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

Location:	Los Angeles, California
Date:	November 3, 2003
Exchange Host Agency:	Southern California Association of Governments
Exchange Participants:	Denver Council of Governments Metropolitan Transportation Commission Portland Metro Council San Diego Association of Governments Los Angeles Metropolitan Transportation Authority Orange County Transportation Authority Riverside County Transportation Commission Southern California Regional Rail Authority KLK Consulting Mark Bradley Research and Consulting Caltrans University of Texas

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Executive Summary

The following report summarizes the results of a Peer Review Panel held through the Transportation Model Improvement Program (TMIP), which is sponsored by the Federal Highway Administration (FHWA). The Southern California Association of Governments (SCAG) hosted a one-day peer panel review composed of MPOs, private consultants, and local transportation agencies to review the scope of work for its current travel demand model improvement project. The work involves improvements to the trip generation model, mode split models, external trip models, and the trip assignment model. The consultants under contract to SCAG, Cambridge Systematics and Urban Analytics, presented proposed work plans for each of the travel demand components, including auto availability and trip generation models, external trip models, mode choice models, and trip assignment models and solicited comments on the validity of the proposed work from the peer review panel.

This peer review session is the first of three to be held for the SCAG model improvement program. The second meeting, tentatively scheduled to occur in late February 2004, will concentrate on reviewing the results of the trip generation and mode choice models. The third meeting, to be held in May or June 2004, will review the results of the external trip models and the highway assignments.

Deng Bang Lee of SCAG and Maren Outwater of Cambridge Systematics facilitated the SCAG TMIP peer review. Participants in the peer review included transportation model experts from the Denver Regional Council of Governments (DRCOG), the Metropolitan Transportation Commission (MTC), the Portland Metro Council, the San Diego Association of Governments (SANDAG), the Los Angeles Metropolitan Transportation Commission (MTA), the Riverside County Transportation Commission, the Southern California Regional Rail Authority (SCRRA), KLK Consulting, Mark Bradley Research and Consulting, California Department of Transportation (Caltrans), the University of Texas, FHWA, FTA, and the Volpe Center. The peer review was held on November 3, 2003 in Los Angeles, California.

Background

The Southern California Association of Governments serves as the Metropolitan Planning Organization for six Southern California counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura, and Imperial. The region encompasses a population exceeding 16 million people in an area of more than 38,000 square miles. SCAG collaborates with the California Department of Transportation (Caltrans), county transportation commissions, and other agencies in the region that perform transportation planning and analysis.

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.

Over the years, SCAG has continuously sought to refine and improve its travel simulation and forecasting capabilities. This is attributable to the increasing significance of travel simulation models in support of the region's plans, programs, and major projects. During the 1990's, SCAG embarked on the first comprehensive overhaul of its travel simulation capabilities since the mid-1970's. Several major data collection activities for ongoing model improvements and the development of new modeling components have been undertaken, including:

- 1991 Regional Household Travel Survey
- Year 2000 Post Census Regional Travel Survey
- Transit On-Board Origin-Destination Surveys
- Regional Cordon Survey
- Street/Highway Inventory Survey
- Arterial Speed Study
- Regional Airport Demand Allocation Model
- Heavy Duty Truck Model
- Parking Cost Model

In 2002, SCAG initiated an effort to utilize the 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 June 2003, SCAG awarded a contract to Cambridge Systematics to improve the current travel demand model. There are six objectives in the SCAG Travel Demand 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

These short-term model improvements were the subject of the November 3, 2003 Peer Review Panel. The November meeting is the first of three planned peer review meetings. The second meeting will concentrate on reviewing the results of the trip generation and mode choice models. The third meeting will review the results of the external trip models and the highway assignments.

Presentation and Discussion

The current model improvements to take place over the next eight months will focus on:

- Auto availability and trip generation models
- External trip models
- Mode choice models
- Trip assignment models

The current model improvements are scheduled to be completed by July 2004. Because of the requirement for the region to adopt a new regional long-range transportation plan by April 2004, this model improvement work will not be incorporated into the current draft plan but will be incorporated into work for the following plan, tentatively scheduled for 2007.

Concurrently, modeling work is being performed by the Los Angeles MTA on a regional destination choice model. The MTA will use SCAG travel surveys for input into the model development and when completed, the MTA regional destination choice model may be incorporated into SCAG travel demand model.

Future model improvements, which are not included in this scope of work, but are expected to occur over the next several years includes work on:

- Trip distribution models
- Freight models
- Time-of-day models
- Software evaluation and conversion

Vehicle availability and trip generation models

Vehicle Availability

A key descriptive characteristic within SCAG's current regional travel demand model is how many vehicles are available (owned or leased) to particular households in the region. Household vehicle availability has a significant impact on trip generation and mode choice, so it is important that changes in auto ownership levels over time be captured during the forecasting process. This effort will look at vehicle availability rather than just auto ownership. This will help capture instances where a person who does not own an auto has one available from a neighbor or relative, for example.

The first step undertaken will be the validation of the current SCAG auto ownership estimation procedures using the 2001 SCAG Travel and Congestion Survey (TCS) and the 2000 US Census data.

Two general analysis approaches have been used to model vehicle availability:

1. Multivariate regression model — using a linear function of explanatory household, person, zonal, and transportation system variables
2. Discrete choice models — using either a multinomial logit (MNL) structure, an ordered response logit (ORL) structure, or a nested logit (NL) structure

For the current model improvement work, it is the recommendation of the consultant to use the discrete choice models because these types of models provide the ability to include more potential variables than the multivariate regression model.

Within the discrete choice model formulation, three separate model structures will be tested (MNL, ORL, and NL). The MNL structure implies that a household makes a single choice of the number of vehicles to acquire. The ORL structure assumes a sequential choice by households of whether to add another vehicle or whether to keep the existing number. The ORL structure also assumes that the base choice is whether to have any vehicles at all. The NL structure also assumes that choices are made sequentially, but this structure allows for the fact that some choices are more similar to each other than others.

Since the potential model structures are based on abstractions of the collective behavior of a large number of households, the final model structure will be selected mainly on empirical grounds – namely, which structure best fits the available data. After testing each model using the available data, the consultant will then recommend the best fitting model. Independent variables that will be examined in developing the vehicle availability model include:

- Persons per household
- Workers per household
- Household income
- Density measures
- Area type
- Pedestrian environment measures
- Highway accessibility variables
- Transit accessibility variables

The estimated vehicle availability models will be validated using the 2000 US Census Summary File 3 data (SF3) estimates and Public Use Microdata Samples (PUMS) data, which are census files that contain records for a sample of housing units with information on the characteristics of each unit and each person in it.

Panel members made a number of comments and suggestions. The model structure should be selected based on whether the models are more capable of capturing the current and future conditions and provide more sensitivity to policy variables. It was noted that the variables used are as important, if not more so, than the type of discrete choice structure that is chosen. The initial test will include the variables of auto, transit and walk accessibility. Accessibility and urban form variables should be used, if possible.

Noting that one of the best sources of data for this task is the PUMS data, it was stated that it is important to understand where there are concentrations of elderly residents, since many of the zero auto availability households are composed of elderly residents.

Trip Generation

The current trip generation model was developed from the more than 16,000 household interviews collected in the 1991 Regional Household Travel Survey (RHTS). The trip production and trip distribution submodels apply 13 trip rates and consider the number of households in a traffic analysis zone (TAZ). The trip production component uses the "cross-classification" method to apply trip rates to various zonal data characteristics. The trip attraction component uses regression equations to apply trip rates. The trip generation model is to be updated by using approximately 17,000 household interviews from the 2001 TCS to revise the previously estimated trip rates. Work on the trip generation model will include the estimation of a new trip production and attraction rate and the performance of statistical tests to measure the significance of differences between existing and new rates. After the re-estimation of trip production and attraction rates, the consultant will test other model structure options that are not currently in use. This includes using cross-classification variables representing the number of household members that are 18-years old or less, household income level, and age.

Model improvements to be accomplished include the identification of weaknesses in the trip generation model and the recommendation of improvements to its functionality, the determination of a desired interface and program features by SCAG, and the recoding of the existing trip generation model with new input data.

The panel recommended that population by age is an important variable to consider, especially given the changing demographics of the region. It is expected that the Southern California region will see a change in the composition of age cohorts in the next decade. It will be important to use demographic data to determine the breakdown of children, adults, and the elderly. The estimation of trips per type can be heavily dependent on the age composition of the population. Panelists also suggested further defining home-based shopping into two categories: convenience shopping and comparison shopping. Panelists added that the non home-based "other" category should follow the same segmentation for the home-based "other" category. The panel also recommended using data from the SCAG Global Positioning System (GPS) surveys to identify any problems in the trips in the RHTS.

One of the problems facing SCAG and the travel demand model is the complexity of the region. The region is large and diverse in economic and land use characteristics, density and population, and subject to changing development pressures. This means that it is important to use the correct set of variables for the different regions when clustering them into groups. Suggestions included taking into consideration the distinctive land use types, economic composition, and seasonal populations.

Because of the size of the model territory (3,800 square miles) and the complexity of the network with over 4,100 traffic analysis zones in the region, one commenter questioned whether SCAG was trying to have the travel demand model do too much. Is it better to have several smaller models, since most of the trips that occur in one sub-region tend to stay within that region, and then have a larger one that deals with interregional travel? SCAG responded that they used to have several models, one for Imperial Country for example, but that this caused problems with performing regional air quality analysis, integrating the various models, and calibrating cordon numbers at boundaries.

External Trip Models

Improvements will be made to the external trip model. External trips are split into two components:

1. through trips [external to external (E-E)]
2. other external trips [external to internal (E-I), and internal to external (I-E)].

Work will be done to re-estimate external trips based on 17 of the existing cordon locations and using the Caltrans statewide transportation model volumes. A fratar model will be used to develop the through trip table (E - E) using the total through trips and the distribution from the previous cordon survey. The other trips (E - I, and I - E) will be distributed using a gravity model. The two trip tables will then be combined to create a total external trip table. To put the external trip model in perspective, it was noted that external trips are less than 5% of total trips and through trips are less than 1% of total trips.

The external trips will be split between truck and passenger trips. The truck data will come from the commodity flow data, Caltrans truck volumes, port-related truck trips, and air cargo trips. The passenger data will be using the above mentioned cordon information and Caltrans statewide model volumes. External transit trips will not be represented.

The panel had several recommendations for improvements. It was noted that it is important to coordinate results and estimates with the external models of other surrounding areas. SCAG reported that they have worked with the San Diego region to agree on the estimated trend line growth at shared external cordon stations. Use of the statewide model will also be considered.

Panelists suggested that three external trip purposes that are important to capture are work, business and pleasure trip purposes. Panelists also noted that it is important to have information on vehicle occupancy since there is an extensive system of high occupancy vehicle lanes (HOV) in the Southern California region. It was also noted that it is important to verify that external trips are not double counted as internal trips.

Mode Choice Models

The mode choice model work will consist of updating the set of five mode choice models currently included in the SCAG travel demand-forecasting model. Work will begin by defining modes and purposes, alternatives and what mode choices are currently available for each of the different trip purposes, home-based work, home-based school, etc. Alternatives will be tested in a multinomial logit format. Variables will be introduced incrementally and sensitivity testing will be done for significant variables.

A nested logit model will be used, as it has the ability to present modes and submodes as distinct alternatives to the traveler. Alternatives to be introduced will include the toll/non-toll alternative and a new mode of commuter rail to account for Metrolink trips. Commuter rail will be distinct from urban rail.

Observed data from the 2000 Regional Household Travel Survey and the existing transit on-board surveys will be used in the calibration/validation phase of the model development. There are a total of approximately 16,000 household surveys. SCAG is working with these surveys to clean up some of the data and rectify geocoding errors. SCAG will weight the data from the survey using the 2000 U.S. Census.

Several other model work improvements involving mode choice are underway in the region. This includes an airport study, a heavy-duty truck study, an airport passenger demand travel model study, and an intercity rail model study. The panel noted that it is important to coordinate with these other studies to ensure regional consistency.

The panel had several recommendations for areas to consider in developing the mode choice model. The panel noted that it is important to consider high-speed rail as a mode. High-speed rail is a mode choice in the current model, and there was a consensus among the panel that this mode should be included in the update. Transit modes will include commuter rail, urban rail, high-speed rail, express bus, and local bus modes. The panel also recommended that the walk and bike level of service should be developed using X-Y coordinates rather than relying on the centroid connectors.

The panel recommended consideration of splitting out the “shared ride 3+” category. The current proposal is to look at “drive alone”, “shared ride-2 people”, and “shared ride 3 and more people”. Because some of the HOV lanes are approaching capacity, it is important to be able to test policies that might increase the vehicle occupancy requirement to use the HOV lanes. There should also be a toll/no-toll nest for shared rides and a maximum threshold for toll users.

The panel made several recommendations to improve the nesting structure for “auto access to transit”. Panelists suggested adding a nesting structure with “auto access to transit” to the auto nest. Because it is possible for a household member to not own a vehicle but have access to one, there should be no restriction on a household characterized as not owning a vehicle but choosing to drive to transit. The panel agreed with the proposal that it is not a priority to treat kiss-and-ride transit trips from park-and-ride transit trips. Panelists also recommended reviewing the data to verify whether or not

it is necessary to provide a link between auto and local transit. The transit model network does not currently assume auto access to local bus stops unless the local bus service coincides with express bus park-ride lots or rail stations.

The panel felt that it was important to obtain accurate data on both household income and ethnicity to be able to apply proper weights to the variables in the nested logit. Both income and ethnicity can be difficult to forecast.

It was noted that there could be several issues relating to larger households. For large households (4 or more persons), there are some problems with incomplete diaries for each member of the household. The panel agreed that it was a good idea to use the household surveys of large households even if one diary was missing. It was recommended that the number of missing trips for the household should be imputed for use in the trip generation model, but not in the mode choice model. There is also a problem of drivers reporting more passengers than passengers reporting themselves as passengers. Some additional validation may need to be done. The survey records also need to be re-weighted and linked to improve the accuracy of trip purposes.

Trip Assignment Models

The current trip assignment procedures in the SCAG Regional Transportation Model include a highway assignment with a heavy-duty truck component, a transit assignment, and a toll assignment procedure to assign toll trips. Work on this component will begin by revalidating and establishing a model validation standard. Model improvement work will include testing alternative volume delay functions (VDF). Work will also re-validate the trip assignment model based on volumes, volume to capacity ratios, and by speeds by facility type. The calibration will be done at the regional level and whatever market segments are introduced, such as zero auto available households. Transit validation will be done using line level and corridor level data.

Panel members suggested that validation should not be done to "standards" but instead to goals or targets as discussed in FHWA technical guidance on model development. Meeting specific assignment standards is problematic because trip distribution and truck models, which are not being validated, affect these standards.

It was proposed that a starting point for establishing a validation criterion for speed is by facility type. Recommendations by panel members included updating peaking factors using results from the 2000 RHTS and using distance in the volume-delay functions for freeways. The panel also expressed concern about the appropriateness of performing a validation of speed before completing work on the new mode choice model. Other inputs recommended to use in the speed validation process include the GPS and PEMS data for observed speeds, and using data from the gravity model.

The panel also expressed concern about updating the mode choice models and the trip assignment models without updating the trip distribution model. The MTA is currently performing parallel work on a destination choice model that may be incorporated into the

SCAG model. It was felt that it is important for there to be close coordination between these two efforts.

There was also discussion on the panel about the appropriateness of SCAG continuing to pursue improvements to its trip-based model structure. Several panel members recommended exploring the possibility of moving towards an "activity based" model. It was noted that at least ten other regions across the country, specifically New York City and Columbus, Ohio, are working on or have implemented activity based modeling.

The main feature of activity-based modeling approach is that it predicts "tours" of travel rather than "trips". These activity-based models simultaneously predict the main components of all of a person's travel across the day. A home-based tour includes the entire chain of trips made between leaving home and arriving back at home. By using tours as a key unit of travel, one can capture the interdependence of different activities in a trip chain. This provides a better understanding of non-home-based trips, especially in the case of the work-based sub-tours that represent a significant proportion of non-home-based travel.

The main motivation in developing activity-based models is the need to better understand traveler's responses to transportation policies. There are a number of ways that activity-based models provide these capabilities. Activity-based models can account for tradeoffs for auto ownership based on the employment location of the primary worker in the household.

Activity-based models can account for tradeoffs between making additional stops on the primary tour or making additional tours by defining the primary tour, tour type, and number of stops simultaneously. Activity-based models can also account more reliably for the complexities involved in multi-mode trip-making. Travel modes are affected by decisions to travel in a round trip rather than an individual trip segment and certain modal options have multiple options for modes within a round trip.

The panel recognized the fiscal and time constraints facing the Southern California region that would be involved in shifting to an activity-based model. It was recognized the importance of having a working model in place to perform conformity and other regulatory functions and recognized the need to improve the current trip based travel demand model.

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.

- It is important to understand where there are concentrations of elderly residents as they compose a large percentage of zero auto availability households.

Trip Generation

- If possible, population by age should be used as a variable.
- If possible, home-based shopping should be separated into convenience versus comparison shopping.
- If possible, non-home-based other should be separated using the same segmentation as home-based other trips.
- The GPS survey should be used to identify problems in reporting trips in the household survey.
- Because the region is so large and complex, SCAG should be aware concerns about having the one model do too much.

External Trip Models

- Results and estimates should be coordinated with other surrounding areas.
- External trip purposes should represent work, business, and pleasure trips.
- Information on vehicle occupancy is important to capture since the Southern California region has an extensive network of HOV lanes.
- It is important to verify that external trips are not double counted as internal trips.

Mode Choice Models

- An "auto access to transit" nesting structure should be added to the auto nest.
- There should not be a restriction on a household characterized as not owning a vehicle but choosing to drive to transit.
- The data should be reviewed to see if it is necessary to provide a link between auto and local transit.
- Accurate data on both household income and ethnicity is important in applying the proper weights to the variables in the nested logit.
- 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.

Trip Assignment

- Validation of the model should be done to a goal or target, not a "standard".
- A starting point for establishing validation criteria for speed is by facility type.
- Peaking factors should be updated using results from recent surveys.
- There is a concern about performing a validation of speed before completing work in the new mode choice model.
- There is a concern about updating the mode choice models and the trip assignment models without updating the trip distribution model.

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.

Next Steps

This TMIP peer review was intended to provide initial feedback from a panel of experts to SCAG and its consultants, Cambridge Systematics and Urban Analytics, on the proposed improvements to be made to the SCAG travel demand model. SCAG and the consultants will incorporate the recommendations from this one-day session to into the scope of work and will begin work on the proposed model improvements. It is expected that this model improvement work will be completed by the consultants by June 30, 2004.

The next step will be to reconvene the panel of experts in late February 2004 to both review the work produced to date and to offer advice on work to be performed between March and June 2004. A third meeting will be held in late Spring, 2004 to again provide a review of work on the travel demand model improvement project.

Appendix

List of Participants

- William McFarlane, San Diego Association of Governments
- Keith Lawton, Portland Metro
- Erik Sabina, Denver Regional Council of Governments
- Henning Eichler, Southern California Regional Rail Authority
- Chuck Purvis, Metropolitan Transportation Commission
- Keith Killough, KLK Consulting
- Mark Bradley, Mark Bradley Research & Consulting
- Chandra Bat, University of Texas
- Tony Van Haagen, Caltrans District 7
- Shirley Medina, Riverside Country Transportation Commission
- Ron Taira, Orange County Transportation Authority
- Chaushie Chu, Los Angeles County Metropolitan Transportation Authority
- Sandra Balmir, FTA/FHWA LA Metro
- Bruce Spear, FHWA
- Deng-Bang Lee, Southern California Association of Governments (SCAG)
- Guoxiong Huang, SCAG
- Jim Sims, SCAG
- Srini Bhat, SCAG
- Maren Outwater, Cambridge Systematics
- Arun Kuppam, Cambridge Systematics
- Firouzeh Nourzad, Urban Analytics
- Terry Regan, U.S. DOT Volpe Center
- Steve Smith, San Bernardino Association of Governments

Agenda

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Peer Review Panel for the Regional Model Improvement Program

AGENDA

DATE: Monday, November 3, 2003
TIME: 9:30 a.m. to 3:30 p.m.
PLACE: 818 W. 7th Street, 12th Floor, Los Angeles, CA 90017 909-784-1413

9:30 a.m. Overview of the Model Improvement Program

- Current model improvements
- Future model improvements
- Related modeling studies in the region

10:00 a.m. Approach to Trip Generation and Auto Ownership Models

- Model Structure
- Model Estimation
- Model Validation

11:30 a.m. Approach to External Trip Models

- Model Structure
- Approach to Forecasting

12:00 p.m. Lunch

1:00 p.m. Approach to Mode Choice Models

- Model Structure
- Model Estimation
- Model Validation
- Sensitivity Testing

2:30 p.m. Approach to Trip Assignment Model

- Validation standards
- Test alternative volume-delay functions
- Prioritize new capabilities

3:30 p.m. Adjourn/Schedule Next Meeting

Travel Demand Model Improvement Program Presentation

See attached PowerPoint presentation: PT1_SCAG Peer Review Meeting_Nov03.ppt