Transportation Model Improvement Program (TMIP)
Report on Findings of the Second Peer Review Panel for the Southern California Association of Governments (SCAG)

Location:	Los Angeles, California
Date:	April 16, 2004
Peer Review Host Agency:	Southern California Association of Governments (SCAG)
Peer Review Participants:	Los Angeles County Metropolitan Transportation Authority (MTA) Denver Regional Council of Governments (DRCOG) Orange County Transportation Authority (OCTA) KLK Consulting Keith Lawton Consulting Mark Bradley Research & Consulting FTA/FHWA Los Angeles Metropolitan Office Cambridge Systematics, Inc. Urban Analytics, Inc. U.S. DOT Volpe Center

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I. Executive Summary

This report summarizes the results of a peer review panel meeting held as part of the Travel Model Improvement Program (TMIP), which is sponsored by the Federal Highway Administration (FHWA). This was the second of three meetings of peer review panelists to be held for the travel demand model improvement project of the Southern California Association of Governments (SCAG). It took place in Los Angeles, California, on Friday, April 16, 2004.

This peer panel held its first meeting in November, 2003, to review the scope of work for SCAG's travel demand model improvement project. The findings of the first meeting are also available on the TMIP website. During the second meeting, documented in this report, the modeling consultants presented their work to date for review by the panel.

Topics reviewed by the panel at the second meeting included:

- Validation targets for all model components
- Vehicle availability model
- Trip generation model
- External trip model
- Proposed variables for the mode choice model

Development of the revised mode choice and trip assignment models will begin in the near future. The trip distribution model is being recalibrated and the transit network validated by SCAG itself during the same time frame. Freight models are not being revised at this time. A third meeting of the peer panel, tentatively scheduled to take place in July, 2004, will include review of the consultants' mode choice and trip assignment models, as well as of SCAG's recalibrated trip distribution model and validated transit network.

The second meeting was co-facilitated by Deng Bang Lee, the head of SCAG's modeling division, Maren Outwater and Ron West of Cambridge Systematics, Inc., and Firouzeh Nourzad of Urban Analytics, Inc. Participants in the peer review panel included transportation modeling experts from Los Angeles County Metropolitan Transportation Authority (MTA), Denver Regional Council of Governments (DRCOG), Orange County Transportation Authority (OCTA), KLK Consulting, Keith Lawton Consulting, Mark Bradley Research & Consulting, and the FTA/FHWA Los Angeles Metropolitan Office.

II. Background

The Southern California Association of Governments (SCAG) is the Metropolitan Planning Organization (MPO) for a population of over 16 million people in six southern California counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura, and Imperial. These counties encompass an area of over 38,000 square miles, and the travel model has recently been expanded to cover the entire SCAG region.

To support the federally required Regional Transportation Plan and the Regional Transportation Improvement Plan, SCAG maintains a transportation demand model for predicting the impact of travel growth and evaluating potential transportation improvements. The current SCAG travel simulation model follows the traditional four-step modeling structure: generation, distribution, mode choice, and network assignment.

In 2002, SCAG initiated an effort to utilize new data to update and recalibrate its travel simulation modeling process. In January, 2002, a peer review panel of modeling experts concluded that the SCAG travel simulation model was at the leading edge of state-of-the-practice techniques, but that there were several areas where further improvements should be investigated.

In accordance with that panel's recommendations, the following are the objectives of the SCAG Travel Model Improvement Program:

1. Re-estimate trip generation models (production and attraction) and auto ownership models
2. Re-estimate mode choice models with emphasis on expanding submodel components (toll roads, Metrolink, commuter rail, etc.)
3. Revise highway network assignment, including refining multimodal methods and volume-delay functions
4. Update external trip models
5. Validate the model
6. Document the process

Another panel of transportation modeling experts was convened to serve as peer reviewers for SCAG's travel model improvement project. This TMIP peer review panel held its first meeting in November, 2003, to review the scope of work for the project. The findings of the first meeting are also available on the TMIP website. As a result of the first meeting, a set of peer panel recommendations were developed to help guide the model revisions. Appendix C lists these recommendations and the responses from the consultant team. During the second meeting of the peer review panel, documented in this report, the modeling consultants presented their work to date on model development and revision for review by the panelists. Topics reviewed included validation targets for all model components; revised vehicle availability, trip generation, and external trip models; and selection of variables for the mode choice model. A third meeting, tentatively scheduled to take place in July, 2004, will include review of the revised mode choice and trip assignment models. Recalibrated trip distribution models and a newly validated transit network, which are being completed by SCAG itself, will also be reviewed at the third meeting. Freight models are not being revised at this time.

III. Presentation and Discussion

A. Introduction

The second meeting of the SCAG TMIP peer review panel included presentations and peer panelist discussion of the model work completed to date on the following topics:

- Model validation process and targets
- Vehicle availability model
- Trip generation models, including production and attraction models
- External trip models
- Mode choice models: selection of variables to consider

The following report describes the results of the discussion on each topic.

B. Model Validation

Maren Outwater, Cambridge Systematics

1. Process

Ms. Outwater presented the model validation approach following that outlined in the *Model Validation and Reasonableness Checking Manual*, prepared for the FHWA in 1997 by Barton Aschman Associates, Inc. and Cambridge Systematics. As part of this approach, newly developed or revised modules of the travel model will be validated with reasonableness checks as well as by disaggregate validation (where appropriate). Aggregate results for each model component will be checked using modeling targets as well as comparisons to independent data sources, where available. Input data for the travel demand model has been previously developed by SCAG and thus will not be fully validated by the consultants at this time.

At the first meeting of the peer panel, panelists had voiced concern about validation of mode choice, highway assignment, and transit assignment models before revision of the trip distribution and freight models, which is not being conducted at that time. In response to this, the consultants developed targets for validation of each model component, rather than attempting to use validation standards. Ms. Outwater led the discussion of each proposed target.

2. Targets

Panelists had a few minor suggestions on how validation target percentage deviations could be made more appropriate, and the consultants agreed to implement these suggestions. For validation of some parts of the model, such as trip generation, however, the only independent data for comparison is that from other regions, and there are limits on how much fine-tuning and consideration of differences among regional sizes and complexities can be accomplished within the resources of this model improvement

project. The following sub-sections present more detailed results of the discussion of validation targets for each individual model component.

a. Vehicle Availability Models

The consultants proposed the creation of a single vehicle availability model to replace SCAG's current use of a vehicle availability model for mode choice and a separate vehicle ownership model for trip generation. Although panelists did not object, the lack of available literature establishing validation targets for vehicle availability models meant that the consultants were particularly interested in panel feedback on their proposed targets for this model component.

Validation targets for the vehicle availability model, as originally proposed, were:

- Plus-or-minus four percent of the total number of households in each market segment, when modeling the percentage of that market segment falling within each vehicle availability category;
- Regionally, plus-or-minus two percent in the number of households within each vehicle availability category; and
- Plus-or-minus four percent in the average number of vehicles in each market segment of households.

The consensus of the panelists was that the first target would work better for vehicle availability categories representing a wide range of percentages of market segment, if it were stated in terms of "percent of percent" falling within a given vehicle availability category. As originally proposed, for example, the target would have meant that, if 37 percent of medium income households have two vehicles available, then the modeled percentage for that vehicle availability category should fall between 33 and 41 percent of medium income households. Although in this case such a target sounded reasonable, several panelists worried that a target phrased in terms of percent of total market segment would represent too large a permitted error for zero-car households. Since only ten percent of most market segments within the SCAG region fall within the zero-car category, and the precision of modeling that small percentage is critically important in later model stages for predicting transit demand, panelists felt that it is important that validation targets be narrower for zero-car households. On the other hand, if the target were shrunk to plus-or-minus one percent of the total market segment for each vehicle availability category, this would restrict two-vehicle households to 36-38 percent, which seemed unreasonably tight. Therefore, the panelists recommended that the validation target be phrased in terms of "percent of percent" within each vehicle availability category. Ms. Outwater agreed to implement this, using the "percent of percent" approach for all vehicle availability categories, rather than the percent deviation method, in order to establish appropriate ranges of acceptance around all sizes of vehicle-availability categories. In keeping with panel suggestions, Ms. Outwater proposed that the target be set at ten percent of the percentage of households within each vehicle availability category. This would give modeling target ranges of nine to 11 percent for zero-car households (observed at ten percent of the total households) and 33 to 41 percent

for two-car households (observed at 37 percent of the total) in any particular market segment.

For validation of the total number of households regionally (plus-or-minus two percent within each vehicle availability category), panelists felt that a straight percent-of-region interpretation was acceptable.

For the third validation check listed above, the target was proposed in terms of percent of the average vehicle availability level for that market segment. For example, if a market segment has an average vehicle availability level of 2.00, the model will be judged to have met this target if modeled vehicle availability is between 1.92 and 2.08. The panel did not object to this target.

b. Trip Generation Models

Ms. Outwater began discussion of validation targets for trip generation models by noting that trip production data present several unique challenges for validation. The only source for trip production rates in the southern California region is the household survey data, from which the trip production model was derived. Other than the extremely limited sample of households whose vehicles were outfitted with GPS units, there is no independent source by which to validate modeled trip production rates. Therefore, the consultants proposed to perform reasonableness checks on the modeled trip-production rates in the SCAG region by comparing them with survey data from other urban areas. The value of available comparison data may be limited, however, by the fact that much of it is over ten years old, and may have unknown errors associated with non- or under-reporting. The consultants also clarified that the intention of comparing the output of the SCAG model with survey data from other regions was not to take into account detailed differences in size or complexity of regions, but rather to provide a general double-check for Southern California telephone survey results. Therefore, disaggregation of targets by household size in order to account for differences in distribution of household size among urban areas will not be performed.

Comparison data is being processed by SCAG itself. Panelists expressed concern that validation targets for home-based non-work and non-home-based trips may be based on data from regions where strategic work trips were not considered separately. As discussed below under *Choice and Definition of Trip Purposes*, the consultants proposed to process southern California data into strategic home-based work trips if the data proves able to support Home-Based Work - Strategic as a separate trip purpose. The consultants clarified that they plan to address regional inconsistencies in trip-purpose processing in their impending development of the mode choice model.

Discussion led to clarification of the limits to revalidating the original trip production model by comparing model outputs with data from the Year 2000 Post-Census Regional Travel Survey. The 2000 data included direct survey of non-household-based trips, while the 1991 Regional Household Travel Survey, upon which the original model was based, did not. The panel recommended that the final model documentation should note that

non-household-based trips in the original trip production model were counted by statistically padding the household-based trips, rather than from a direct survey.

One panelist was concerned that a target of 1.3 to 1.9 home-based work attractions per employee, per day, seemed a bit high. Consensus, however, was that this target was acceptable, especially for the SCAG region, where as many as six percent of the regional population work two jobs.

c. Trip Distribution Models

Although the trip distribution model is currently being recalibrated by SCAG in work that will be reviewed by the peer panel at its third meeting, revision of the trip distribution model is not being conducted at this time. Therefore, validation performed by the consultants will be limited to ensuring that the existing trip distribution model provides acceptable results when used with the other revised components. Results generated by the trip distribution model using input from the revised trip generation model will be compared with results using input from the pre-revision trip generation component. Trip length frequency by trip purpose will also be compared with the most recent survey data for the SCAG region. Panelists discussed the value of a disaggregate destination choice model currently being developed by the Los Angeles County MTA, the results of which may be incorporated at a later date. For now, however, log sums from the current mode choice model will be used.

d. Mode Choice Models

Ms. Outwater explained that validation of the mode choice model will be accomplished by comparing model parameters and derived values, such as time, to data from other urban areas. The consultants propose to conduct disaggregate and aggregate validation, by mode and market segment.

Based upon a calibration matrix developed from the household survey data and transit ridership statistics, the following were the proposed aggregated validation targets:

- Regionwide trips by mode within plus-or-minus five percent (percent of percent).
- Regionwide mode shares by market segment within plus-or-minus two percent.

As originally proposed, the target for mode share was phrased in terms of percent of market segment; however, panelists strongly recommended that the target be scaled by making it a "percent of percent" of mode share. Once this is done, two percent would be too tight a target. Panelists recommended ten to 15 "percent of percent" of mode share by market segment as a revised target. The consultants responded that a range of 15 "percent of percent" seemed most appropriate, based upon the example of an observed ten percent mode share ranging from nine to 11 percent when modeled, and a five percent mode share ranging from four to six percent.

The consultants plan to test the sensitivity of mode choice to change in travel time and cost. Ms. Outwater proposed validation targets for elasticities of demand by mode, with respect to level of service, of -0.6 to -0.1. One panelist suggested that time elasticity could be higher, while another mentioned that, for transit modes, cost tends to have a higher elasticity in the Los Angeles area than elsewhere. Mr. Lee clarified by explaining that although transit used for work trips often reflects higher-income ridership and more time-sensitive characteristics, in the Los Angeles region transit is only competitive for choice riders along rail corridors. Panel consensus was that time elasticity could be higher than -0.6, at least for Metrolink, but there was no consensus as to how much higher or as to whether the target should be changed. Ms. Outwater suggested in response that the targets be left as they are, but that SCAG allow for the expectation that time elasticity may not fall within the stated target ranges.

Ms. Outwater explained several factors that had the potential to complicate the process of validating the mode choice model, so that SCAG could address them. The consultants were concerned about estimating mode choice before the new transit skims were released. In response, SCAG decided to extend the timeframe of the modeling contract, so that the consultants can wait for SCAG to complete validation of the transit networks before estimating mode choice, thus ensuring the durability of mode choice estimates. Another complication is that the modeling area is expanding at the same time that the model is being revised, so that parts of the region have no baseline data to compare. Mr. Lee commented that any difficulty caused by lack of baseline data will be remedied by conducting several iterations when using the model.

e. *Trip Assignment*

i. External Travel

The consultants proposed to validate the external travel models by conducting reasonableness checks of the generated parameters, as this is the best available method. Panelists did not object.

ii. Transit Assignment

The proposed validation target for transit assignment was that modeled regional boardings match ridership counts within plus-or-minus ten percent. Panelists emphasized that this validation needs to be broken out by mode. There was also discussion of the fact that the consultants' validation of the transit assignment model needs to be conducted with care because the transit network itself is not being revised at this time, although SCAG is revalidating the existing network.

The differences among various types of transit in terms of elasticity for time and cost, as well as differences in headway, emphasize the special modeling needs of Metrolink. There was consensus on the critical importance of breaking Metrolink out as a separate mode, as has been planned. Mr. Lee explained that SCAG has validated passenger miles by boarding, and found its existing model to be very good with respect to bus and urban rail modes, but quite poor for Metrolink, predicting fewer than half of passenger miles

reported. One panelist suggested that this may be because commuter rail has a different in-vehicle value of time than do other transit modes.

Discussion of validation targets for Metrolink centered around the influence of station parking demand and availability, as well as fare zones and vehicle speed, on station choice. Chaushie Chu, MTA, explained that, because there are no residential parking permit programs around Metrolink stations, passengers park on residential streets when designated parking fills up. Thus, predicting ridership by number of designated parking spots available tends to grossly underestimate the number of riders at certain stations. SCAG plans to finish parking lot surveys in May, and will provide them to the consultants to analyze their significance. The consultants also suggested that perhaps it would be best to conduct an on-board survey of access mode to the station (drive, bus, walk, bicycle, etc.), and SCAG agreed to consider the feasibility of such a survey.

Mr. Chu offered to provide the MTA's Metrolink station choice model and data to the consultants for reference in considering the effects of several factors. Mr. Chu commented that Metrolink station choice appears to have been affected by fare zone changes, which caused riders to drive further into the center of the city in order to save on fare. The consultants mentioned that in San Francisco small changes in commuter rail vehicle speed, and hence in times to downtown, had resulted in significant changes in passengers' station choice, thus raising another factor to consider. The consultants may review the MTA model; however, they are not obligated to include it in SCAG's revised travel demand model, as both station choice modeling and validation by station are outside the scope of the current contract.

Panelists recommended that the consultants look into current literature on modeling commuter rail headways, in which trains are spaced far apart but passengers tend to time their arrivals at the station such that few actually wait the entire headway. Simply reducing the weighting of headways in the model would reduce its accuracy for local service transit modes. A possible solution is to introduce a non-linearity by using two separate coefficients, one for commuter rail and another for local transit modes.

Several panelists, including representatives of the MTA, discussed how their transit agencies compare modeled time with scheduled time. Such a comparison has not yet been performed for the entire SCAG region, but SCAG will be conducting one in the next few months in order to validate the region-wide transit networks.

Mr. Lee also requested that the consultants include cordon counts for transit in their model validation. The consultants responded that inclusion of transit cordon counts in validation of the transit assignment model is dependent upon the availability of transit networks which include transit routes across the cordons, and that it was their understanding that SCAG did not have such networks available.

iii. Highway Assignment

Ms. Outwater proposed validation targets for Vehicle Miles Traveled (VMT) per household, per capita, by road facility type, by lane use (toll or High Occupancy Vehicle

[HOV]), and by area type. Panelists emphasized that validation must include targets for total regional VMT as well; plus-or-minus five percent for regional VMT is the target proposed in response. SCAG representatives explained that the California Department of Transportation (Caltrans) has strict rules on validation of total VMT by air basin for purposes of gauging conformance with air-quality regulations. The consultants proposed to include additional validation targets for VMT by county (plus-or-minus two percent) and by air basin (plus-or-minus five percent) to address these issues.

One panelist questioned whether modeling of VMT per household would be necessary, and suggested per-driver modeling of VMT (per capita modeling for drivers only). However, data are not available for modeling of VMT for drivers only. Household VMT could not be estimated from simple per capita modeling of VMT, as such a correlation would be complicated by the fact that larger households often include a number of children and do not always have more drivers. Thus, the suggestion was rejected by the panel, and the consultants still plan to model, and validate, VMT both per household and per person, including drivers and non-drivers alike.

Other panel recommendations for highway assignment validation targets included:

- Itemize cordon count as one type of screenline for which there will be a validation target. The consultants agreed to implement this.
- The panel agreed that the validation of speeds and screenlines were so closely related to calibration of the trip distribution model that it may be necessary for SCAG to adjust trip distribution models in order to achieve the stated validation targets for speeds and screenlines.
- Consider using the ratio of speeds (modeled vs. reported), graphed against volume-to-capacity ratios (V/C), as a pre-processor for calibration. The relationship of ratio of speeds to V/C will yield correct travel times for travel between two points, and this relationship can then be used for trip assignment and mode choice modeling. There was no consensus on whether these calibration benefits were worth the resources that would be required to implement this approach.
- Be careful in balancing time against distance in modeling motorists' choice of arterial or freeway. The Atlanta Regional Commission was mentioned as a good source of information on this point.

The consultants clarified that their proposed targets for root-mean-squared (RMS) error for each type of modeling facility are for the whole modeling region, not the screenline level.

SCAG representatives asked about internal consistency between assignment algorithms and mode choice models. For example, transit headway is modeled non-linearly so that an increase in headway from 15 minutes to 30 minutes will have a large effect on trip assignment, while an increase from three hours to four hours will not. However, nonlinearities cannot be included in the path-building model. The panel resolved concern about this difference in model structure by pointing out that mode choice is a behavioral

model, while path building is not. Therefore, they are mathematically different and so are by definition not necessarily consistent.

C. Vehicle Availability Model

Maren Outwater, Cambridge Systematics

Since the first meeting of the peer review, the consultants tested three potential structures for the vehicle availability model (multinomial logit, nested logit, and ordered response logit). Results generated by all three models were quite close, and the advantages of the more complicated model structures were not great enough to make them worth the extra resources. Therefore, the consultants recommended use of the multinomial logit (MNL) model. The consultants emphasized that their recommendation that vehicle availability, rather than vehicle ownership, be modeled is based on the result that vehicle availability proved more robust than vehicle ownership when the vehicles-per-household ratio was modeled.

Panelists suggested that the number of persons over age 16 in the household be tested as a variable (as a surrogate for the number of drivers), which the consultants agreed to do. Independent variables previously tested for inclusion in the vehicle availability model included persons per household, workers per household, household income, and age of head of household. The consultants recommended that head of household age only be broken out for the category of over-65, as this was the only age-group that showed statistical significance.

Accessibility of destinations by highway, transit, and walk modes were also considered as variables in the vehicle availability model. Walk turned out not to be statistically significant, and the consultants proposed not to use it. Panelists suggested that it may be possible to bring the effects of walk accessibility back in to the model by considering only retail/service employment destinations when modeling employment accessibility. One panelist also suggested using a function, such as a simplified log-sum, to model distance to employment, rather than a fixed value.

The consultants presented estimated effects of each chosen variable on vehicle availability. Panelists questioned the effect of one variable, which showed that having employment accessible within six miles by highway lowered the likelihood of having more vehicles available. It was explained that nearby employment accessible by highway is a proxy for density; with more density, residents can share a car more easily.

Some panelists felt that the consultants should test ethnicity or time-in-country as variables in the vehicle availability model. The consultants had not originally planned to include ethnicity or time-in-country as variables, arguing that dependency on these factors shows changes over time and that other variables such as income and age should be able to represent more durable relationships. Mr. Lee suggested, as a compromise, that the consultants conduct disaggregate validation by ethnic group to see if the vehicle availability model has biases by ethnicity. If aggregate validation to test for bias is

additionally desired, the panel suggested that the consultants work with SCAG to make a list of what additional demographic data would be needed, and determine what is available before proceeding. If these validation tests show that the model accounts equally well for vehicle availability within each ethnic group, then ethnicity can be ignored, since other variables will be acting satisfactorily as surrogates. If not, however, the issue of inclusion of ethnicity as a variable may need to be considered further.

D. Trip Generation Models

Maren Outwater, Cambridge Systematics

1. Trip Production

a. Data Processing

Modeling of trip production will be accomplished by using a cross-classification structure and then testing a number of independent variables for significance. The consultants explained two possible methods of processing the cross-classification tables:

- The Multiple Classification Analysis (MCA) technique, which is a mathematical model that takes row and column marginals and uses them to correct individual cells. The MCA technique has been used in a number of trip generation models where it is believed that the marginals represent the data better than any individual cell does.
- Another option is to look for suspect cells and smooth or combine them only. This would be a good choice if the marginals in the MCA technique appear to be dominating the other cells too much.

Panelists agreed that either method was acceptable and left the choice to the consultants' professional judgment.

b. Choice and Definition of Trip Purposes

At the previous meeting of the peer review panel, panelists had recommended breaking out more trip purposes. The consultants thus presented percentage of total trips for a number of potential new trip purposes that are being considered for trip production modeling. However, the consultants expressed concern that fine subdivisions of the data may imply that the resulting model can be used to support inferences that there is simply not enough original data to support.

The consultants did propose to model Home-Based Work – Strategic (HBWS) as a distinct trip purpose if the data proves able to support it. An HBWS trip is defined as any chain of trips beginning or ending at home or work with at least one, and possibly more, intermediate stops. The home-to-work trip and the work-to-home trip will each be considered as strategic, or not, for purposes of classification. The panel made several recommendations to the extent that tour-based modeling would be preferable to trip-based for use in defining trip purposes. These recommendations are presented here for

reference only. They cannot be implemented at this time as tour-based modeling falls outside the consultants' current contract.

- Both the home-to-work and work-to-home trips should be classified as strategic if either involves an intermediate stop. This is recommended because one purpose of modeling strategic work trips is to capture the effect on mode choice (specifically, on auto use) of chaining together trips on the way to or from work.
- One panelist carried this suggestion further, recommending dividing HBWS trips into the two subsets of Home-Other and Other-Work. The two subsets would permit modeling of mode choice to be based on the round-trip tour, while trip distribution could still be based upon each individual direct trip. This is recommended because, for purposes of trip distribution, each individual direct trip within a strategic chain should be modeled separately.

As one panelist explained, the Home-Based Work - Strategic trip purpose was originally intended to cover quick stops, such as buying gasoline, stopping at a convenience store, or dropping off a child. Several panelists posed the question of whether a tour should be classified as HBWS even if the intermediate stop is far out of the direct path, or if the stop has a long duration. The consensus was that the consultants should check the data to see if HBWS trips with long or distant intermediate stops represent a significant number of total trips before considering this question further. Since even with these trips included, HBWS represents only five percent of total trips, the subset of trips with long or out-of-the-way stops may be too small to warrant further concern.

Ms. Outwater pointed out that Home-Based Work is the only trip purpose for which strategic trips will be considered separately from direct ones. In addition, once HBWS has been broken out, Work-Based Other trips will consist almost exclusively of lunchtime errands. Several discussion points related to other trip purposes that may be possible to break out included:

- Should Home-Based Quick Stop (HBQS) be considered separately, as part of Home-Based Other, or as part of Home-Based Shopping? To gauge the relative effects of these choices, the consultants will look further into how Home-Based Other trips, excluding HBQS, break down by sub-purpose.
- One panelist suggested that Serve Passenger be broken out as a distinct trip purpose, mentioning Houston and St. Louis as cities where this was successfully done. The consultants agreed to evaluate Serve Passenger trips in the SCAG household survey to determine if they warrant being treated as a separate purpose.

Ms. Outwater then presented preliminary trip rates by household size for a number of trip purposes, graphed against variables that had shown the most statistically significant effects for that trip purpose. One panelist expressed concern that, for policy purposes, it may be a problem not to carry the same variables through for all trip purposes. Although

this point was well-taken, it was the consensus of the panelist group that choosing variables individually for each trip purpose would be worthwhile in order to get the most insight into individual dependencies.

Several panelists were stunned that the model showed such a great dependency on income for Home-Based Social Recreational trip rates. Households with income greater than $100,000 reported trip rates over three times higher than those earning less than $25,000. The consultants confirmed that these rates include walk and bike modes, so that this difference in trip rates is not simply a function of reduced vehicle availability for lower-income households. They also stated that there are few other examples of such models, but the ones that exist also show strong income dependency.

Some panelists suggested that trip rate tables should be created on a per capita basis, not by household size. The consultants replied that they had considered per capita trip rate tables but concluded that such tables are impractical at this stage.

2. Trip Attraction

Input for trip attraction models was generated by merging socioeconomic zonal data with the results of the household survey. Although the limitations to this merging approach are widely recognized, it is agreed to be the best practical choice for most modeling situations.

Linear regression models were then estimated by trip purpose at the zone, super-zone (about five zones together), and regional statistical area (RSA) level. The consultants reported that some coefficients at the zone level were quite strange, and the super-zone level also appeared flawed. Therefore, attraction model coefficients for each destination type by trip purpose were obtained from the linear regression model at the RSA level. The consultants suggested that regional average rates be used in place of the results of the RSA-level linear regression for certain trip purposes where the regression had been based on only a single variable, since, in those cases, regional averages are more robust than the RSA estimates. In addition, the consultants proposed to constrain coefficients for certain trip purposes of household variables in order to prevent them from overwhelming the trip attraction model. Panelists did not object to these recommendations.

Attraction coefficients for K-12 school destinations and college destinations had been based on enrollment. Panelists suggested that the consultants look into instead using average weekly attendance to estimate attraction coefficients for the Home-Based School and Home-Based University/College trip purposes.

3. Under-reporting of Trip Rates

This model improvement project has access to ground-breaking data on trip under-reporting obtained by outfitting the cars of some survey respondents with GPS units. The GPS data show that, contrary to many previous conjectures, people under-report all trip purposes by the same amount. Previously, it had been thought that work trips were under-reported less or not at all. One panelist commented that the statistics research firm NuStats had found that work trips were indeed not under-reported, but perhaps Home-

Based Work - Strategic, as it is considered in this model, is under-reported. To clarify this issue, the panelists recommended that under-reporting rates for Home-Based Work be broken out by direct and strategic trip purposes.

The consensus of the panelists was that the overall magnitude of the under-reporting revealed by the GPS data made sense, since taking this degree of under-reporting into account would boost reported trip rates into the middle of the target ranges, and that this under-reporting should be incorporated into the trip rates by modifying household expansion factors. Some panelists, however, were concerned that it may be difficult to make the requisite trip distribution adjustments required to compensate for the fact that short trips and trips by some household types were more under-reported.

Some panelists asked if it would be possible to use logic constraints to accomplish trip-rate adjustments, adding the most trips to households that most resemble severe under-reporters. Another panelist commented that, for his city's model, he added trips for the busiest families, assuming that those that severely under-reported or did not respond to the survey were most like those families. However, since SCAG is not conducting a microsimulation, use of logic constraints or specific trip additions would not be practical. The consultants responded that, instead of adjusting trip rates, they propose to apply statistical weights to all households based on the level of under-reporting that was documented in the GPS survey. This will address panelists' concerns about how to make adjustments to trip distribution in order to account for differences in under-reporting rates among market segments.

Panelists also discussed their experiences with determining how to compensate for survey non-response, and discussed the complications caused by the fact that data from various cities show that some percentage of persons in actuality do not travel at all. This means that not all non-responders can be assumed to represent unreported trips. Although compensation for non-response bias is the responsibility of the survey firm rather than of the modeling consultants, the modeling consultants offered to report the number of persons in the survey who responded that they had not traveled at all. This will help SCAG better interpret the compensation that has been done.

E. External Trip Models

Ron West, Cambridge Systematics

Mr. West presented the technical approach and method used for modeling external trips, including a discussion of the separation of external-external through-trips (X-X) from internal-external or external-internal (I-X/X-I) trips. Modeling of all classes of external trips is in this case complicated by the fact that the SCAG modeling coverage area has recently expanded, although the consultants have accounted for this as well as possible during data processing. The added modeling areas east towards the Nevada and Arizona borders represent a significant additional length of highway, but little additional population. Preliminary examination of Caltrans Ramp Volume Reports shows that traffic volumes in this area are relatively low, and are balanced in both directions. Traffic

volumes at the existing cordons and the state lines are thus rather similar. The consultants plan to document this conclusion more exactly.

One of the recommendations from the previous peer review was to use the California Statewide Model loaded daily highway network volumes to predict traffic volumes at the perimeter of the new modeling area. The consultants briefly investigated the statewide model and made a tentative conclusion that it requires more validation and thus would not be particularly helpful. However, they plan to look at the state's model in more detail and document their conclusions as to its usefulness.

Mr. West noted that logic-checking has been applied during the processing of cordon survey vehicle trips by county of origin and destination. Illogical trips, such as those from San Diego to San Diego across the Grapevine, have been removed. Panelists pointed out that a few of the cordon surveys, when presented by time-of-day shares, reported no night trips. As this seemed suspect for a 24-hour survey, the consultants agreed to check the source.

The consultants presented a table of external Traffic Analysis Zones (TAZ's) with their accompanying cordon location. For each cordon that has been relocated by the expanded model coverage area, a proposal was presented for which existing survey location to use as representative of direction, time-of-day, and trip purpose results. Mr. Lee requested justification and documentation for each recommended choice of representative cordon.[1]

F. Mode Choice Models

Firouzeh Nourzad, Urban Analytics

Work on the mode choice models completed as of the second peer review meeting included selection of variables affecting the walk-friendliness and bicycle-friendliness of an area. In addition, the effect of response bias on mode choice modeling was discussed briefly. Results of discussions of walk- and bicycle-friendliness variables and the effects of response bias are presented below.

1. Walk-Friendliness Variables

Selection of walk-friendliness variables was based on significance of the variable, as well as on ready availability of data. For instance, although ratio of sidewalk miles to street miles has proven quite useful as a variable in a few other regions, measuring of sidewalk miles for the SCAG coverage area is beyond the resources available for this modeling project.

Therefore, the proposed walk-friendliness variables are:

[1] SCAG representatives also noticed that external TAZ numbers were misprinted in the table of external cordons and recommendations for unsurveyed locations (Table 5.7 in the draft report). The numbering should start at 4110, not 4107.

- number of non-freeway street intersections per square mile,
- length of non-highway streets per square mile,
- average grade per mile of non-highway streets, and
- land use mix/employment and residential densities.

The consultants proposed that modeling of walk-friendliness be conducted by zone. However, several panelists expressed concern that consideration of the proposed walk-friendliness variables by zone could pose a problem. In downtown areas, zones are small, and tend to miss possible on-foot destinations. In large zones, land use mix/employment and residential densities may tend to average out over the zone and miss localized variation. Therefore, the panelists would prefer to see walk-friendliness modeling done by walk-distance (circles of ½ or 1 mile radius) rather than by zone, if possible.

One panelist suggested that a root-mean-squared (RMS) variable be used for average grade per mile of non-highway streets in order to reflect the difficulties of walking on hilly ground, even if the ending altitude is the same as the starting. However, such data is not available. The consultants stated that the existing variable is weighted and seems to do well in accounting for walk-friendliness.

2. Bicycle-Friendliness Variables

Mileage of bicycle right-of-way in each TAZ were considered by type (restricted, separated, and signed) for use as variables in modeling of bicycle-friendliness. The data did not support this fine division, however, so the consultants proposed simply using a single variable of total miles of bicycle right-of-way per zone, and the panelists agreed. As of the second meeting of the peer panel, bicycle right-of-way data for Riverside and Ventura counties was not yet available. Mr. Lee stated that data for at least one county may be released within a few weeks.

Some panelists recommended modeling bicycle accessibility by radius (10 – 30 minute ride), rather than by zone. One panelist asked if bicycle accessibility modeling could be correlated with modeling of origins and destinations, but there are too few reported bicycle trips (only about one-tenth as many as walking trips) to permit such correlations.

3. Affect of Response Bias on Mode Choice Model

The under-response of transit riders in most household travel surveys was raised as an issue affecting all parts of the mode choice model. Panelists conjectured that this under-response is due to lower likelihood of having a home telephone or to literacy obstacles with written surveys. The panelists recommended consideration of whether this issue can somehow be addressed within the revised mode choice model. The consultants responded that under-response of transit riders is being addressed by merging onboard survey data with household data in order to have an over-sample of transit trips.

IV. Summary of Panel Recommendations

A brief summary of the panel's recommendations at the second peer review meeting is included in the list below:

Model Validation Targets

Vehicle Availability Models

- Validation targets for number of households within vehicle availability categories, by market segment, need to be postulated as "percent of percent" in that category in order to scale them to the size of each category. The consultants suggest in response a target for each vehicle availability category of plus-or-minus ten percent of the percentage of market segment households falling within that vehicle availability category.

Trip Generation Models

- When comparing the output of the pre-revision trip production model with the newer data set (the Year 2000 Post-Census Regional Travel Survey), the final model documentation should explain that non-household-based trips were calculated differently in the original input data than in the newer data set. In the original trip production model, non-household-based trips were counted by statistically padding the household-based trips from the 1991 Regional Household Travel Survey, rather than by direct survey, while the 2000 data included direct survey of non-household-based trips.

Mode Choice Models

- The mode share validation target should be stated as "percent of percent" of mode share within a given market segment. Once this is changed, the current target of plus-or-minus two percent becomes too tight and a higher percentage needs to be chosen. The consultants propose in response that a target range of 15 "percent of percent" be used.
- Panelists agree that time elasticity could be higher than the high boundary of the target range (-0.6), at least for Metrolink, but there is no consensus as to how much higher or as to whether the target should be changed. Therefore Ms. Outwater suggests that the targets be left as they are, but that SCAG allow for the expectation that elasticity for time may not fall within the stated target ranges.

Trip Assignment Models

Transit Assignment

- Validation of modeled regional boardings needs to be broken out by transit mode, and should be done with care, as the transit network is not being revised at this time.
- The consultants should analyze the significance of the Metrolink parking lot surveys, which SCAG plans to complete and provide to them in May.

In addition, the modeling consultants suggest that SCAG consider the feasibility of conducting an on-board survey of access mode to Metrolink.

- Deng Bang Lee requested that the consultants include cordon counts for transit in their model validation, but it is the understanding of the consultants that transit cordon counts are not available, as SCAG's transit network does not include routes out of the region. If this is not the case, SCAG should discuss this issue further with the consultants.

Highway Assignment

- Validation of highway assignment modeling must include targets for total regional VMT. In response the consultants propose a target range of plus-or-minus five percent for regional VMT.
- SCAG representatives requested that the consultants take into consideration the modeling required to gauge conformance with Caltrans air-quality regulations. The consultants propose to include additional validation targets for VMT by county (plus-or-minus two percent) and by air basin (plus-or-minus five percent) to address these issues.
- Validation targets should be developed for cordon counts as one type of screenline.
- SCAG may have to consider adjusting trip distribution models in order to achieve the stated validation targets for speeds and screenlines, as their validation is closely related to calibration of the trip distribution model.

Vehicle Availability Model

- The number of persons over age 16 in a household should be tested as a variable in the vehicle availability model (as a surrogate for the number of drivers).
- The consultants should examine the feasibility of bringing the effects of walk accessibility back into the vehicle availability model by considering only retail/service employment destinations when modeling employment accessibility.
- A function should be considered for modeling distance to employment, rather than a fixed value.
- SCAG would like the consultants to perform disaggregate validation of the vehicle availability model by ethnic group in order to check if the model has biases by ethnicity.
- If aggregate validation to test for bias is additionally desired, the consultants should work with SCAG to develop a list of what additional demographic data would be needed, and determine what is available. SCAG and the consultants should then make further decisions about the feasibility of conducting aggregate validation by ethnicity.
- If it proves feasible to conduct sufficient validation by ethnicity, the consultants should consider the results in partnership with SCAG. Together, a decision should be made as to whether the results indicate that ethnicity needs to be included as a variable in the vehicle availability model.

Trip Generation Models

Trip Production

Data Processing

- Both the MCA technique and the option of smoothing only suspect cells are both acceptable as methods for processing the cross-classification tables created for modeling of trip production. Therefore, the consultants should use their professional judgment in selection of a method.

Choice and Definition of Trip Purposes

- Although tour-based modeling falls outside the scope of the current contract, it should be considered for inclusion in future work, as the panel felt that tour-based modeling would be preferable to trip-based for use in classifying Home-Based Work trips as direct or strategic.
- The data should be examined more closely to determine if Home-Based Work – Strategic (HBWS) trips with long or distant intermediate stops occur frequently enough in the data set to warrant special consideration.
- The consultants should look further into the breakdown by sub-purpose of Home-Based Other trips, excluding Home-Based Quick Stop (HBQS), in order to determine the relative effects of considering HBQS separately, as part of Home-Based Other, or as part of Home-Based Shopping.
- Serve Passenger trips in the SCAG household survey should be evaluated to determine if they warrant being treated as a separate purpose.

Trip Attraction

Modeling of Reported Data

- Average weekly attendance at school or college should be examined as a more appropriate variable than enrollment for use in estimating attraction coefficients for the Home-Based School and Home-Based University/ College trip purposes. SCAG would need to provide attendance data for this purpose.

Under-reporting of Trip Rates

- Under-reporting data obtained from the GPS study for Home-Based Work trips need to be broken out by direct and strategic trip purposes in order to clarify whether under-reporting rates differ.
- Although the overall magnitude of under-reporting of trips obtained with the GPS units is reasonable, SCAG should examine carefully whether it will be feasible to perform the adjustments of trip distribution required in order to add the missing trips back in. The consultants propose to account for differences in under-reporting rates among market segments by applying statistical weights to all households based on the level of under-reporting that was documented in the GPS survey.
- In order to help SCAG better interpret the survey firm's compensation for non-response bias in the travel survey, the modeling consultants should report how many responders in the survey did not travel at all.

External Trip Models

- The consultants should check the source of the external cordon survey vehicle trip data, as the time-of-day shares for some cordons reveal suspect results with respect to nighttime trips.
- SCAG requests justification and documentation of each recommendation for choice of representative cordon to use for each unsurveyed cordon location.
- Misprinted numbering of TAZ's in Table 5.7 of the draft report should be corrected.

Mode Choice Models

Walk-Friendliness Variables

- Walk-friendliness variables should be modeled by walk-distance radius (1/2 or 1 mile) rather than by zone, if possible.

Bike-Friendliness Variables

- Bicycle right-of-way mileage should be modeled by radius (10-30 minute ride time) rather than by zone, if possible.
- SCAG should provide the consultants with bicycle right-of-way data for Riverside and Ventura counties as soon as they are ready.

Effect of Response Bias on Mode Choice Model

- The panelists recommended consideration of whether the under-response of transit riders to surveys can be addressed within the mode choice model. In response, the consultants state that they are addressing under-response of transit riders by merging onboard survey data with household data in order to have an over-sample of transit trips.

Though development of the revised Trip Assignment Model was not formally discussed as part of the second peer panel meeting, several recommendations for this model came out of the discussion about its validation. These recommendations are presented below. Development of the revised Trip Assignment Model will be reviewed in depth at the third peer panel meeting.

Trip Assignment Model

Transit Assignment

- Chaushie Chu will provide the MTA's Metrolink station choice model to the consultants. Though modeling of station choice is outside of the scope of the current contract, it is recommended that the consultants use the MTA model for reference in determining whether and how the effects of Metrolink parking demand and availability, fare zones, and vehicle speed can be reflected in SCAG's transit assignment model.

- The transit assignment model needs to account for the special characteristics of commuter rail headways. Current literature on modeling these headways should be reviewed for reference.

Highway Assignment

- Care must be exercised in balancing time vs. distance in modeling motorists' choice of arterial or freeway. The work of the Atlanta Regional Commission is recommended for reference on this topic.

V. Next Steps

The consultants plan to finish the external trip modeling, fully develop the mode choice model, and begin on the trip assignment model. The tentative date for the third and final meeting of the peer review panel is set for July, 2004.

VI. Appendices

A. List of Participants

- Mike Ainsworth, Southern California Association of Governments (SCAG)
- Sandra Balmir, FTA/FHWA Los Angeles Metropolitan Office
- Srini Bhat, SCAG
- Mark Bradley, Mark Bradley Research & Consulting
- Paul Burke, SCAG
- Chaushie Chu, Los Angeles County Metropolitan Transportation Authority (MTA)
- Guoxiong Huang, SCAG
- Dale Iwa, SCAG
- Keith Killough, KLK Consulting
- Keith Lawton, Keith Lawton Consulting
- Deng Bang Lee, SCAG
- Rena Lum, MTA
- Firouzeh Nourzad, Urban Analytics
- Maren Outwater, Cambridge Systematics
- Hannah Rakoff, U.S. DOT Volpe Center
- Erik Sabina, Denver Regional Council of Governments (DRCOG)
- Ron Taira, Orange County Transportation Authority (OCTA)
- Frank Wen, SCAG
- Ron West, Cambridge Systematics

B. Presentation

<*SCAG Travel Model Improvement Peer Review Panel*, April 16, 2004.>

C. Handouts

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Memorandum

TO: Deng Bang Lee, SCAG

FROM: Maren Outwater, CS

DATE: January 26, 2004

RE: Implementation of Peer Review Panel Recommendations

This memo identifies how we will test and implement the peer review panel recommendations from the November 3, 2003 peer review panel meeting. The following identifies the peer review panel recommendations and our proposed strategy to test these recommendations.

Summary of Panel Recommendations

A brief summary of the panel's recommendations is included in the list below.

Vehicle Availability

- The model structure to be used for vehicle availability should be selected based on whether the models are more capable of capturing the current and future conditions and provide more sensitivity to various policy variables. CS will test three model structures for vehicle availability (multinomial logit, nested logit and ordered response) and test all relevant demographic variables and select the best structure based on the capabilities and sensitivities of the models.
- It is important to understand where there are concentrations of elderly residents as they compose a large percentage of zero auto availability households. CS will test persons by age group as a variable in the vehicle availability models.

Trip Generation

- If possible, population by age should be used as a variable. CS will test persons by age group as a variable in the trip generation models.

- If possible, home-based shopping should be separated into convenience versus comparison shopping. CS will review the sample sizes and test the separation of the shopping trip purpose.
- If possible, non-home-based other should be separated using the same segmentation as home-based other trips. CS will test the separation of non-home-based trips into work, school, shopping and other trip purposes.
- The GPS survey should be used to identify problems in reporting trips in the household survey. CS will review the under-reporting in the household survey compared to the GPS survey and determine if changes to the trip generation model are warranted.
- Because the region is so large and complex, SCAG should be aware concerns about having the one model do too much. This concern is for SCAG and will not be addressed directly within the scope of work of the CS contract.

External Trip Models

- Results and estimates should be coordinated with other surrounding areas. CS will review the statewide model at the external stations to see if the statewide model can provide useful information to the SCAG external travel model.
- External trip purposes should represent work, business, and pleasure trips. CS will test the separation of external trips by trip purpose.
- Information on vehicle occupancy is important to capture since the Southern California region has an extensive network of HOV lanes. CS will make sure the conversion of person to vehicle trips in external trip models reflects the vehicle occupancy of external trips.
- It is important to verify that external trips are not double counted as internal trips. CS will review the internal and external model results to ensure that double-counting has not occurred.

Mode Choice Models

- An "auto access to transit" nesting structure should be added to the auto nest. We will test the inclusion of an auto access to transit nest within the auto mode.
- There should not be a restriction on a household characterized as not owning a vehicle but choosing to drive to transit. CS will not restrict households with no vehicles to transit modes.
- The data should be reviewed to see if it is necessary to provide a link between auto and local transit. CS will review the data for these linkages and determine how to best represent this in the mode choice models.
- Accurate data on both household income and ethnicity is important in applying the proper weights to the variables in the nested logit. CS will test the inclusion of income in the mode choice models. For political reasons, we will not propose ethnicity as a variable in the mode choice models.
- Additional validation might need to be done to the surveys for large households (4 or more persons), especially where there are some missing diaries for members of the

household. The 4+ person households will be reviewed in the survey re-weighting process to ensure that they are adequately represented in the survey data.

Trip Assignment

- Validation of the model should be done to a goal or target, not a "standard". CS will develop validation targets for each model component.
- A starting point for establishing validation criteria for speed is by facility type. Facility type validation targets will be included.
- Peaking factors should be updated using results from recent surveys. CS proposes to update the peaking factors using the recent household survey data.
- There is a concern about performing a validation of speed before completing work in the new mode choice model. Speeds will be validated after completion of mode choice models.
- There is a concern about updating the mode choice models and the trip assignment models without updating the trip distribution model. This concern is noted and will be addressed if the trip distribution model does not adequately validate to observed data.

Other

- There was concern expressed about the region continuing to pursue improvements to the current trip-based model structure. Several panel members felt that the region should explore moving to an "activity based" model because this type of model can better capture the interdependence of different activities in a series of trips. It is not within the scope of this project to estimate activity-based models. SCAG is exploring the future development of activity-based models.

D. Agenda

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Southern California Association of Governments

Peer Review Panel for the Regional Model Improvement Program

AGENDA

DATE:	Friday, April 16, 2004
TIME:	9:30 a.m. to 4:30 p.m.
PLACE:	818 W. 7th Street, 12th Floor, Los Angeles, CA 90017 909-784-1413

9:30 a.m.	Overview of Model Improvement Progress ▪ Trip Generation, Vehicle Availability and External Models ▪ Mode Choice and Trip Assignment Models
9:45 a.m.	Model Validation Process
10:30 a.m.	Vehicle Availability Model Results ▪ Model Structure ▪ Model Estimation ▪ Model Validation
12:00 p.m.	Lunch
1:00 p.m.	Trip Generation Model Results ▪ Model Structure ▪ Model Estimation ▪ Model Validation
2:30 p.m.	External Trip Model Results ▪ Model Structure ▪ Approach to Forecasting
3:30 p.m.	Status of Mode Choice Models ▪ Issues
4:30 p.m.	Adjourn/Schedule Next Meeting