High-Occupancy Vehicle Network Expansion through Lane Conversion rather than New Construction

Overall effect on California petroleum use		Affects Petroleum Demand Through Intermediate Indicators:	
Magnitude	Low-Medium	**Primary**	Mode Choice
Certainty	Medium	**Secondary**	System Operation Efficiency
Applicable Level of Government	County, Regional, State, Federal		
Relevant Laws or Cases Affecting Factor	23 CFR §810.108(b), 23 USC § 166 (b)(4-5), 23 USC § 166 (d)(2), California Vehicle Code §21655.5-6, Public Resources Code §21080(b)(11)		
Overall Time-Horizon of Reversal	If California policymakers decided to permanently convert existing lanes to HOV lanes rather than constructing them anew, the benefits of a completed metropolitan HOV network lanes would begin nearly instantaneously, reaching a steady state in the near term as individuals adjust their travel behavior. If transportation system users perceive a conversion as temporary, they may seek to wait out the change rather than adjust travel behavior.		
Relevant Topics	carpool, rideshare, transportation network expansion, incentives		
Summary	Policymakers expect HOV lanes to encourage rideshare by providing a benefit, time savings and reliability, to those in high occupancy vehicles. Nearly all HOV lanes implemented in California have been newly constructed rather than converted from existing general purpose lanes. Constructing rather than converting lanes delays the implementation and increases the expense of a complete HOV network. The result is the delayed effectiveness and lost opportunities to reduce petroleum use.		

Introduction

Transportation planners use high-occupancy vehicle (HOV) lanes to create an additional incentive for rideshare. Sharing travel costs among vehicle occupants creates a monetary incentive for rideshare across all routes, but time savings and reliability on routes with HOV lanes can augment rideshare incentives. The incentive is a function of perceived time-savings and reliability: dependent on relative attractiveness of HOV lanes versus general purpose lanes. When general lanes are congested or unpredictable and HOV lanes are less congested and more predictable, drivers are likely to perceive a benefit from ridesharing. Transportation planners can manage an HOV users' time savings by adjusting vehicle

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occupancy requirements at certain times of day. If poorly-managed HOV lanes lose their relative advantage, they are unlikely to augment rideshare incentives.

A complete well-managed HOV network can provide benefits that exceed the sum of individual HOV segments. While adding segments creates immediate time savings and system operations efficiency gains for ridesharers whose current routes include segments without HOV lanes, a complete network will create the perception of consistent ridesharing benefits throughout the highway system.

One question transportation planners face is whether to convert HOV lanes from existing general purpose lanes or to construct new, additional HOV lanes. Converting lanes can create nearly-instantaneous ridesharing benefits, as an inexpensive, low-delay implementation option. Constructing a new HOV lane or facility can attract additional federal highway capital funding versus converting an existing lane. HOV construction can also avoid political backlash associated with removing a general purpose lane for restricted access by high occupancy vehicles. It's likely the perceived costs of removing a general purpose lane will be higher where the segment experiences congestion during some times of the day – precisely where the rideshare-inducing benefits of the HOV lane will be higher.

Since a failed experiment on the Santa Monica Freeway in Los Angeles in 1976, every new high-occupancy vehicle (HOV) lane-mile in California has been constructed rather than converted from existing lanes. This has significantly slowed the pace and increased the cost of expanding and completing high-occupancy vehicle network. An incomplete network limits rideshare incentives, and constructing rather than converting HOV lanes requires additional construction emissions and energy use.

HOV lane conversion attempts in California

The Santa Monica Freeway experiment began on Adriana Gianturco's first day as Director of the California Department of Transportation. Governor Jerry Brown appointed her to broaden the agency's focus beyond highway-building and bring greater balance to the state's transportation system. However, the Santa Monica Freeway project was planned under Governor Ronald Reagan's administration as a measure to reduce air pollution in order to conform to the Clean Air Act's standards (Levine, 1994). Failing to comply with the Clean Air Act can jeopardize a region's federal highway funding.

The HOV 3+ lanes operated between 6 to 10 AM and 3 to 7 PM (Riker, 1976). On the first morning, the *Los Angeles Times* reported that commuters waited 15 to 20 minutes to get on the freeway, only to travel 5 miles per hour (Kendall, 1976). The lane conversion was not the sole cause if this delay, as ramp meters that control freeway access weren't adjusted for the HOV lane implementation (Herbert, 1976c). The conversion brought some benefits to certain system users. Travel time for one carpooler reduced from 35 minutes to 20 minutes (Kendall, 1976). On the first day, only 814 passengers used 59 buses from park-and ride lots on the Westside (Kendall, 1976).

Over the five month project, Caltrans never saw the degree of shift to carpools and transit that they expected. Some carpoolers may have been discouraged by the nails scattered in protest on the HOV lanes (Herbert, 1976c). The experiment lasted 110 days - from 6AM on Monday, March 15th to 7PM Friday, August 13th. In the end, the Federal 9th Circuit Court of Appeals ruled that Caltrans erred in not conducting an environmental review for the pilot project (Herbert, 1976a). Caltrans contended the pilot project was categorically exempt from the environmental review process.

HOV lanes briefly returned to the Santa Monica Freeway after the 1994 Northridge Earthquake (Murphy 1994). However, the 1976 Santa Monica Freeway experiment stands as California's only attempt to permanently convert a general purpose lane to a high-occupancy vehicle lane.

Conversion attempts elsewhere

Since the Santa Monica Freeway experiment, a few other U.S. regions have attempted HOV lane conversions. In 1977, the Massachusetts Department of Transportation converted a general lane to an HOV lane during the AM peak period. The conversion lasted over 5 months—between May 4th and October 17th (Simkowitz, 1977). The Massachusetts Department of Transportation later converted a general purpose lane on I-93 to a 0.8 mile reversible "zipper lane", a permanent conversion (Kim, 1995).

In 1991, the Metropolitan Washington Airports Authority nearly finished constructing a new HOV lane on the Dulles Toll Road. The Authority decided to open completed portions of this lane to general purpose traffic on October 15, 1991. The plan at the time was to restrict the lane to high occupancy vehicles when construction crews completed the lane in December (Fehr, 1991). Public opposition to this HOV 3+ lane delayed implementation until September 1, 1992. The HOV 3+ lane operated for a month before Virginia's Governor terminated it in response to federal legislation that would have done the same (Bates, 1992).

In November, 1993, the Washington State Department of Transportation converted a general lane to an HOV lane on an uncongested portion of I-90. The Department extensively studied public opinion and prior conversion attempts before implementing the conversion (Manning 1995). The project has not been reversed and was deemed a qualified success (Kim, 1995).

Regulations governing HOV lane conversion

Federal law and regulations govern the construction, conversion, and operation of HOV lanes. Under current regulations, the Federal Highway Administrator may approve the conversion of an existing general-purpose lane to a high-occupancy vehicle lane on any public road provided that the change facilitates more efficient use of any Federal-aid highway (23 CFR §810.108(b)). Most provisions in federal law restrict the conversion of HOV lanes to general purpose lanes, rather than the other way around. 23 USC § 166 (b)(4) allows for conversion of HOV lanes to high-occupancy toll (HOT) lanes, which allow low-occupant vehicles to pay for access, unless facility is degraded. 23 USC § 166 (b)(5) allows for low-occupant low-emissions vehicles to access HOV lanes unless facility is degraded. 23 USC § 166 (d)(2) defines a degraded facility as a facility with a minimum average operating speed under 45 mph.

States are mostly prohibited from converting an HOV lane to a general purpose lane if it used Congestion Mitigation and Air Quality (23 USC §149) funding to construct the HOV lane. The Congestion Mitigation and Air Quality program is a major source of federal funding for regions seeking to comply with the Clean Air Act.

In California, various laws place somewhat greater restrictions on the conversion of general purpose lanes to HOV lanes. Vehicle Code §21655.5 permits Caltrans to implement high-occupancy vehicle lanes, Public Resources Code §21080(b)(11) establishes the statutory CEQA exemptions for projects to institute or increase utilization of high occupancy vehicle lanes. Vehicle Code 21655.6(a) requires Caltrans to obtain permission from a County Transportation Commission or other local authority prior to implementing a carpool lane, (b) requires Caltrans to obtain 2/3rds majority approval from the Los Angeles County Metropolitan Transportation Authority Board prior to establishing an HOV lane on the 101 freeway within Los Angeles city limits, and (c) requires evaluation of any HOV lanes implemented in unincorporated Alameda County.

How the incomplete HOV network affects fuel use

First, there are the differences in vehicle operations efficiency of HOV facilities versus general purpose facilities. Single-lane HOV facilities in California have lower maximum effective per-lane vehicle capacity than do multiple general purpose lanes (Kwon 2008). This has nothing to do with vehicle occupancy, but rather occurs because throughput in a single-lane facility is subject to the speed of the slowest vehicles, whereas traffic in a multiple-lane facility can pass slow-moving vehicles. Other physical characteristics of the HOV facility matter, as vehicles operating in continuous-access HOV lanes achieve higher operational efficiency than those in limited access HOV lanes (Boriboonsomsin, 2008). One scholar found that the capacity of the general purpose lanes is not affected by the HOV lane (Menendez, 2007).

A primary goal of all HOV projects is to provide travel time savings to users. This goal is operationalized through congestion-avoidance measures, the most imperative of which is reducing the demand for a lane below a critical threshold that would lead to forced vehicle movements. The result is that many, but not all HOV lanes have fewer vehicles that operate more efficiently than do vehicles in the general purpose lanes. Furthermore, although a single-lane HOV facility has a lower maximum vehicle capacity than each lane in a multiple-lane general purpose facility, this is not the case when traffic in the HOV lane is free flowing and traffic in the general purpose lanes is congested.

Second, the presence of HOV lanes can induce ridesharing. This incentive is larger when the HOV lane provides significant time savings over the general purpose lanes and when the carpool can utilize HOV lanes over a greater portion of their trip (Guiliano, 1990). Thus, the effectiveness of regional HOV lanes is subject to a network effect: the carpool-inducing effect becomes larger as HOV facilities appear on a greater proportion of a region’s freeway network. By inducing carpools, HOV lanes can reduce vehicle trips.

The net effect of greater operations efficiencies and induced rideshare depends on the unit of analysis: the vehicle, the person, the facility, the corridor, or the travel-shed. Johnston (1996) found that the construction of a new HOV lane increases vehicle miles traveled, increasing petroleum use. The same is true for any addition in capacity. The net travel effects of converting a general purpose lane to high-occupancy will depend on each corridor’s conditions. Such a conversion can lead to substantial increases in person-throughput through use of carpools, transit, and vanpools (Kwon, 2008). Inducing traffic congestion and providing a congestion-free alternative is a powerful long-term strategy to reduce discretionary single-occupant vehicle trips, but has significant non-petroleum effects.

Because relatively little California travel occurs on HOV lanes, completing the HOV network would have a small effect on motor vehicle fuel demand. If California’s HOV network were fully built out, with 2,330 miles rather than the current system length of 1,391 miles, then the lanes would accommodate roughly 2.5% of all vehicle travel in the state. Converting HOV lanes from general purpose lanes rather than constructing them anew would lead to a greater reduction in motor vehicle fuel use. Even if the effect HOV lanes have on vehicle occupancy and operating efficiency led to a 20% reduction in motor vehicle fuel use, the statewide effect of a complete network would be roughly 0.5%, or 0.21% larger than the current network.

2011 statistics for HOV and freeway network

	Directional Miles	Vehicle Miles Traveled (2011 or projected)	Percent of Statewide VMT
HOV	1,391	4,743,672,034	1.45%
General Purpose Lanes where HOV exists	1,391	45,819,037,501	13.98%
HOV Buildout (*projected)	2,330	8,000,000,000*	2.5%*
All Public Roads		327,800,000,000	

Source: (Federal Highway Administration, 2012).
Note: This analysis does not account for the petroleum use and emissions needed to construct new HOV lanes, or differences in vehicle fuel type for priority access.

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