Equilibrium Traffic Assignment with High-Occupancy Vehicle Lanes

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Traffic forecasts were prepared by the Chicago Area Transportation Study (CATS) for a proposed high-occupancy vehicle (HOV) lane in northeastern Illinois as part of a Stevenson Expressway HOV lane feasibility study. The traffic assignment procedure developed for this project is outlined. Problems encountered in adapting traffic assignment to highway networks with HOV lanes are first presented. Then, network equilibrium concepts are used to illustrate driver behavior when an HOV lane is available. It is concluded that an equilibrium traffic assignment procedure may be applied to HOV lane traffic assignment. Remaining sections of the paper deal with particular issues in applying the HOV lane traffic assignment in the Stevenson Expressway project. Coding of different HOV lane alternatives in CATS traffic assignment network is discussed and network coding for a concurrent HOV lane illustrated. Trip tables are adjusted for altered mode and vehicle occupancy choices caused by the time savings between the HOV lane and general purpose expressway lanes. The HOV lane traffic assignments were accomplished with software from the Urban Transportation Planning System. The resulting HOV lane traffic assignment procedure is only slightly more complex than normal equilibrium traffic assignment. Results from one of the project's HOV lane traffic assignments are reported in the final section.

A review of potential high-occupancy vehicle (HOV) lane locations in northeastern Illinois was completed in 1990 as part of the region's Operation GreenLight congestion relief program (*1*). Three expressway corridors were identified as the most promising locations for an HOV lane. Two radial corridors, the Kennedy (I-90/94) and Stevenson (I-55) expressways, and a suburban circumferential corridor (I-290 and I-355 tollway) were selected (*2*). The map of the region's expressway network in Figure 1 shows the locations of these corridors.

The three corridors were screened using general criteria to evaluate the feasibility of an HOV lane. Evaluation criteria included the following: (a) existing traffic congestion and average speed; (b) potential HOV lane travel time savings; (c) HOV traffic based on current two-person carpools; (d) feasibility of expanding or reducing existing roadway capacity; and (e) impact on parallel transit services.

After this preliminary evaluation, the Stevenson Expressway (I-55) corridor was selected for additional study. This is the southwest radial expressway corridor shown in Figure 1. A consultant was then contracted by the Illinois Department of Transportation in mid-1992 to perform a feasibility and preliminary design study of an HOV lane in the Stevenson Expressway corridor. A draft report was completed in early 1993 (*3*).

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The Chicago Area Transportation Study (CATS) provided the consultant with forecasts of HOV traffic. The traffic assignment procedure developed at CATS for these HOV traffic estimates is described here. With the exception of one program written at CATS, the HOV lane traffic assignment procedure is applied with existing models and Urban Transportation Planning System (UTPS) model software (*4*). Although not formally proven in this paper, the HOV lane traffic assignment appears consistent with equilibrium traffic assignment.

HOV LANE TRAFFIC ASSIGNMENT ISSUES

A number of complex issues are associated with traffic assignment on HOV lanes. An HOV lane traffic assignment requires at least two vehicle trip tables, one for single-occupant vehicles (SOVs) and trucks and one for carpool vehicles and other HOVs. Additional HOV trip tables for different sized carpools may be needed to determine the most desirable vehicle occupancy requirements for the HOV lane.

The coded highway network on which these trip tables are assigned includes conventional roadways that may be traveled by all vehicles and HOV links that may be used only by carpools. Characteristics of different HOV lane designs must be specified and accurately coded in the network.

An HOV lane traffic assignment requires separate minimum time paths for the SOV and HOV trip tables. Link travel times for non-HOV facilities depend on all vehicles assigned from both SOV and HOV trip tables, whereas HOV link travel times only reflect HOVs. Although it is possible to carry out separate assignments and then combine them, the order of the assignments affects the link volumes. Should the SOV trip table be loaded first and the resulting link times be used to assign the HOV trip table, or vice versa?

Assignment procedures that approximate the behavior of drivers when HOV facilities are present conflict with state-of-the-art multiple path equilibrium traffic assignment. This traffic assignment algorithm converges to the theoretical equilibrium conditions between link travel times and drivers' route choices, and it is now available in most model software packages. These equilibrium conditions are the following. First, all paths traveled between the same origin-destination zone pair have similar travel times. Second, no driver may reduce travel time by transferring to another route (*5*).

The concept of network equilibrium is especially relevant to HOV lane traffic assignment because HOV lanes usually parallel general purpose expressway lanes. Small differences in travel times between the HOV lane and general purpose lanes can determine the link that appears in most zone-to-

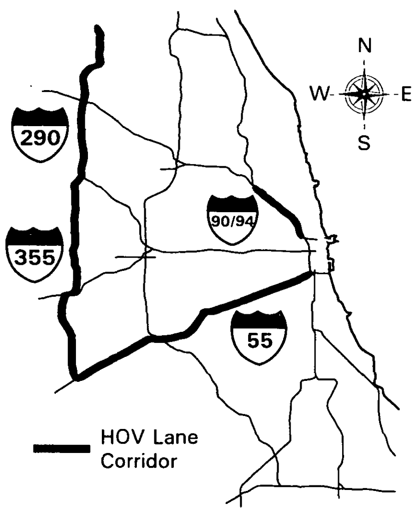

FIGURE 1 Potential northeastern Illinois HOV lane corridors.

zone minimum time paths. Traffic assigned to the HOV lane and general purpose lanes may vary substantially from one traffic assignment to another if the sequence followed to assign trips and calculate link times favors either the HOV or general purpose lanes.

Accurate HOV lane traffic assignments are particularly important for the design of an HOV lane because of the interdependence between an HOV lane's characteristics and its traffic. Some concurrent HOV lanes permit access at many locations. However, HOV lanes separated from general purpose lanes sometimes restrict access to a few interchanges, which effectively eliminates some traffic movements from the HOV lane. Design of an HOV lane is further complicated by the vehicle occupancy permitted to use the facility. The best design for an HOV lane for carpools of two or more people may be quite different from the preferred design for an HOV lane restricted to carpools of three or more people.

Estimated travel times on an HOV lane are as critical as accurate traffic forecasts. If the HOV lane offers a major time savings over general purpose expressway lanes, then shifts in mode choice and vehicle occupancy must be considered. An HOV lane will also reduce travel times for single-occupant vehicles because vehicles are removed from general purpose lanes. This means that the HOV lane may cause transit riders to shift to both SOVs and HOVs.

NETWORK EQUILIBRIUM WITH HOV LANES

Equilibrium traffic assignment with an HOV lane in the network is illustrated by the following example. Figure 2 shows the simplest possible network when only two paths are possible between an origin and destination. One path includes only conventional roadways, whereas the second path travels through an HOV lane at some point. All drivers may use the first path, but only drivers of HOVs may travel the second path. It is assumed that all HOVs will use the HOV path if it offers a time savings.

Trips between the two locations include a fixed number of carpools. The remaining trips are single occupant vehicles and trucks that may not use the HOV facility. The three diagrams in Figure 3 show the possible equilibrium assignments of SOV and HOV traffic onto the two paths, depending on the relative path travel times and traffic volumes for SOV and HOV traffic.

Each diagram shows two relationships between path travel time and the traffic on the conventional roadway and HOV lane paths. The HOV lane path travel time–traffic relationship points to the right and travel time via the HOV lane path is read on the left y-axis. The travel time–traffic relationship for the conventional roadway path points to the left. Travel time via the conventional roadway path is read from the right y-axis.

The full width of the x-axis represents all vehicles traveling between the origin and destination. However, the x-axis is divided into two parts for SOV and HOV traffic. HOVs are shown on the left side of the x-axis and SOVs on the right side. Any point on the x-axis, therefore, indicates the split between HOVs and SOVs in the trip interchange.

Figure 3(*a*) shows the unlikely situation of the HOV traffic on the HOV lane being equal to the equilibrium traffic volumes. The split between HOVs and other vehicles is such that traffic on the HOV lane and conventional roadway paths produce identical travel times. This is the equilibrium condition that would normally be reached if both paths were unrestricted conventional roadways.

Now suppose there are fewer HOVs than the equilibrium volume. This situation is depicted in Figure 3(*b*). Equilibrium

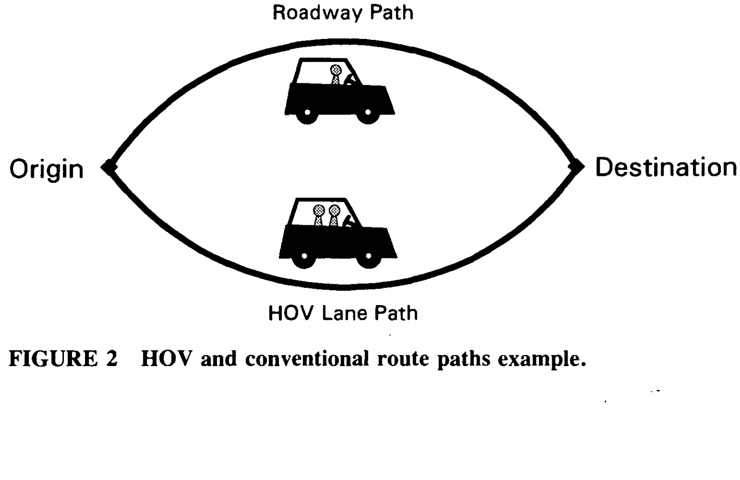

FIGURE 2 HOV and conventional route paths example.

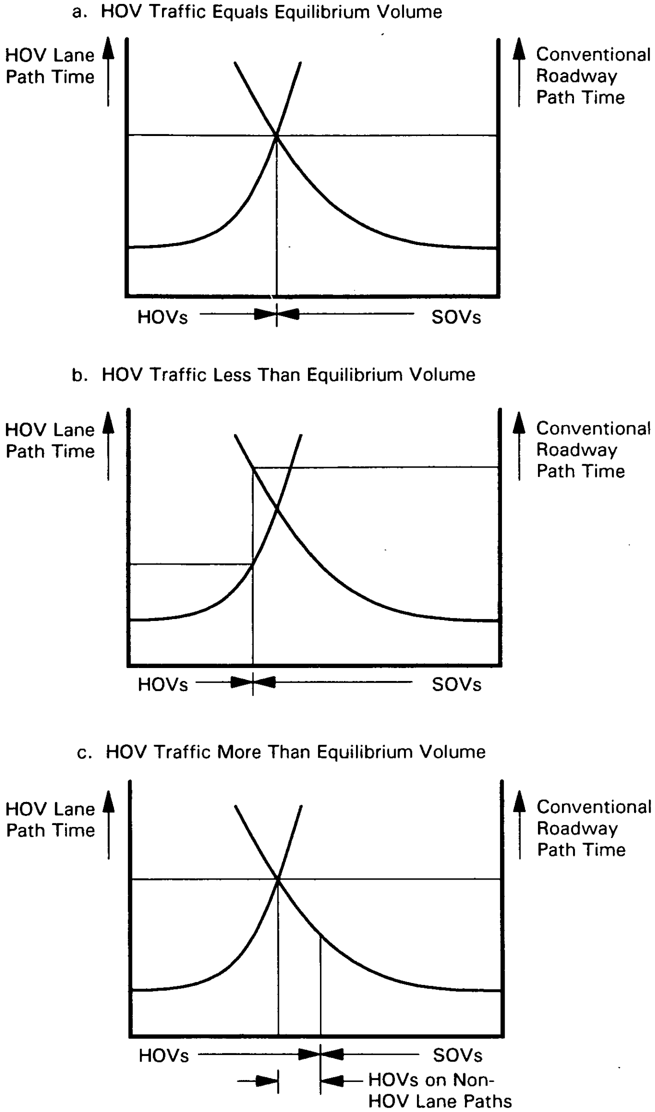

FIGURE 3 Possible equilibrium assignments of SOV and HOV traffic.

traffic conditions cannot be reached because of the restrictions barring SOVs from the HOV lane. Trucks and single occupant vehicles may not freely transfer from the slower conventional roadway path to the faster HOV lane path. Travel time via the HOV lane path remains less than via the conventional roadway path. In practice, this is the desired situation so that the HOV lane provides a higher level of service.

The third case shown in Figure 3(*c*) is the most complex of the three diagrams. There are more HOVs than the equilibrium volume. HOVs spill over into the conventional roadway path since they may transfer between the two paths. Drivers of HOVs make path choices to bring about equilibrium traffic conditions, and travel times via the HOV lane and conventional roadway paths become equal.

The algorithm for equilibrium traffic assignment determines those traffic volumes that minimize the sum of the areas under the travel time–traffic relationship between zero and the assigned traffic for all links. As discussed previously, this would normally produce equal travel times among all paths between the same origin and destination. This algorithm is still valid for traffic assignment if the network contains an HOV lane. Minimizing the sum of the areas under the link travel time–traffic relationships will produce one of the latter two solutions shown in Figure 3, depending on the availability of HOVs. In contrast to usual equilibrium assignment, travel times via HOV lane and conventional roadway paths may differ because too few HOVs are present to reach equilibrium traffic conditions.

THE STEVENSON EXPRESSWAY FEASIBILITY STUDY

The Stevenson Expressway (I-55) HOV lane project featured considerable interaction between the project consultant and CATS. The consultant specified an alternative HOV lane and CATS then coded the design features of the HOV lane into the agency's traffic assignment network. Morning and evening peak-hour traffic assignments were completed by CATS and the results transmitted to the consultant for their evaluation. The traffic assignment for one HOV lane alternative would then be used in developing the next HOV lane alternative to be tested. The recommended HOV lane evolved through four HOV lane alternatives during the course of the project.

Coding of the HOV Lane in the Traffic Assignment Network

Figure 4 depicts network coding for an eastbound concurrent HOV lane alternative next to the Stevenson Expressway general purpose lanes in the CATS regional traffic assignment network. This network covers the six county northeastern Illinois region and includes more than 30,000 one-way links. Movements between general purpose lanes and the HOV lane are permitted at the weaving locations shown in Figure 4. The HOV lane is separated from the general purpose lanes elsewhere.

A separate set of HOV links are coded parallel to the links for the existing Stevenson Expressway general purpose lanes. Connecting links are included where it is possible to move

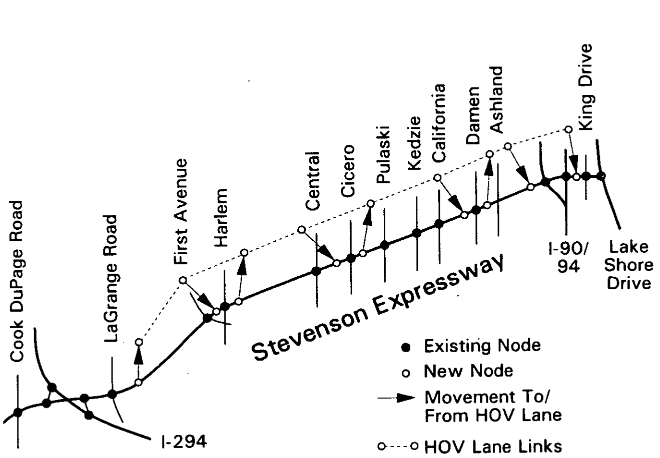

FIGURE 4 Coding of concurrent HOV lane.

between the HOV lane and the general purpose lanes. They are coded without travel time because these connecting links represent only a merge into an adjacent lane.

This network coding is done with the UTPS program HNET. The network is maintained in the UTPS N and Z-file formats. In these formats, each link attribute is tabulated in a vector containing an entry for every link in the network. The HNET-UROAD programs allow multiple HOV lane alternatives and the base network to be combined in one network. HOV lane and HOV–general purpose lane connecting links are coded with a link use code that allows them to be included or excluded from the network during assignment in program UROAD.

Figure 5 shows the network coding at an interchange in more detail. It shows an existing interchange between an arterial street and the eastbound lanes of the Stevenson Expressway. The concurrent HOV lane is coded adjacent to the general purpose Stevenson lanes. The connecting links are represented as links 1-2 and 6-7.

Major weaving movements occur on links 2-3 and 5-6 on the general purpose Stevenson lanes. These links are important in the minimum time paths because considerable travel time may be required to move from the HOV lane across the general purpose lanes to the exit ramp, as well as for the reverse movement from the entrance ramp to the HOV lane. In the Figure 5 diagram, an exit from the HOV lane to the cross-street would be represented as a movement through links 1-2, 2-3, and 3-4, a connecting link, weaving link, and ramp link. A movement from the cross-street to the HOV lane would follow the link 4-5, 5-6, and 6-7 path.

HOV Lane Traffic Assignment Algorithm

The equilibrium assignment procedure available in the UTPS program UROAD was adapted to perform an equilibrium assignment with an HOV lane coded in the network. The HOV lane assignment is not performed within UROAD, but relies on UROAD for path building and assignment.

A short program written at CATS replaces the part of UROAD that merges assignments from separate iterations of the equilibrium assignment algorithm. This program was required because UROAD does not allow different networks to be simultaneously assigned. Development of a separate program appeared to be a better option than changing UROAD because the program is extremely complex and is difficult to reliably alter.

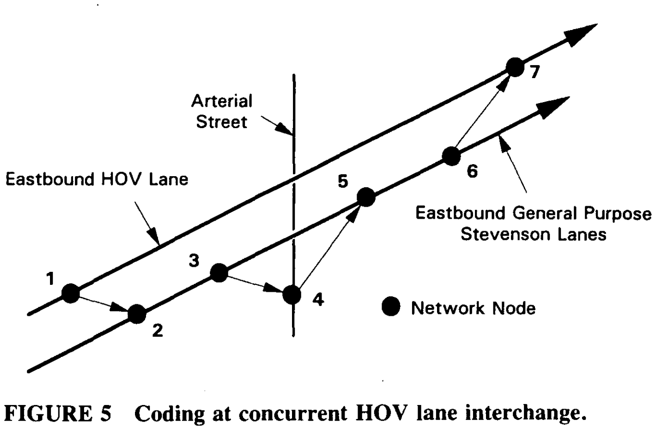

FIGURE 5 Coding at concurrent HOV lane interchange.

The following is a summary of the HOV lane equilibrium assignment algorithm and its implementation with UTPS software:

1. An initial feasible traffic assignment on the network with the HOV lane is completed. This starting point assignment includes link volumes from an assignment of SOV trips plus the link volumes from an assignment of HOV trips (carpools of two or more people or three or more people).
   a. HOV lane links are coded into a base network using HNET. HOV lane links have a use code of 2; all other links have a use code of 1.
   b. The SOV trip table is assigned to all network links with a use code of 1 with the program UROAD. This initial SOV assignment may be an all-or-nothing, incremental, or equilibrium assignment because it is just the starting point for the algorithm.
   c. The HOV trip table is assigned to all links in the network (use codes 1 and 2) using UROAD. This first HOV assignment also may be an all-or-nothing, incremental, or equilibrium assignment. Initial link travel times may either be uncongested link times or the times after the initial assignment of SOVs.
2. Travel times in the network are updated based on the combined SOV and HOV link volumes. Program UMATRIX adds the volumes from the two assignments into total link volumes, then computes new link travel times with the totaled SOV and HOV link volumes.
3. An all-or-nothing SOV and HOV combined assignment is completed. This requires two separate UROAD runs.
   a. The SOV trip table is assigned to its network (links with use code 1) using the updated travel times from Step 2 in an all-or-nothing assignment.
   b. The HOV trip table is assigned to its network (links with use codes 1 and 2) also with the updated travel times from Step 2 in an all-or-nothing assignment.
   c. Link volumes from the HOV and SOV all-or-nothing assignments are added together to obtain total HOV and SOV link volumes using the program UMATRIX.
4. The initial assignment HOV and SOV link volumes from Step 1 are merged with the total HOV and SOV all-or-nothing link volumes from Step 3. A CATS program that is compatible with UTPS computes the optimal linear combination of the initial and all-or-nothing assignments to form the merged assignment. The fractions (usually noted as λ and $1-\lambda$) of the two assignments in the merged assignment minimize the summed areas under the conventional roadway and HOV lane link travel time-traffic relationships.
   a. The λ value is determined by the search procedure in the CATS program.
   b. Program UMATRIX writes out new link volumes computed by

$$(1 - \lambda) * \text{initial HOV and SOV volumes}$$
$$+ \lambda * \text{all-or-nothing HOV and SOV volumes} \quad (1)$$

5. The link travel times are recalculated with the link volumes from Step 4 by UMATRIX.

6. The algorithm returns to Step 3. The link travel times from Step 5 are used for the next SOV and HOV all-or-nothing assignments. The current solution link volumes determined in Step 4 replace the initial assignment in the algorithm. Additional iterations of the algorithm continue until link volumes are approximately equal from one iteration to the next.

Mode Choice and Vehicle Occupancy Adjustments

Only route choice is dealt with by the HOV lane traffic assignment. However, mode choices and vehicle occupancies will also adjust if the time savings from traveling the HOV lane are substantial. Other modeling steps are needed to introduce mode and vehicle occupancy choices into the HOV lane traffic forecasts. The entire model process used to forecast traffic on the Stevenson HOV lane alternatives is summarized in Figure 6.

Trip tables are developed from several sources. Daily work trip tables are assembled from the 1980 census (the 1990 file is not yet available) journey to work data (*6*), which contains detailed work trip mode choice and vehicle occupancy data. The census work trips are expanded to 1990 using regional employment and households. Base 1990 trip tables from CATS long-range planning supply the daily nonwork automobile, transit person, truck, and external vehicle trip tables for the project. Nonwork trips are further factored by automobile occupancy.

These trip tables were also adjusted for a new rail transit service that will shortly begin operation in the eastern part of the Stevenson corridor. Transit mode shares from the alternatives analysis for this new line were used to factor selected trip interchanges. The net effect is to reduce automobile trips in zones served by the new line.

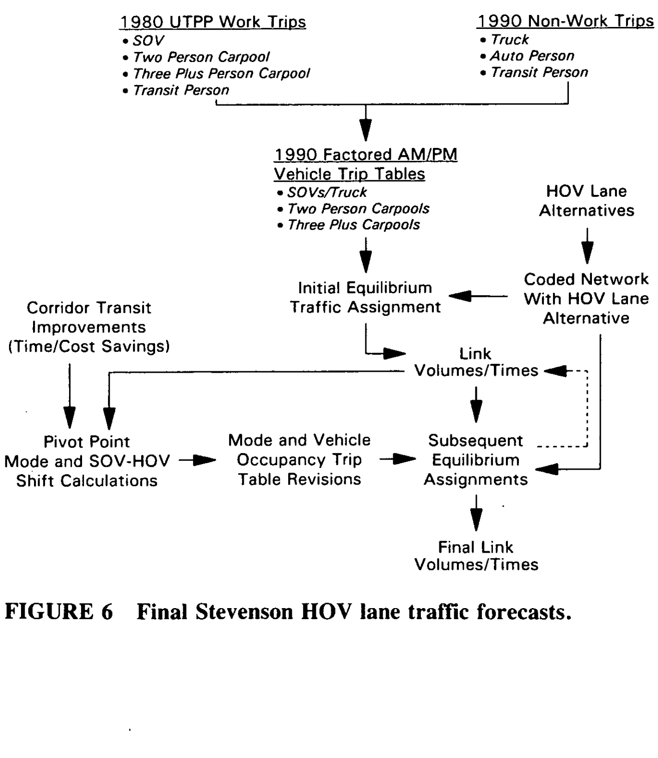

FIGURE 6 Final Stevenson HOV lane traffic forecasts.

As a final step, the daily trip tables are factored to morning (7:00 to 8:00 a.m.) and evening (4:00 to 5:00 p.m.) peak hours. The resulting peak-hour trip tables strongly reflect the work trips reported in the census.

After this processing, three a.m. and p.m. trip tables are available for assignment: SOVs and truck; two-person carpools; and carpools of three or more people. The two-person carpool trip table is included in the SOV or HOV trip table assigned, depending on the carpool occupancy requirements of the HOV lane.

An HOV lane alternative is coded into the network, and the initial trip tables are assigned. This first assignment provides link travel time estimates. The time savings between the HOV lane paths and non-HOV lane paths, as well as any overall reduction in highway travel times caused by the added capacity of the HOV lane, may be estimated from these travel times.

Transit-Automobile Mode Choice Adjustments

The bottom portion of the model process shown in Figure 6 assumes that the HOV time savings are large enough to significantly alter mode and vehicle occupancy choices. To adjust mode choices, automobile and transit trip tables are revised through pivot-point calculations. The pivot-point method approximates the change in mode share that would be estimated by a logit mode choice model given some change in the time and cost characteristics of a mode. The general pivot-point calculation for this trip table adjustment is as follows:

$$\Delta \text{ mode share} = \text{mode share} * (1 - \text{mode share}) * \text{time savings} * \text{model time coefficient} \quad (2)$$

Equation 2 is first used to estimate the transit ridership diverted to HOVs given the change in HOV travel time due to the HOV lane. All trips shifted from transit to automobile are calculated using base automobile and transit mode shares, time savings via HOV lane paths, and the in-vehicle time coefficients from the CATS logit automobile-transit primary mode choice model (*7*). Because only carpool trips can benefit from the HOV lane time savings, the total transit trips diverted must then be factored downward by the ratio of carpool person trips to all automobile person trips.

A similar calculation estimates the change in SOV mode share as a result of the improved operating conditions for SOVs after the HOV lane is opened. Trips shifted from transit to automobile are again calculated, but with the before and after HOV lane travel time savings for SOVs. Because transit ridership shifted to HOVs is already determined, the total transit trips diverted are factored by the ratio of SOV person trips to all automobile person trips.

The CATS mode choice model in-vehicle time coefficients are presented in Table 1. Transit improvements in the corridor may also be introduced into the Figure 6 modeling process through transit cost and time savings and additional automobile-transit pivot-point calculations. All trip table adjustments are carried out with the UTPS program UMATRIX.

TABLE 1 CATS Mode Choice Model In-Vehicle Time Coefficients (minutes)

Category of Trip	Model Coefficient
Work Trip to Central Business District	0.0159
Work Trip to non-Central Business District	0.0186

Vehicle Occupancy Adjustments

To use the pivot-point approach for vehicle occupancies, mode choices are replaced with vehicle occupancy choices. These choices correspond to the project drive alone, two-person carpool, and three-or-more-person carpool trip tables. The vehicle occupancy model structure and coefficients for in-vehicle time savings that affect the choice of vehicle occupancy are from the model developed by COMSIS Corporation for the Maryland National Capital Parks and Planning Commission (MNCPPC) (*8*).

The portion of the MNCPPC model that is used in the project features two nested choices for the level of ride sharing and drive versus shared ride. A logit shared ride model determines the proportions of two-person, three-person, and four-or-more-person carpools. A higher level logit model is linked to the shared ride model and allocates automobile users to drive alone and shared ride options. Coefficients from the MNCPPC model used in the vehicle occupancy pivot-point calculations are presented in Table 2.

The pivot-point calculations depend on the carpool occupancy permitted on the HOV lane. If two or more person carpools are permitted on the HOV lane, then a single pivot-point calculation is used to predict the shift from drive alone to carpooling. Two pivot-point calculations are needed if the minimum HOV lane automobile occupancy is raised to three or more persons. In this case, one pivot-point calculation estimates automobile drivers shifted to carpools of three or more people, and a second pivot-point predicts the two-person carpools that are shifted to three-person carpools.

After completing the pivot-point calculations, the trip tables are revised for additional traffic assignments. In Figure 6, the dashed line shows potential iterations through the pivot-point and traffic assignment steps. The intent is that the trip tables and travel times resulting from the traffic assignment should be brought into near equilibrium. This iterative procedure is far from robust, but the trips shifted from transit and to higher vehicle occupancies will generally not be large enough to greatly affect zone-to-zone travel times because route choices are also adjusting during each iteration.

TABLE 2 MNCPPC Mode Choice Model In-Vehicle Time Coefficients (minutes)

Category of Trip and Auto Occupancy	Model Coefficient
Work Trip Shared Ride Choice (2 Person, 3 Person, 4 or More Person Carpool)	0.1380
Work Trip Drive Alone-Shared Ride Choice (Drive Alone, Carpool)	0.0740

SAMPLE HOV LANE ASSIGNMENT RESULTS

Some results from an HOV lane assignment are presented in this section. The HOV lane alternative is similar to the one shown previously, except that it has a separated HOV lane configuration with direct ramps onto the HOV lane. A single HOV lane is provided in each direction.

Eight iterations of the HOV lane assignment algorithm were completed. The SOV trip table is loaded onto a maximum of nine different paths between each origin-destination zone pair—the paths from the initial feasible carpool assignment plus eight paths built for all-or-nothing assignments during the assignment algorithm.

The λ values determined for the eight iterations of the algorithm are presented in Table 3. The adjacent column shows the contribution of each assignment to the final link volumes. These shares are computed by multiplying each assignment's initial fraction times $(1 - \lambda)$ for subsequent iterations. All λ values are fairly small, which implies the initial assignment was reasonably close to equilibrium conditions. Slightly more than 69 percent of each link's final traffic volume comes from the initial feasible assignment.

Travel times and assigned traffic volume are compared with capacity ratios via the Stevenson general purpose lanes and the parallel HOV lane in Table 4. These quantities are measured over the eastern two-thirds of the HOV facility, from Harlem Avenue to the Dan Ryan Expressway, a distance of 15.0 km (9.3 mi). Uncongested or free-flow travel times are the same, 89 km/hr (55 mph), for the HOV lane and Stevenson general purpose lanes.

Travel times via the HOV lane and general purpose lanes are reasonably stable after eight iterations. The HOV lane is 4.4 min faster over this section than the general purpose lanes on the basis of the travel times calculated from the link volumes after the algorithm's eighth iteration. This is equivalent to a speed differential of 10.1 km/hr (6.3 mph) between the HOV lane and general purpose lanes. There are not enough carpool trips to reach equilibrium volumes and travel times, which corresponds to the desirable situation depicted in Figure 3(*b*).

The average volume to capacity ratios on the HOV lane and Stevenson Expressway general purpose lanes between Harlem Avenue and the Dan Ryan Expressway are also summarized in Table 4. Average volume-to-capacity ratios are obtained by dividing total vehicle-kilometers traveled by the vehicle-kilometers of available capacity. The lane capacity is

TABLE 3 Eight Iteration HOV Lane Assignment Results

Assignment	λ	Contribution to Link Volumes
Initial Feasible		0.6923
First All-or-Nothing	0.0389	0.0280
Second All-or-Nothing	0.0394	0.0295
Third All-or-Nothing	0.0477	0.0376
Fourth All-or-Nothing	0.0517	0.0429
Fifth All-or-Nothing	0.0456	0.0397
Sixth All-or-Nothing	0.0483	0.0442
Seventh All-or-Nothing	0.0474	0.0455
Eighth All-or-Nothing	0.0403	0.0403

TABLE 4 Morning Peak-Hour Assignment Times and Volume-to-Capacity Ratios Between Harlem Avenue and Dan Ryan Expressway

	HOV Lane		General Purpose Lanes	
Algorithm Step	Travel Time (min.)	Volume to Capacity Ratio	Travel Time (min.)	Volume to Capacity Ratio
Initial Feasible	33.9	1.43	20.6	1.19
First Iteration	30.6	1.38	21.0	1.20
Second Iteration	27.7	1.33	20.5	1.19
Third Iteration	24.9	1.28	20.8	1.19
Fourth Iteration	22.4	1.22	20.9	1.20
Fifth Iteration	20.6	1.18	21.0	1.20
Sixth Iteration	19.1	1.14	21.5	1.22
Seventh Iteration	18.1	1.10	21.7	1.22
Eighth Iteration	17.7	1.09	22.1	1.23

1,650 vehicles per hour. After the eighth iteration, the HOV lane has approximately 230 fewer vehicles per hour per lane than the general purpose Stevenson lanes. This difference in lane volumes again indicates that equilibrium conditions will not be reached because of limited HOV trips.

FINAL COMMENTS

Procedures developed at CATS for traffic assignment when the network includes an HOV lane are documented in this paper. The intent was to develop an HOV lane assignment algorithm that was consistent with equilibrium assignment principles and could be carried out with CATS network coding and assignment software. Most of the discussion is directed toward the practitioner who must work with the models and resources available at a metropolitan planning organization.

Many outstanding questions remain about HOV lane assignment practices. Accurately coding the characteristics of the many different HOV lane designs in a traffic assignment network is a challenge for the practitioner. The best approach to prepare the initial assignment of HOV and SOV also entails research. Acceptable equilibrium conditions and the number of assignment algorithm iterations required may vary substantially among HOV lane projects.

Future year traffic assignments were not prepared by CATS for the consultant's use. Project trip tables are based on reasonably current observed travel behavior. Following a similar procedure for future HOV traffic assignments appeared questionable at best. One may readily argue that underlying travel behavior may change substantially in the long-term. The Intermodal Surface Transportation Efficiency Act of 1991 and the requirements of the Clean Air Act Amendments of 1991, plus increasingly congested traffic operating conditions, will likely affect automobile occupancy and traffic peaking. Whether the automobile occupancy and peak-hour factors used to create the 1990 trip tables will remain valid in the future is uncertain.

Although the procedure described in this paper may appear awkward, it allows the analyst to track the progress of the assignment as it iterates. This may be the best way to determine whether volumes on the HOV links are nearing steady-state conditions. Traffic forecasts for HOV lanes will generally require more detailed analysis of assignment results than conventional traffic assignments.

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