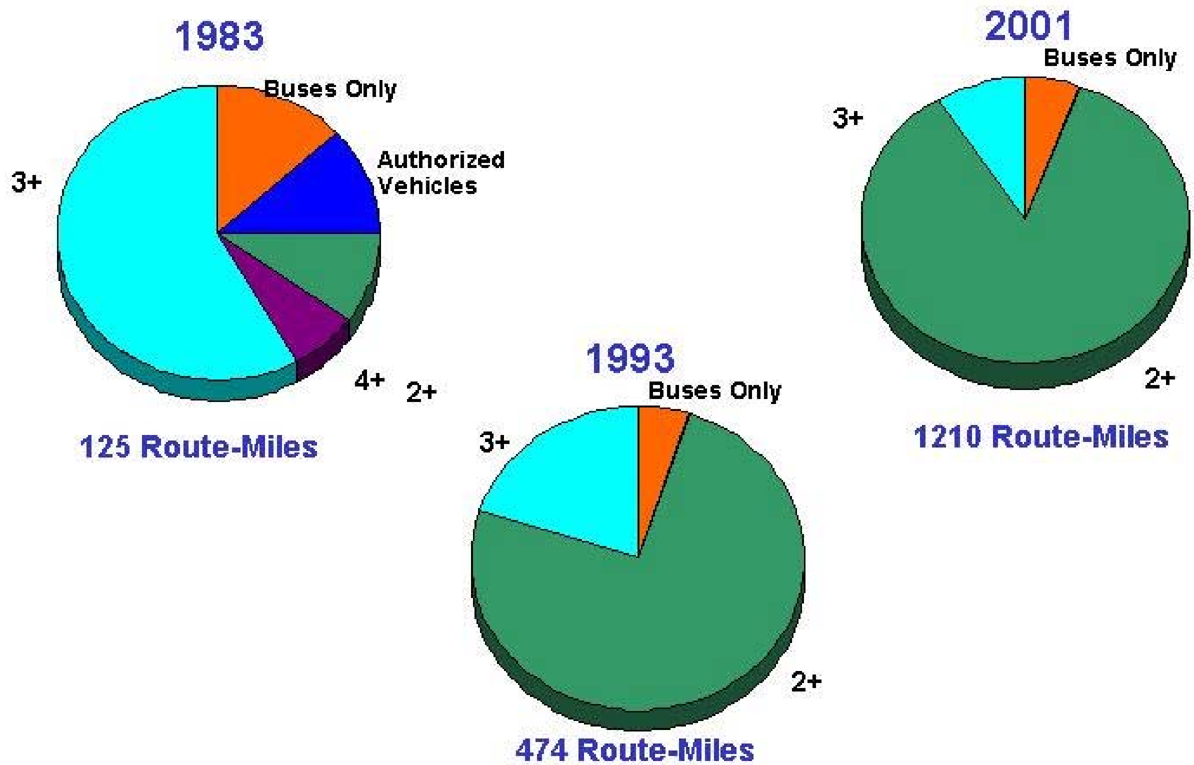

Figure 6: Comparison of Freeway HOV Lane Vehicle Eligibility Policies, 1983 to 2001

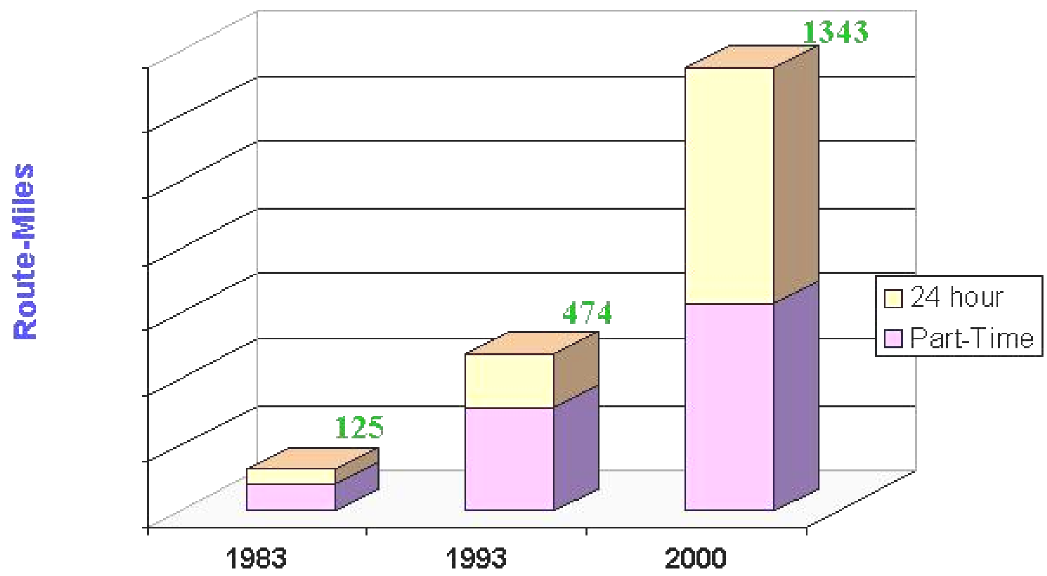

Figure 7: Trends in Hours of Operation

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