Forecasting Use on Proposed High-Occupancy-Vehicle Facilities in Orange County, California

LARRY WESEMANN

Mobility problems being encountered in Orange County, California, are significant and are expected to become worse. In response, the Orange County Transit District is pursuing a transit development strategy that involves the provision of exclusive preferential facilities for buses and high-occupancy vehicles (HOVs). In developing this transitway program, a detailed analysis of potential long-range use was made, focusing on the emerging major activity centers in Orange County. The required HOV and transit demand estimates were developed through a microcomputer-based estimation process that involved nine specific tasks; a spreadsheet program was used along with various BASIC programs. Journey-to-work travel data for 1980 from the Census Bureau Urban Transportation Planning Package were used as a base and expanded to the year 2010 by using adopted population and employment growth factors. Mode splits were determined on the basis of the degree of travel-time savings that trips would achieve by using the preferential facilities in the a.m. peak hour versus mixed-flow freeways as well as origin and destination characteristics. The degree of increase in mode-split values for transit and HOVs was largely a function of corridor statistical trends from studies of before-and-after conditions on other priority projects nationwide. HOV trips were assigned by microcomputer to a network of preferential facilities using equations that specified the ranges of cells from the trip matrix that would pass through links in the network. The equations were applied to a master file of projected HOV trips to produce directional link and access-egress volumes.

In this paper the travel-forecasting approach is described that was employed by the Orange County Transit District (OCTD) to provide bus and high-occupancy-vehicle (HOV) use estimates necessary for OCTD's Transitway Concept Design Study, the primary planning phase of the Transitway Development Program for Orange County, California. The application selected is highly specialized and was developed and performed by staff using available microcomputer hardware and software. The approach is a product-driven process that focused on meeting the demand requirements necessary to conduct concept design work at the expense of answering broader intermodal travel-forecasting questions.

Planning Department, Orange County Transit District, 11222 Acacia Parkway, Garden Grove, Calif. 92642.

REQUIREMENTS FOR A DIFFERENT APPROACH TO TRAVEL FORECASTING

In 1985, OCTD made a decision to develop its own approach to travel forecasting that focused solely on meeting the demand requirements necessary to conduct the Transitway Concept Design Study. The forecasting approach selected is radically different from the traditional Urban Transportation Planning System (UTPS) process and is highly flexible, has easily tracked input and output, and can be performed on available microcomputer hardware and software. The development of this process was governed by the requirements discussed in the following sections.

Shifting Program Emphasis

A need had been identified for a different travel-forecasting approach to meet the complex planning requirements of OCTD's new transitway program emphasis. The UTPS aggregate model chain provided output that was suitable for previous rail project analysis. However, the new emphasis on preferential facilities required that HOV as well as conventional transit demand be more thoroughly analyzed.

Lack of Proven HOV Travel Model in Los Angeles Region for Transitway Study

No conventional travel model being used within the region in 1985 was capable of replicating behavior shifts to ride-share modes in response to newly available exclusive facilities and changing corridor characteristics. In addition, no regional agencies had developed packages for assigning HOV trips to a separate network of exclusive facilities.

Flexibility and Tracking Ability

A need existed for maximum flexibility in developing forecast output for Transitway Concept Design Study tasks and easily tracked input and output. As work progressed

on the study, OCTD staff needed to respond to emerging planning and design issues that affected facility capacity, operations, and access features. A forecasting tool was needed that would allow for ease in modifying input assumptions and variables and would facilitate a quick analysis of the effects of these changes on output.

Comparison Capability

A need existed for the ability to compare travel-forecasting input and output with data from HOV model development and field work being done by other agencies in the Los Angeles region.

Spatial Requirements

A need existed to develop detailed estimates for site-specific analysis, such as that for an access ramp, as well as a corridorwide focus. Several rapidly growing employment centers in Orange County required a more detailed analysis of demand from exclusive facilities in the a.m. peak period.

Limited OCTD Travel-Forecasting Resources

On a short-range basis for initial concept design tasks, OCTD needed to develop an estimation approach that could use available in-house microcomputer resources and staff expertise. At the same time, it was decided to begin an evaluation study of long-range travel-forecasting needs, eventually allowing the agency to perform more sophisticated travel-forecasting activities.

STUDY OVERVIEW

By 2010, Orange County's population is projected to have grown by 45 percent to more than 2.8 million, jobs by nearly 65 percent to nearly 1.6 million, and daily trips by nearly 90 percent to 13 million. The mobility problems currently being encountered by Orange County residents will become worse as the growth occurs. As previous studies have shown, these problems have a magnitude and complexity that cannot be solved entirely by the building of more streets and highways. Clearly, a multimodal solution is needed. One such approach, successful in Southern California, involves the implementation of bus-HOV facilities within freeway rights-of-way (e.g., the El Monte Busway in Los Angeles County along I-10). This preferential treatment provides travel-time savings to those willing to share a ride. Eligible users include public transit, private buspools, vanpools, and carpools.

Planning Approach

The planning for the transitway development program for Orange County involved an intensive analysis of the major activity centers in Orange County and the need to serve these centers through a higher level of transportation service than can be provided by today's transportation system. The analysis focused on the relationship of a transitway system to the major activity centers, transitway demand estimates for both buses and carpools for the year 2010, and the benefits that are likely to accrue from use of transitways. As shown in Figure 1, the proposed 19.4-mi system of limited-access transitways is directly adjacent to most of the county's activity centers and provides an interface with current and proposed commuter (carpool) lanes.

Location and Size of Activity Centers

The eight activity centers that are within the central core of Orange County are shown in Figure 1. All of the centers are within 1 mi of freeway corridors, and workers at these centers are heavily dependent on these freeways for access to their jobs.

Forecasts of jobs for each center were made on the basis of adopted plans. The eight centers currently have a combined total of approximately 245,000 jobs. Employment in these centers is projected to increase to a cumulative total of nearly 350,000 jobs by 2010, a 43 percent increase. These forecasts served as a basis for projecting use of the proposed barrier-separated transitways.

The existing employment and the growth planned over the next 15 to 25 years highlight the need for a more efficient use of the transportation system. This growth further reinforces the need for the development of a program of preferential facilities to move large numbers of people more effectively.

DEMAND ESTIMATION APPROACH

Methodology

The selection of a travel estimation approach for projecting HOV and transit use on exclusive facilities was based on fulfilling specified output requirements constrained by a limited time frame and available in-house forecasting resources. The approach selected for estimating demand for transitways and commuter lanes was called the Urban Transportation Planning Package (UTPP) Base/Socioeconomic Growth Approach. The process involved nine specific tasks, which are described in the following section, and the analysis was conducted on an IBM XT personal computer using a spreadsheet software program along with various BASIC programs developed by the staff.

The 1980 U.S. census journey-to-work travel data from the UTPP formed the base data set for producing year 2000 and 2010 projections of facility use. The base-year person-trip data were built up to forecast-year trip totals by using an iterative distribution application that was constrained by the adopted Orange County growth forecasts for origin and destination areas. This iterative approach

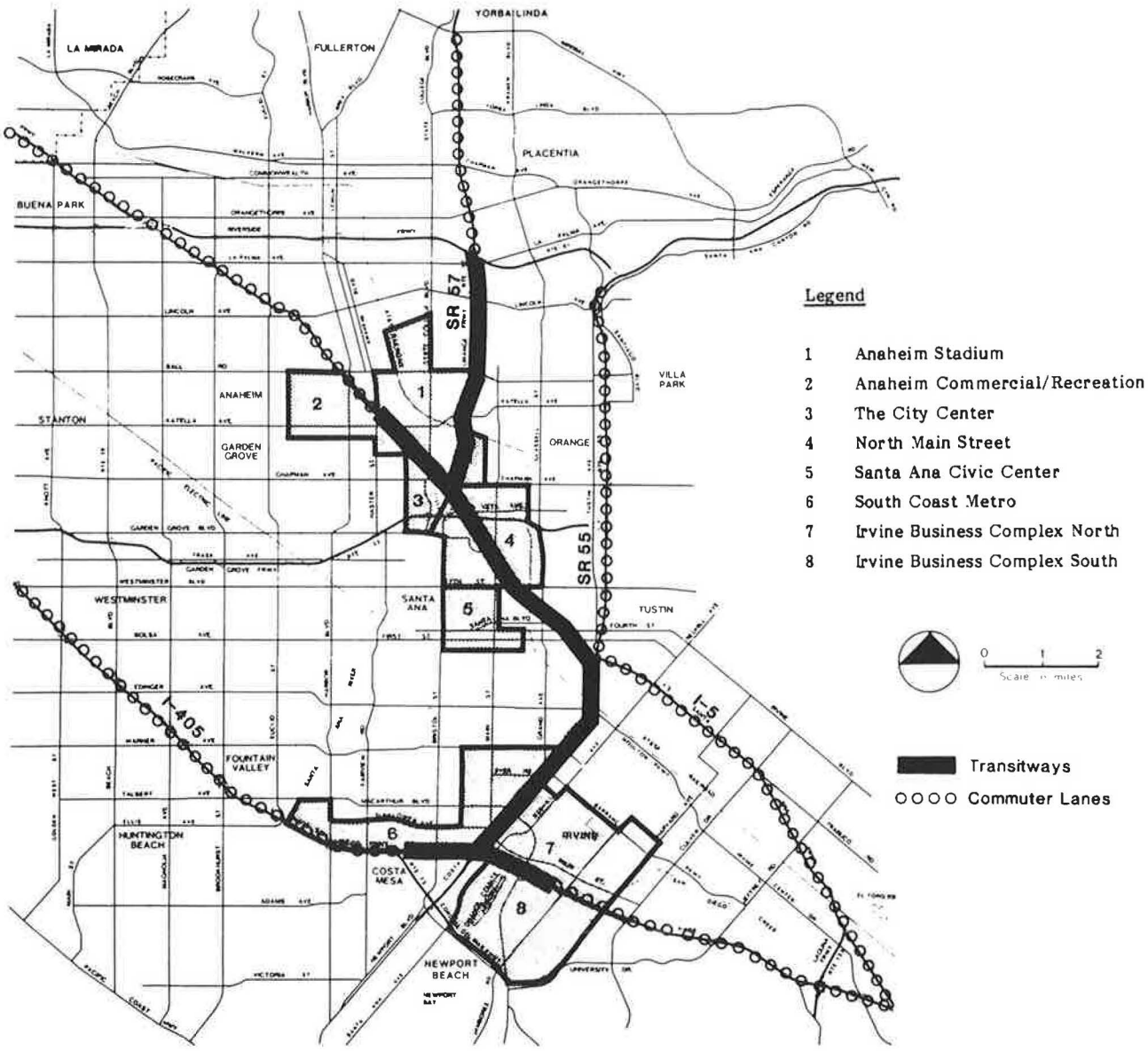

FIGURE 1 Relationship of transitway system and activity centers.

used the trip distribution from the UTPP data base as a platform on which to expand the journey-to-work trip table to levels more representative of the forecast years.

Transit and HOV mode splits were primarily determined on the basis of the degree of travel-time savings that commute trips would achieve by using preferential facilities rather than mixed-flow freeway lanes in the a.m. peak hour along with origin and destination area characteristics. (From the employee survey results in the 1986 Commuter Network Evaluation Study conducted by OCTD, travel-time savings was identified as the principal incentive that would encourage Orange County commuters to rideshare.) The degree of increase in mode-split values for transit and HOVs was established on the basis of changes in facility and corridor modal statistical trends from before-and-after studies related to the opening of other HOV priority projects nationwide. [Transitway Concept Design Working Paper B-2: Operations Plan (*1*) contains a detailed analysis of facility and corridorwide statistics on modal shift from before-and-after studies related to the opening of preferential projects around the country.]

Demand Estimation Process

The demand estimation process involved nine specific tasks, some of which contained numerous steps. Figure 2 shows the sequence of tasks along with key input and output.

Task 1: Review System-Level Demand Analysis Assumptions, Process, and Output

An HOV estimation process from a previous OCTD system-level analysis of preferential facilities was reviewed,

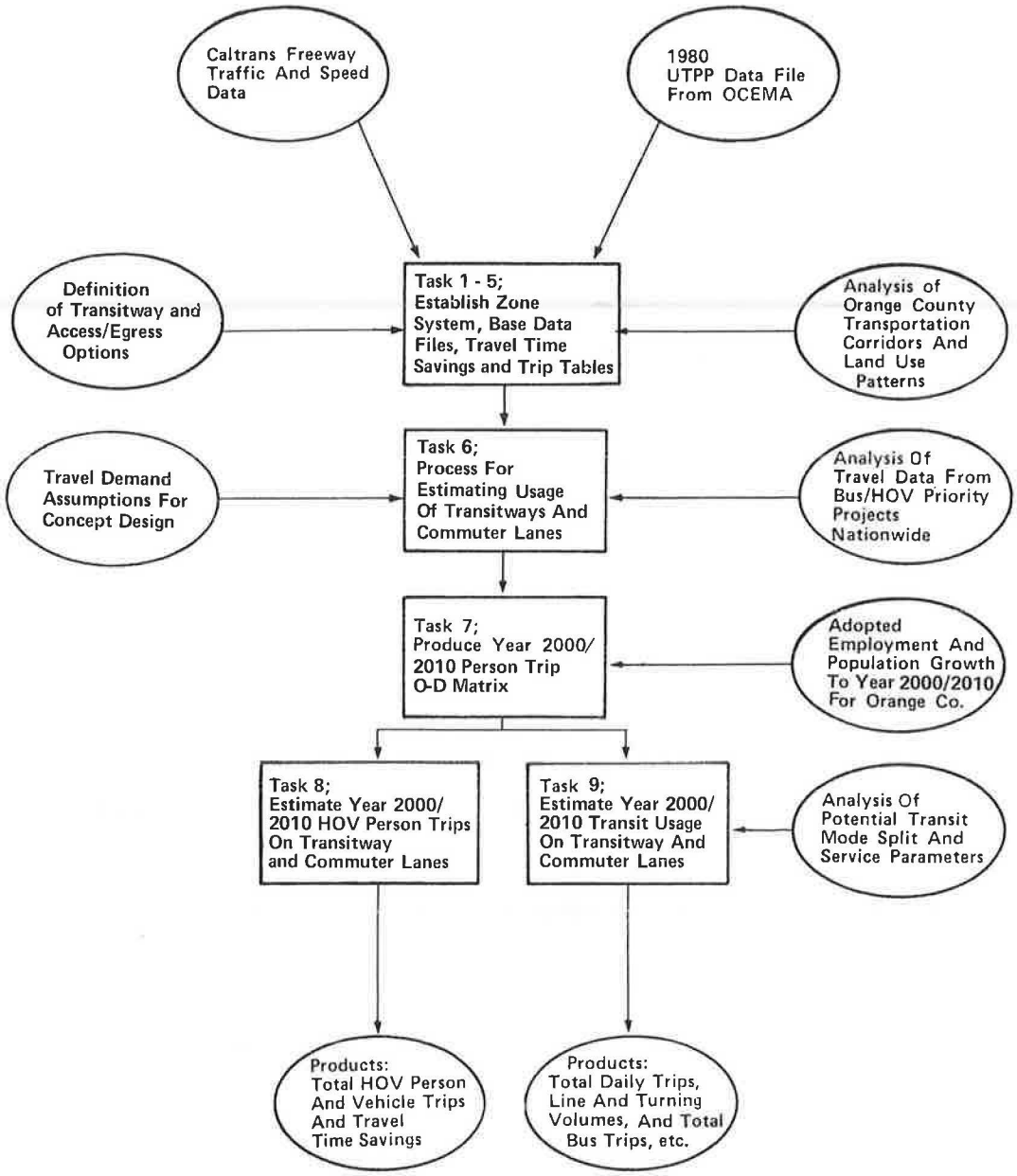

FIGURE 2 Process for estimating transit and HOV use on transitways.

and changes were made as required to, among other things, the zone system, speed assumptions, prior mode assumptions, and transit and HOV mode-split factors.

Task 2: Establish Zone Systems and Design Origin-Destination Matrix for Microcomputer Analysis

The Transitway Concept Design Study zone system was designed to be more detailed to allow for a more concentrated analysis of access and egress along specific travel corridors in the study area. A 54-zone system was established for the study, and an origin-destination (O-D) matrix was designed.

Task 3: Establish Base Data Files and Determine Background Assumptions

The 1980 UTPP data files for total person-trips, two-person carpools, and three-person carpools were aggregated to the zone system, and specific background assumptions were established using travel behavior information from nationwide studies of preferential facility projects along

with freeway data from the California Department of Transportation (Caltrans), HOV counts, and vehicle occupancy data.

Task 4: Estimate Travel-Time Savings on Transitway Versus Freeway for All Trip Interchanges

Existing Caltrans peak-hour speed and congestion data were compared with free-flow speeds assumed for preferential facilities to determine the amount of line-haul travel-time savings that would be assigned to each O-D cell in the matrix. Travel-time savings estimates were computed on the basis of the higher speeds that commuters would achieve on preferential facilities within individual corridor segments as well as through major freeway interchanges via high-speed ramps and on exclusive access ramps into activity centers.

Task 5: Delete O-D Cells with Short Trip Lengths and Produce 1980 Trip Tables

Because of the difficulty in weaving across congested freeway lanes both into and out of commuter lanes and the infrequency of controlled transitway access and egress ramps, few commute trips of less than 7 mi would gain from using these preferential facilities. Therefore, all short trips, along with trips made in areas of the county not served by preferential facilities, were deleted from the matrix. (Commute trips of less than 7 mi combined with trips outside the scope of the study constituted approximately 53 percent of all 1980 journey-to-work trips within Orange County, according to the UTPP data.)

Task 6: Estimate HOV Person-Trips on Transitways and Commuter Lanes

First, each O-D cell in the matrix was categorized by the amount of line-haul travel-time savings attributable to each cell's travel path on the preferential facilities versus that on mixed-flow freeways. O-D trip cells with less than 5 min of travel-time savings were not added to the trip table for preferential facilities because this level of savings was not considered sufficient to cause commuters to switch from freeway lanes. Varying portions of the trip totals for all other O-D pairs were added to the appropriate category of travel-time savings in the transitway trip table within which they fell (see Table 1).

Next, HOV trips in the transitway trip tables were increased by the degree of travel-time savings to account for the influence of the benefits of the transitway on propensities to form carpools. Finally, all HOV person-trip totals were reduced by 10 percent to account for a daily travel factor (vacations, sick time, etc.), and an additional 20 percent more trips was added to account for nonwork HOV travel on the preferential facilities in the a.m. peak period.

TABLE 1 FACTORS USED IN ESTIMATING HOV PERSON-TRIP USE FOR TRANSITWAYS AND COMMUTER LANES

Category of Travel-Time Savings	Percentage of Existing Trips Shifting to Transitways		Percentage of Increase in HOV Formation for Trips Using Transitways
	Trips 7 mi or Less	Trips > 7 mi	
< 5 min	No shift	No shift	No increase
5–9 min	No shift	65–75	20–30
10–14 min	No shift	75–85	30–40
15 min or greater	No shift	85–95	40–50

(Data in this section are derived from the 1984 Caltrans survey of HOV users on the El Monte Busway in Los Angeles during peak periods.)

Task 7: Produce Person-Trip Tables for 2000–2010

Years 2000 and 2010 were selected as projection years for OCTD's Transitway Concept Design. Year 2000 represents a design year for the transitway and 2010 is the horizon year for the demand analysis. The production of future years' trips was accomplished by increasing the base-year 1980 UTPP person-trip table by adopted socioeconomic growth factors for Orange County [Orange County Preferred-1985 (OCP-85) Projections prepared by the Forecast and Analysis Center of the Orange County Administrative Office]. Origin zonal trip totals were increased on the basis of population and destination zonal trip totals by employment. An iterative approach was used to build from the 1980 trip distribution that existed in the UTPP data base to a future-year distribution. Trip imbalances between origins and destinations were eliminated by reallocating trips from cells with trip excesses to cells with trip deficiencies. This task was accomplished on an IBM XT personal computer with a software program developed by staff and written in BASIC. This quick-response procedure for projecting a future-year person-trip table in an O-D format produced output that was used on Lotus 1-2-3 spreadsheets to perform the estimation of future-year HOV person-trips using mode splits derived in Task 6.

Task 8: Estimate and Assign HOV Person-Trips on Transitways for 2000–2010

HOV trip totals were assigned to transitway links using a microcomputer assignment application developed by staff. The software application contained a series of equations that specified the ranges of O-D trip cells from the trip matrix that were assumed to pass through each directional link in the transitway network. One equation of O-D ranges was specified for each directional transitway link. The equations were applied to a master file of projected HOV

vehicle trips using a Lotus 1-2-3 spreadsheet to produce directional link volumes and ramp counts for the a.m. peak hour.

Task 9: Estimate Transit Use on Transitway for 2000–2010

Transit use on preferential facilities was estimated for future years. Origin market areas and destinations that can be collectively served by transit were identified in the estimation matrix. The largest of these, along with individual O-D cells of 300 person-trips or more, were selected from the 2010 trip table as having transit potential. Next, a range of transit mode splits was developed based on the degree of travel-time savings and origin and destination characteristics, along with trip distance and level of service. These mode splits were applied to appropriate O-D pairs in the table of person-trips with transit potential to produce a transit trip table. The transit trip cell totals were then categorized by size; those in excess of 150 peak-period trips were assigned to express bus routes. Totals under 150 were assumed to be too low to justify express bus service. Express bus use totals were increased by 7 percent to account for nonwork trips carried during the peak period. (Data in this section are based on output from the 1979 and 1982 OCTD on-board surveys and the 1984 Caltrans survey of transit riders on SCRTD routes using the El Monte Busway.)

Key Assumptions Used in the Demand Estimation Process

Three categories of assumptions were made in the demand estimation work: general (e.g., travel growth, operating speeds), HOV (e.g., person-trips assigned to facilities, increase in formation), and transit (e.g., market requirements, mode splits) (Table 2).

Of particular note in the demand estimation process is the step-by-step build-up approach used. Beginning with existing HOV person-trips (1980 UTPP data file), each step of the process allows for two important activities to occur:

1. Trip tracking: O-D pair trips can be tracked throughout the entire HOV demand estimation process. This allows the forecaster to assess the validity of every step in the forecasting process.
2. Changing assumptions: In the event that different data exist, any of the assumptions can be altered and the process redone.

In combination, these two facets of the estimating process allow the forecaster to communicate clearly to the technical community precisely how the HOV and transit link volumes and facility access-egress estimates were derived.

Data Base for 1980

Table 3 (*2*) contains a summary of the 1980 UTPP journey-to-work data base that formed the basis for this demand analysis. Of the nearly 1 million journey-to-work person-trips in the data base (internal Orange County trips plus those of external origin), only 507,243 were included in this analysis because of the exclusion of trips shorter than 7 mi and trips that occurred in areas and directions not served by either transitways or commuter (carpool) lanes.

In this analysis 95,792 journey-to-work person-trips listed as being in HOVs of two persons or more are included, which constitutes nearly 19 percent of the total of 507,243. The remaining 79,475 journey-to-work carpool person-trips were dropped from the analysis because of short trip lengths or trip directions not served by the proposed preferential facilities.

Congestion Assumptions and Travel-Time Saving

At least four factors were assumed to contribute to the attractiveness of transitways and carpool lanes to commuters in Orange County: improvements in travel reliability (more on-time arrivals), a better traveling environment (increased freedom from congestion and incidents), improved safety (protection because of barrier separation), and shortened travel time during peak commute hours. Of these benefits, shortened travel time is the most quantifiable in terms of its impacts on user behavior. Therefore, it was the principal variable used in this analysis to govern increases in carpool formation rates within travel corridors.

Travel-time savings affected two steps of the demand estimation process under Task 6: mode choice and the assignment of HOVs to the transitway. For these two steps, travel-time savings was interpreted as the number of minutes that could be saved if commuters would use exclusive transitways for the line-haul portions of their trip, including use of the special direct-egress ramps to activity centers. These travel-time savings were calculated for a.m. peak-hour travel on transitways versus congested mixed-flow freeways.

Travel-time savings affected the assignment of HOV person-trips to transitways in two ways. First, a minimum travel-time savings of 5 min was used as a low end point for assigning trips to transitways. Second, three categories of line-haul travel-time savings (5 to 9 min, 10 to 14 min, and 15 min or more) were used to assign percentages of HOV person-trips to transitways.

Travel-time savings were also used to determine mode choice for HOVs and express transit using transitways. For HOV person-trips, the degree of increased carpool formation that was applied to O-D trip cells was determined by which of the three categories of travel-time savings applied. For express bus, the degree of travel-time savings directly affected the percentage of total journey-to-work person-trips that transit attracted from each trip cell in the O-D matrix.

TABLE 2 ASSUMPTIONS USED IN THE HOV AND TRANSIT ESTIMATION PROCESS

CATEGORY	ITEM	ASSUMPTION
GENERAL	Travel Growth	1980 to 2000: 45% increase in travel. 1980 to 2010: 62% increase in travel.
	Travel Distribution	1980 UTPP distribution used for 2000 and 2010 except for employment centers not existing in 1980.
	Operating Speeds	General freeway: 1983 peak period speeds. Transitway & Commuter Lanes: 55 mph on mainlines. Transitway Ramps: 20-45 mph, depending on geometrics.
	Travel Time Savings for Transitways and Commuter Lanes	Mainlines: Based on speed difference (1983 existing and 55 mph). Access/Egress Ramps: 1-5 minutes.
HOV	Base Person Trip File	All 1980 HOV person trips from UTPP with travel distances greater than 7 miles and travel paths containing transitways or commuter lanes.
	HOV Person Trips Assigned to Transitways and Commuter Lanes	65% - 95% of O-D pairs in trip file, depending on travel time savings (refer to Table 1).
	HOV Formation	Increase of 20% - 50% of assigned trips depending on travel time savings (refer to Table 1).
	Non-Work Trips	Increase of 20%
	HOV Occupancy	With 2+ Restriction: 2.50 persons/vehicle With 3+ Restriction: 3.50 persons/vehicle
	3+ HOV Growth	Increase of 30%-50% from 1980 UTPP (Note: Base person trip file reflected 25% of HOV person trips were in 3+ vehicles).
TRANSIT	Base Data File	Base Person Trip File (HOV), with O-D cells of greater than 150 person trips.
	Transmit Mode Split	3% - 15% depending on travel time savings, level of transit service, origin/destination zonal characteristics.
	Prior Mode	15% - 25% of new transit users were formerly carpoolers. Carpool person trips reduced accordingly.

VALIDATION OF HOV DEMAND ESTIMATION APPROACH

A validation check was performed on output from the HOV demand estimation approach using available ground counts of HOVs before and after commuter lanes were opened on Route 55 in Orange County. Table 4 contains a comparison of UTPP travel demand estimates for 1980 and 1985 with carpool volumes observed by Caltrans before and after the opening of the Route 55 commuter lane project (*3*). Two southbound cut lines (Walnut Street 90 days after opening and Santa Clara Street 6 months after opening) are compared after the carpool lanes opened with corresponding links from the demand analysis network.

Three aspects of the HOV demand estimation approach were validated against observed data on Route 55: the percentage of carpools shifting to the commuter lane versus that remaining on the freeway, commuter lane use in the a.m. peak period, and the growth in HOVs within the corridor resulting from the opening of the preferential facilities. In addition, the vehicle occupancy assumptions used in the HOV estimation approach were compared with observed occupancies for vehicles using the commuter lane, excluding violators.

As shown in Table 4, Caltrans observations indicate that approximately two-thirds of the 730 to 770 carpools observed on the Route 55 freeway before the opening of the commuter lane (62 percent at Walnut Street for 90 days after opening and 69 percent at Santa Clara Street for 6 months after opening) shifted from the freeway to the commuter lane. The remaining one-third of the observed preproject carpools, 290 at Walnut and 230 at Santa Clara, remained in mixed-flow traffic on the freeway lanes. These carpools either were in the process of weaving in or out of the commuter lane at the point of observation or were not using the commuter lane because of a short trip length.

The range of 62 to 69 percent of existing HOVs shifting to the commuter lane found in the field observations on

TABLE 3 SUMMARY OF 1980 DATA BASE

1980 SOCIO-ECONOMIC SUMMARY FOR ORANGE COUNTY[1]

Total Population	=	1,932,709
Total Households	=	687,059
Average Household Size	=	2.81
Workers at Residence	=	974,845
Workers/Household	=	1.42
Workers/Population	=	0.50
Workers at Place of work	=	889,546
SCAG-82 Growth Forecast	=	940,100

UTPP JOURNEY TO WORK TRAVEL CHARACTERISTICS[1]

Total Workers by Area of Origin = 899,457
Breakdowns by Mode:

Drive Alone	=	725,829	(80.69%)
2 Persons/vehicle	=	116,649	(12.97%)
3+ Persons/vehicle	=	38,157	(4.24%)
Total Carpool Persons Trips	=	154,806	(17.21%)
Transit	=	18,912	(2.10%)

Countywide Average Auto Occupancy = 1.130

MODAL SHARES OF TRIPS IN ORANGE COUNTY

Source	Type of Trip Surveyed	Year	Drive Alone %	Carpool Occupant %	Bus %	Other %
US Census Special Survey[2]	Work	1977	79	16	2	3
US Census Decenniel Census[2]	Work	1980	75	16	2	7
SATC Model[3]						
Estimate Home Based Work	1980		81.2	16.4	2.4	-
Other			47.0	52.0	1.0	-
1980 UTPP[1] Data File Work	1980		81.7	17.2	2.1	-

Sources: 1. 1980 U.S. Census - Urban Transportation Planning Package (UTPP) Data File.

2. Selected Characteristics of Travel to Work in 20 Metropolitan Areas: 1977, U.S. Bureau of the Census, U.S. Department of Commerce, January 1981.

3. Santa Ana Transportation Corridor Transit Element Alternatives Analysis (Stage II), Orange County Transit District, February 1984.

Route 55 is somewhat lower than the range of 70 to 75 percent carpool shift used in the HOV estimation approach for transitway network Links 79 and 81. However, this difference is attributable to the fact that short HOV trips of 7 mi or less are included in the observed data but were eliminated from the forecast data set.

In Table 4 observed Route 55 commuter-lane use for 90 days and for 6 months after the November 1985 opening is also compared with use derived through the HOV estimation approach for 1980 and 1985. Two-person-plus HOV volume observed southbound at Walnut Street 90 days after opening was approximately 1,100 vehicles in the a.m. peak hour, whereas HOV volume at Santa Clara Street was 1,178 six months after the opening of the Route 55 commuter lanes. This compared favorably with the projected 1985 HOV volume of 1,266 vehicles in the a.m. peak hour southbound on Link 79 and 1,114 vehicles on Link 81.

The use estimates for the 3-hr a.m. peak period derived through the HOV demand estimation approach also closely paralleled observed use on the commuter lane. The approach yielded 3-hr a.m. peak-period HOV person-trip totals for 1985 of 7,124 for Link 79 and 6,268 for Link 81 southbound. Caltrans observations indicated that approximately 6,150 persons used the southbound commuter lane 90 days after opening during the 3-hr a.m. peak.

The comparison of the derived with the observed percentage increases in a.m. peak-hour carpools for the Route 55 corridor after the opening of the commuter lane indicated that the output from the estimation approach may

TABLE 4 COMPARISON OF HOV TRAVEL DEMAND ESTIMATES WITH OBSERVED 2+ CARPOOL VOLUMES ON ROUTE 55

	CARPOOL VOLUMES OBSERVED BY CALTRANS		UTPP BASE/SOCIO-ECONOMIC GROWTH TRAVEL FORECASTING APPROACH			
	1984 THROUGH 1986		1980 BASE YEAR DATA		1985 ESTIMATE[5]	
	Southbound AM Peak:		Southbound AM Peak:		Southbound AM Peak:	
	Walnut St.	Santa Clara St.	LINK 79	LINK 81	LINK 79	LINK 81
o 1984/85 AM Peak Hour HOV Vehicle Trips Before Commuter Lanes Opened	Before Lanes Opened[1] 770	730	UTPP Input Data 879	734	967	807
	After Lanes Opened 90 days	6 months	After Trip Assignment			
Remained In Mixed Flow Lanes[2]	290 38%	230 31%	264 30%	184 25%	290 30%	202 25%
Switched to Commuter Lane	480 62%	500 69%	615 70%	550 75%	677 70%	605 75%
o Commuter Lane Statistics						
- Peak Hour Vehicles	1100	1178	1151	1013	1266	1114
- 3 Hour AM Peak Period						
o Vehicles	3000	3097	2878	2532	3166	2785
o Persons	6150	6250	6476	5698	7124	6268
o Occupancy[3]	2.05	2.02	2.25	2.25	2.25	2.25
o Total Peak Hour Carpools Southbound In SR 55 Corridor	1390	1408	1415	1197	1556	1316
o Percent Increase In Corridor Carpools After Opening						
- Southbound AM	81%	93%	61%	63%	61%	63%
- Northbound PM	60%	65%	65%	67%	65%	67%
- Composite[4]	70%	78%	63%	65%	63%	65%

[1]Average of three observation days 4/84, 11/84, 10/85.
[2]Derived from observations by Caltrans 90 days and 6 months after the commuter lane opened. Occupancy for freeway lanes between 1.07 to 1.09 persons per vehicle.
[3]Observed average at Meats and Santa Clara Streets southbound on the SR 55 Commuter Lanes.
[4]Average of northbound PM peak and southbound AM peak.
[5]Assumes 10 percent growth in SR 55 corridor between 1980 and 1985.

Source: Route 55 Commuter Lane Demonstration Project 90 Day Evaluation Report, and Six Month Status Report, Caltrans, February 1986 and June 1986

be understating actual growth. The 70 percent composite growth in Route 55 corridor carpools observed 90 days after opening has already surpassed the 63 to 65 percent composite southbound a.m. and northbound p.m. growth produced from the HOV estimation approach. The number of a.m. peak-hour carpools observed 6 months after the opening of the commuter lane had grown to 78 percent higher than preproject levels.

Some caution must be used in validating the HOV estimation approach with the Route 55 commuter lane project. The phenomenal growth in carpools over such a short period of time in the Route 55 corridor is believed to have been caused by many conditions, some of which may not exist in other freeway corridors in Orange County. First, some of the growth may merely be due to the switching of facilities by existing carpools. Route 57 is a heavily congested parallel freeway with no commuter lanes, so it is likely that some of its HOV trips changed to the Route 55 commuter lane after it became operational.

Second, Route 55 serves many long-distance intercounty commute trips that may be more likely to lead to formation of carpools than the somewhat shorter internal Orange County trips. Finally, Caltrans considers Route 55 an undersized freeway facility that has prolonged periods of congestion in both the morning and the evening. This may also stimulate rapid growth in carpool formation because commuters have no other way to avoid congestion, such as shifting their commute trip to an earlier or later time to avoid the heaviest traffic.

DEMAND ESTIMATES AND ANALYSIS RESULTS

Under eligibility rules that allow two-person-plus HOVs, the transitway is projected to carry 55,445 to 68,185 peak-period person-trips in 2010. If the transitway were restricted to three-person-plus HOVs, it would carry 21,160 to 30,695 peak-period person-trips in 2010. On the basis of these projections and the two-person versus three-person-plus modal splits contained in the 1980 UTPP data file, over one-half of the HOV person-trips and nearly two-thirds of the HOV vehicle trips would be removed from the transitway if facility eligibility were increased from two-plus to three-plus persons in vehicles.

In Table 5 the projected 2010 combined three-person-plus HOV and transit volumes for Orange County transitways are compared with existing use from projects nationwide. Included in Table 5 are estimates of both vehicle

TABLE 5 PROJECTED 2010 ORANGE COUNTY TRANSITWAY VOLUMES COMPARED WITH VOLUMES ON EXISTING EXCLUSIVE FACILITIES

LOCATION	A.M. PEAK HOUR, PEAK DIRECTION VOLUME PER LANE	
	VEHICLES	PERSONS
Year 2010 Orange County (3+ carpool)		
Rte. 57 at Katella	950	4,950
I-5 at 17th Street	1,500	6,300
I-5 at 1st Street	1,600	7,000
Rte. 55 at Grand	1,450	6,500
Existing Projects		
El Monte; Los Angeles (3+)	1,100	6,500
Shirley; Washington D.C. (4+)	1,100	7,200
I-66; Washington, D.C. (3+)	1,500	6,000
Lincoln Tunnel; New York City (buses)	680	27,000
North; Houston (6+)	260	4,500
Rte. 55; Orange County (2+)	1,250	2,800
I-95; Miami (2+)	1,300	2,600
RANGE	260-1,500	2,600-27,000

and person-trips for the a.m. peak hour in the peak direction per lane. Estimated Orange County person-trip demand for 2010 is similar in magnitude to the existing use on the El Monte Busway in Los Angeles and the Shirley Highway in Washington, D.C. However, projected Orange County vehicle volumes are much higher—1,600 per hour versus 1,100 per hour for both of these existing facilities—indicating a higher proportion of carpools over buses. The express bus service on the Orange County transitways is projected to carry 11,100 peak-period trips in 2010 as compared with between 22,000 and 30,700 persons in carpools.

EVALUATION OF HOV DEMAND ESTIMATION APPROACH AND CONCLUSIONS

The HOV demand estimation approach developed by OCTD for use in transitway concept design is a highly specialized application that was developed solely for the purpose of providing necessary output on the use of exclusive HOV facilities to assist in facility design decisions. Certainly this narrowly focused approach has many limitations if looked at from a broader travel-forecasting perspective. However, the advantages inherent in this approach have made it an extremely useful tool for forecasting HOV demand in Orange County and deserve some further consideration as OCTD's travel demand capabilities are upgraded in the near future.

Evaluation of Estimation Approach

Advantages

The strengths of the HOV demand estimation approach and its application in Orange County can be analyzed under four separate categories: analysis capabilities, usefulness of output, cost and start-up requirements, and operational performance.

Analysis Capabilities The analysis capabilities that the HOV estimation approach provides for the user are quite significant, primarily because of the flexibility inherent in the process. The user has the ability to fully track progress through the chain of steps and observe the effects of changing input variables and assumptions. The UTPS model chain is very costly and time consuming to use, and it is often impossible to conduct analyses at intermediate steps in the model process. Furthermore, trips cannot be tracked through the UTPS model chain and thus the impacts of various model assumptions cannot be assessed.

Operational Performance The operational performance of the HOV estimation approach is excellent from the standpoint of being able to add, modify, and delete assumptions as the need dictates. The ease in modifying input is very important in Southern California because new information on HOV use characteristics is being made available from the data-gathering and field survey efforts being conducted by OCTD and Caltrans, among others. New regional data on activity-center-based and corridorwide HOV use and before-and-after statistics from exclusive HOV facility projects provide needed base information for model validation and adjustments to input assumptions.

The great flexibility inherent in the HOV demand estimation approach is due primarily to the division of the process into several distinct steps that can be easily isolated and worked with independently. The individual assumptions and variables of each separate step can be readily modified and reapplied to the process because of the record-keeping and tracking functions. Virtually the entire process is performed on data bases that are retained in an O-D format on a spreadsheet program. Therefore, it is

relatively easy to operate by in-house staff who have a rudimentary understanding of microcomputer spreadsheet programs.

Usefulness of Output The usefulness of the output produced from the HOV estimation approach can be measured in terms of its level of detail and convertibility. The ease of operation and tracking abilities inherent in the process allow users to adapt the approach to several levels of spatial analysis. Because the primary input travel data base was the 1980 U.S. census journey-to-work trip table, base-year information was available at the census-tract level. This level of detail allows users to perform site analyses of corridor demand in specific destination areas to determine whether individual access features are required from transitways to arterials in activity centers.

Another strength of the output from this approach was the relationship of travel data to activity-center growth. The iterative trip build-up procedure that was used to produce the future-year person-trip table had a trip-balancing function that targeted growth in trips to specific adopted employment and population growth forecasts. This ensured that the rapidly growing activity centers of Orange County would not have deficiencies in home-based-work trip attractions, which has been the case with some output from past UTPS modeling applications in Orange County.

Cost and Start-Up Requirements The HOV demand estimation approach affords some real advantages in terms of cost and start-up requirements. OCTD was able to use existing hardware and software with some fundamental training of staff. The estimation can be performed on an IBM XT with BASIC and spreadsheet programs. In addition to low capital cost, operating costs are relatively minor, except for certain data-base manipulations that require staff time.

Required start-up time is not major in comparison with the months that are required to calibrate and operate a full application of the UTPS model. Because the HOV estimation approach is a specialized and relatively straightforward application, staff was not burdened with all the complexities of UTPS model calibration, testing, and verification.

Limitations

The HOV demand estimation approach used by OCTD in transitway concept design is a highly specialized demand application that does not provide the ability to deal with broader travel-forecasting issues, particularly for nonwork trip purposes and non-HOV travel modes. In this approach, the user is not able to conduct a complete analysis of intermodal travel relationships because no comparable output of freeway demand is produced. In general, the following limitations should be noted by potential users of this estimation approach:

- The approach is tied to the 1980 U.S. census journey-to-work travel data base. OCTD had to make gross assumptions about nonwork HOV trip purposes in conducting its analysis. Although work trips compose the major trip purpose within the a.m. peak period, other trip purposes have a major impact on facilities in the vicinity of existing and emerging multipurpose activity centers in Orange County.
- The approach to analyzing modal shift may be criticized as overly simplistic because the analysis focuses solely on travel-time savings. Although travel-time savings has been identified through field research as the major influence on commuter travel behavior in Orange County, it is by no means the only variable that affects trip making. Travel costs, income levels, system reliability, and safety considerations are all important influences on travel behavior and modal shift.
- There is no ability to perform a full analysis of corridorwide travel relationships because output is limited to HOV and transit use on exclusive facilities. The approach is not directly tied to any full-scale travel-forecasting effort that has a highway network and an assignment of trips to a system of freeways and surface arterials.
- The approach does not specifically include a trip distribution phase but merely uses trip making that is inherent in the base-year conditions. An analysis of trip making would normally be an integral function of a travel-forecasting process, and future applications of this approach would need upgrading in this respect.

Deficiencies of Current HOV Models

A major deficiency in HOV behavioral data nationwide is the change in HOV vehicle occupancy related to changes in occupancy restrictions on exclusive facilities. The growth in three-person-plus HOV travel over time due to changing facility restrictions is a major issue in forecasting HOV use.

Three-person-plus HOV trips were underestimated in OCTD's forecasting approach for 2010 because the base-year 1980 UTPP ratio of one three-person-plus HOV trip to five total HOV trips was used instead of a lower ratio, which would result from restriction of exclusive facilities to three-person-plus HOVs coupled with aggressive destination-end marketing of ridesharing. Certainly, a major increase in three-person-plus HOVs would occur in Orange County, given the significant travel-time savings that eligible users of exclusive facilities would achieve on their commute trips to work. The rate of increase due to travel-time savings will become known to forecasters as more empirical HOV data become available.

The rate of increase in overall carpool formation because of marketing is an unknown that is not receiving adequate

attention in forecasting. In Orange County, intensive marketing programs are now under way to promote ridesharing in the major activity centers in the county, with the assistance of employers. The comprehensive ridesharing marketing program, which includes on-site amenities such as preferential parking and other services, should have a strong influence on carpool formation in the future. Although it may be difficult in travel forecasting to account for increases in ridesharing that are due to marketing, these efforts are occurring in Orange County and will influence the use of exclusive facilities. Future HOV travel-forecasting applications must address the influences of aggressive marketing on carpool formation where it exists or suffer the consequences of underestimating HOV use.

Follow-On Activities and Conclusions

The HOV demand estimation approach provided the necessary output for early transitway concept design but is too limited in scope and sophistication for continued use in upcoming OCTD planning activities, especially for a federally sponsored transitway alternatives analysis. Realizing this, OCTD has begun to explore ways to upgrade its current HOV estimation approach and expand its overall in-house travel-forecasting capabilities.

In the fall of 1986, OCTD began a study in an effort to more fully evaluate its future travel-forecasting needs. The major products of this study will include recommended strategic approaches for OCTD to follow in travel forecasting as well as specifications of travel-forecasting hardware and software.

Some of the upcoming travel-forecasting-related projects for which OCTD would need increased demand analysis capabilities are as follows:

- A transitway alternatives analysis will require an areawide travel-forecasting effort. The focus of this project is to estimate the potential bus and HOV use on the proposed transitway segments. Therefore, the objective of the travel-forecasting effort will be to project transit and HOV formation caused by the higher-level transportation service provided and the subsequent travel-time savings to be realized.
- A sensitivity analysis to evaluate how land use and socioeconomic change would affect transportation facility use would also require demand analysis capabilities. OCTD performs sensitivity analyses of travel demand on an as-needed basis in conjunction with other agencies and cities in Orange County.
- A transit route service program would use demand analysis to project how transit service changes would affect the ridership, operating costs, and revenues.
- Corridor and subarea analyses would focus on more detailed evaluations of the traffic movements, transit levels of service, and modal characteristics and compare travel distance with travel time.

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