

**Application of a Transit, Walk and Bike Captive  
Trip Forecasting Procedure in the  
Greater Vancouver Transportation Model**

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**Introduction**

The implementation of transit, walk and bike captive trip generation was a part of the recent enhancement and calibration of the Greater Vancouver Transportation Model. The model enhancement program jointly supported by the Greater Vancouver Regional District (GVRD) and the BC Ministry of Transportation and Highways (MoTH) included the introduction of a logit function-based HOV/SOV sub-model and a Park-and-Ride sub-model. The additional refinements and the revised model structure are described in other papers to be presented at the Users Meeting.

Enhancement and calibration of the Vancouver Regional Transportation Model is an ongoing process which maintains the regional transportation planning model at current travel conditions. The regional model was calibrated in the mid 1990's based on data collected in the 1992 Greater Vancouver Travel Survey and the 1994 Greater Vancouver Trip Diary. The 1996 Screenline Survey and 1996 Census data provided by the GVRD Strategic Planning Department allowed the model to be updated to 1996 conditions.

The ability of the model to discretely identify captive and non-captive riders is very important for several reasons. Firstly, the demand elasticities to changes in transit fares and schedules are different for people with and without choice of travel mode. Captive trip makers are less sensitive to changes in transit service due to their lack of choice. Modeling of this behavioral difference better reflects trip distribution changes for future scenarios. Secondly, captive and choice trip makers need to be exclusively defined since a portion of choice travelers utilize the Park and Ride service offered in the Greater Vancouver area as described in another paper<sup>1</sup>.

**Development of Generation Equations**

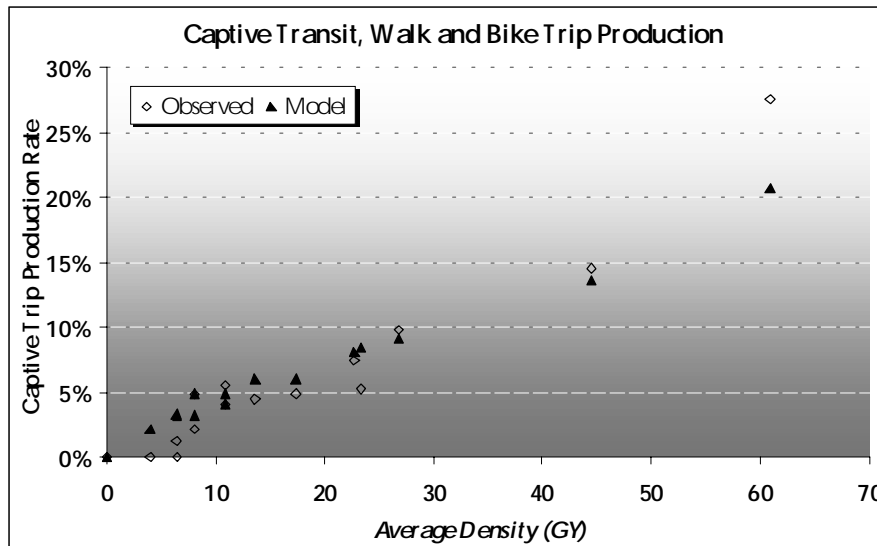
The 1992 Greater Vancouver Travel Survey provided the baseline information for development of the generation equations for captive trips. Automobile ownership is not used as a demographic variable in the regional model due to the difficulties of forecasting this variable. Other variables such as population density, income and distance from the CBD were investigated as potential generation factors due to their availability and relative ease of forecasting. Close analysis of the travel survey for morning period work trips revealed a linear relationship between captive trip production rates and population density. Income and distance from CBD also revealed functional relationships between captive trip production but the simplistic approach proved a better fit to the travel survey.

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<sup>1</sup> " Application of a Park-and-Ride Forecasting Procedure in the Greater Vancouver Transportation Model" , Edwin Hull, Edwin Hull Associates.

A simple linear equation based on population density and capped to approximately thirty percent of work trips is used to predict the number of captive trips. According to the 1992 Travel Survey, captive trip rates typically do not exceed thirty percent of the total work trips produced from within a traffic zone. The production of captive trips by origin traffic zone is illustrated in the following step function:

The following graph illustrates the linear relationship between captive trip production rates versus the population density.

$$Wkcap_i = \begin{cases} 0.0252 Wkprd_i \frac{Poptot_i}{Area_{hd}_i}, & 0 \leq \frac{Poptot_i}{Area_{hd}_i} \leq 100 \\ .252 Wkprd_i, & 100 < \frac{Poptot_i}{Area_{hd}_i} \end{cases}$$


Higher density areas tend to produce more captive trips because of better accessibility to transit services as well as easy access to walk and bicycle facilities. People living in these high density areas can opt to commute with no automobile available to them.

## Implementation

The production of captive trips is performed during the trip generation stage of the urban transportation modeling system. Captive trips are generated and then subtracted off the total work trip matrix giving captive and choice work trip matrices. In essence this procedure is a "pre-mode-split" since a mode of travel is chosen before the trips are distributed onto the O-D matrix. Logit functions are still used to divide transit, walk and bike trips from the captive trip matrix as well as the choice trip matrix.

During the 1992 Travel Survey phone interview a question was asked whether a vehicle was available for the trip or not. People who responded no were considered captive trip makers since they had no choice but to walk, bike or take transit. The results of the survey were cross-tabulated to determine the number of captive trip makers for each GY<sup>2</sup> sub-area. The following table illustrates the goodness of fit of captive trip generation to the actual travel survey data.

GY	Observed	Modelled	Difference
1	258	227	(31)
2	1,254	1,268	14
3	3,053	2,293	(760)
4	8,128	7,375	(753)
5	2,729	2,496	(233)
6	777	1,116	339
7	849	1,487	638
8	226	241	15
9	1,346	1,621	275
10	226	284	58
11	-	203	203
12	124	315	191
13	-	72	72
14	331	461	130
15	-	-	-
<b>Total</b>	<b>19,301</b>	<b>19,459</b>	<b>158</b>

The normal matrix can only balance a single single attraction vector. In captive and choice work balancing procedure was two production types and macro used<sup>3</sup> performs a balancing with multiple the matrix calculator macro distributes the onto the work trip O-D captive and choice friction lengths and trip totals for were calibrated to the 1992 Travel Survey.

balancing module 3.22 production vector to a order to distribute the trips properly a unique implemented to handle one attraction type. The two-dimensional matrix production types using module 3.21 only. This captive and choice trips matrix according to the matrices. The trip captive and choice trips

R-squared = 0.982

## Conclusion

The implementation of captive transit, walk and bike trips was an important part of the recent enhancement and calibration of the Greater Vancouver Transportation Model. The effect of changes to transit fares and schedules are better reflected in future planning scenarios. Discrete modeling of captive and choice trip makers was also necessary to properly implement the Park and Ride sub-model. The recent enhancement and calibration of the regional transportation model has brought a better reflection and understanding of the travel patterns of the Greater Vancouver area. Further research and enhancement are required to keep the regional planning model up to date on future policy scenarios and infrastructure plans.

<sup>2</sup> The GY ensemble represents a grouping of traffic zones which adheres to municipal boundaries. A copy of the GY ensemble map is included in the appendix.

<sup>3</sup> BALMPROD 1.4 – Heinz Spiess, EMME/2 Support Center, CH-2558 Aegerten.