Managed lanes forecasting (HOV, HOT, Toll-way lanes)

WFRC and MAG's regional travel demand models have been modified to enable the models to analyze High-Occupancy Vehicle (HOV), High-Occupancy Toll (HOT), and dedicated toll-way demand in the Wasatch Front region. The model system was enhanced to allow explicit representation of HOV and toll trips. This was done by extending the nested logit mode choice model to consider toll and HOV highway travel separately from general purpose lane highway travel, in the same way that the model differentiates between local, express, and rail transit modes.

This structure allows the mode choice model to explicitly trade-off the time and costs associated with each of the highway paths (HOV versus toll versus general purpose lane travel). The model is segmented by household income, reflecting different cost sensitivities by income group, time period (peak versus off-peak), and by trip purpose, reflecting that travelers tend to have a higher value of time when making work trips than trips for other purposes. The model captures trade-offs between highway and transit modes, while recognizing higher bus operating speeds due to the availability of HOV lanes. Trips for each mode are assigned to a network representation and analyzed to determine facility operating characteristics (volume, volume/capacity ratio, congested speed).

The model is flexible enough to test a fairly broad range of policies, including HOV lanes, HOT lanes (where HOVs pay no toll or a smaller toll), and toll-way lanes (where every user pays). The model can analyze a distance-based toll policy, and the toll rate can vary by time period. Daily toll revenue can be estimated by analyzing toll demand and average toll paid on each facility by time period. Different toll rates can be applied to HOT lanes or toll-way lanes, but all HOT lanes must have the same toll rate, and all toll-way lanes must have the same toll rate.

The managed lane model enhancements have not been calibrated to existing data in the WFRC/MAG region, due to no toll facilities existing in the region and limited data from the existing HOV lanes. Some HOV data were available from a study done by the Traffic Lab at the University of Utah and these data were used more to get the base year HOV forecast into a reasonable range. That said, prior to using the model to forecast HOV demand, it is recommended that the base year HOV forecast be reassessed for reasonableness using available data.

More detailed documentation on the nature of the changes and how to make use of the managed lanes' analytical methods are available from WFRC or MAG.

Trip distribution improvements

Several improvements have been made to the trip distribution models, including new HBW destination choice models and refinements to the gravity models for non-work purposes.

The introduction of a destination choice model complicates the model chain and significantly enhances model run-time. The destination choice models utilize mode choice model logsums, among other variables, to estimate work-trip distributions. Therefore to utilize the destination choice model, the mode choice model needs to be run first, whereas in order to run mode choice, we first need a congested network, which requires running distribution and assignment. The sequence of models is shown in Figure 1.

The first trip distribution step is very similar to how trip distribution used to operate, utilizing the gravity model and iteratively running towards convergence with highway assignment. Gravity models are run for each trip purpose, including work. For non-work trip purposes the output of the distribution-assignment feedback loop is the final trip table. For home-based work, the destination choice model produces the final HBW trip table.

The gravity model has newly calibrated friction factor curves, as well as different curves for different conditions (curves specific to free flow speeds as well as congested speeds). Additionally, non-work purposes used to be "doubly constrained," but at the advice of peers non-work purposes are no longer doubly-constrained.

As part of this effort, PB Consult has developed destination choice models for the Home Based Work (HBW) trip purpose. The destination choice model form has many advantages over the traditional gravity model. First, the destination choice models are disaggregate and based on behavioral choice theory, making them more theoretically sound than gravity models. Further, they are more flexible, capturing multiple variables into a utility equation. The models use the logsums calculated in mode choice as the measure of travel impedance. This makes the destination choice model consistent with and sensitive to all transportation modes in the mode choice model. If transit system improvement results in more trips between locations, for example, then these new trips will use the new transit improvement. This feature is fundamental in the evaluation of any proposed transit system extension.

The major impetus for the changes to trip distribution at this time came from the Mountain View Corridor study, where dedicated toll-ways are being considered. The previous trip distribution model was not sensitive to toll level-of-service, only general purpose auto travel time. The implications of this limitation would have been a modeling system that did not recognize toll-ways as influencing trip distribution, and moreover trip distribution would only have been a function of much slower general purpose travel times. The destination choice model effectively considers the ease of travel by all modes in estimating the work trip distribution. To appropriately sensitize the gravity models to more than simply general purpose auto travel time, composite impedances is now used in the gravity models that are a weighted average of general purpose and toll travel times.

Notably, this combination of distribution improvements has resulted in a model that calibrates without the aid of link penalties that have traditionally been applied at geographic choke points. It does not matter whether there are penalties on the network; these penalties are controlled via a script (UpdateLinkPenalties.block).

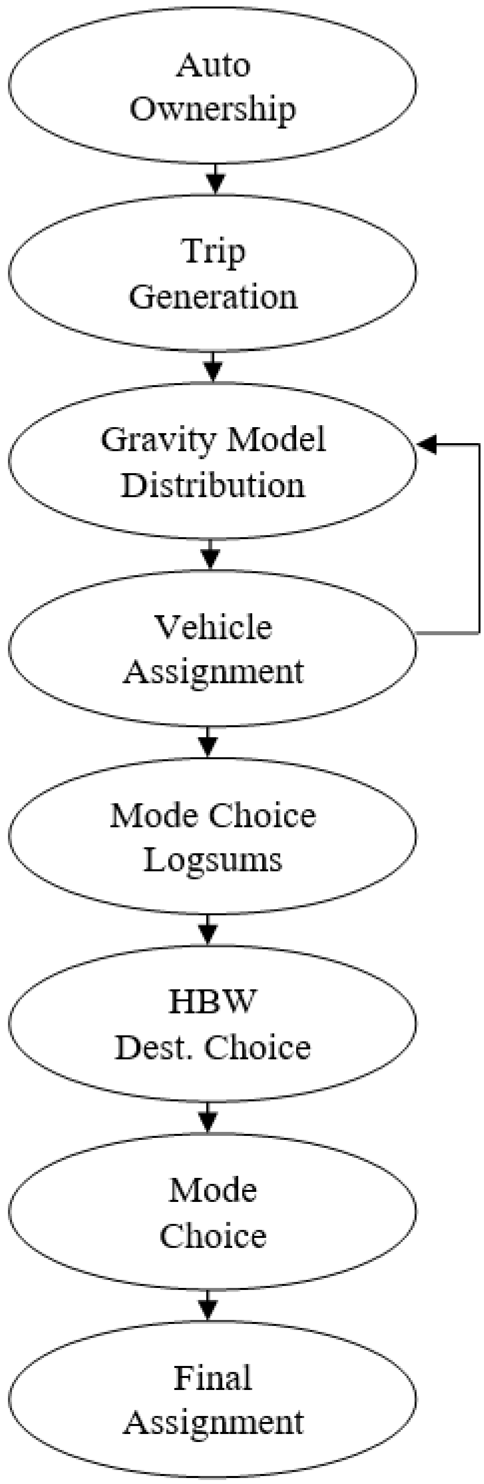

Figure 1: New model chain.

More comprehensive documentation on the destination choice model is available from WFRC or MAG.

Mode choice improvements

The modifications to trip distribution necessitated recalibrating the mode choice model constants to match observed trips by mode. In addition, the new managed lane forecasting process resulted in a new mode choice model nesting structure, as shown in Figure 2. In this structure, auto trips are first split in drive alone vs. shared ride trips, and then further classified as general purpose trips (i.e. no managed lanes), HOV trips (i.e. use an HOV lane) or toll trips (i.e. use either a HOT lane or a toll-way facility). This classification requires skimming different travel times and costs for these new managed lane modes. Trips estimated by the mode choice model to use managed lanes are then assigned to managed lanes during vehicle assignment.

Through extensive review and use of the model it became clear that the on-board survey done by UTA in Fall, 2002 had too many college trips on the light rail system. Utilizing a combination of data sources, including station-level boardings and a Fall, 2002 survey of University of Utah students, the number of college rail trips targeted by the model was significantly reduced. The primary reason for the survey data being too high was thought to be a misunderstanding among survey respondents, where "college" was selected as a trip purpose, even though the person may have been going to work at the college or going to the college for some other reason.

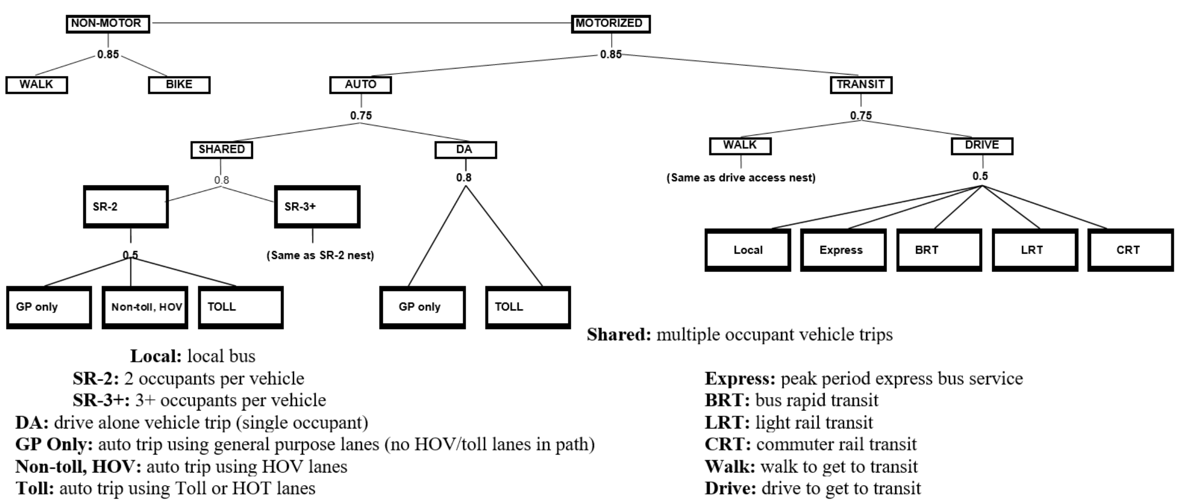

Figure 2: New mode choice model nesting structure.

Vehicle Assignment Improvements

There were two important modifications to the vehicle assignment routine. First, to accommodate managed lanes and utilize different cost functions for long versus short trips, a multi-class, multi-user assignment (MMA) algorithm is now used. This assignment algorithm is very flexible, allowing different assignment rules for different types of trips and/or facilities. For example, managed lane trips are the only trips allowed on managed lanes. In addition, long and short vehicle trips are assigned to shortest paths using different cost functions. Short trips, currently specified as trips under 10 miles, are assigned based on a function of time and distance, with the thinking being that the both time and distance are important when time savings are minimal. For trips over 10 miles, the shortest time path is used, so distance is not a factor.

The second significant change was to the way assignment is run; fixing the number of iterations the assignment routine runs rather than utilizing convergence criteria. To implement this the convergence criteria were set at an unachievable level and a variable was used that defines the maximum iterations. The maximum iterations vary by time period (20 in the AM, 10 in the Midday, 30 in the PM and 10 in the evening). These can be modified if appropriate to reduce run-time assuming calibration results are not adversely affected. The rationale for fixing the number of iterations is one of assignment stability. It has been clearly demonstrated that assignment results oscillate or flip-flop from one iteration to the next between alternating shortest paths. As convergence is more closely achieved, the oscillation is less apparent. This approach attempts to minimize differences between loaded networks due to oscillations by fixing the number of iterations, preventing different assignments from stopping at different iterations. This helps make networks changes outside a corridor of interest (away from where the change occurred) more logical and less significant. The current default max iterations are large enough that previous convergence criteria will be satisfied, but run-time will increase.