Report on Findings of the Peer Review Panel of the San Diego Association of Governments Travel Demand Model

Held June 23-24, 2005
San Diego, California

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San Diego Association of Governments
Travel Demand Model

Location: San Diego, California
Date: June 23-24, 2005
San Diego Association of Governments Contact Person: Bill McFarlane, bmc@sandag.org,
619-699-1976

Peer Panelists

Name	Organization
Ken Cervenka	North Central Texas Council of Governments, panel chair
Chandra Baht	University of Texas
Larry Blain	Puget Sound Regional Council
Gordon Garry	Sacramento Area Council of Governments
Maren Outwater	Cambridge Systematics
Eric Pihl	Federal Transit Administration
Guy Rousseau	Atlanta Regional Commission

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I. Executive Summary

This report summarizes the results of a travel demand model peer review held by the San Diego Association of Governments. SANDAG requested that peer review panelists provide suggestions on short- and medium-term model enhancements to its existing TransCAD®-based four-step model. SANDAG also wanted recommendations on a possible switch to an activity/tour-based model in the long-term.

The panel felt that SANDAG's current model is consistent with the state of the practice, and that the biggest question for SANDAG as it moves forward is how much to invest in revisions to the existing model versus the development of a new activity/tour-based model. The panel's primary recommendations were:

- Expand data collection efforts to include a workplace survey, additional use of two-day travel diaries, and better transit and auto speed data. This enhancement is useful for the current four-step model, but can also be utilized if SANDAG decides to develop an activity/tour-based model.
- Modify trip generation rates so that they are based on households and persons rather than structure type.
- Run all trip purposes to convergence in trip distribution.
- Explain and document the nesting coefficients used in the interim mode choice model. The basis of the coefficients may not be sufficiently scientific to meet Federal Transit Administration (FTA) New Starts criteria.
- Pay special attention to transit network coding. SANDAG is expecting huge increases in the level and types of transit service. The characteristics of these new services must be carefully and comprehensively determined before transit network coding.
- Reduce post-processing volume adjustments by using observed speeds rather than level-of-service/capacity calculations in the volume-delay function.
- Add root mean square error checks to validate model volumes.
- Add a fourth time period for mid-day. This may be important for air quality modeling since ozone levels are highest during the warmest hours of the day.

II. Background

The San Diego Association of Governments (SANDAG) is the metropolitan planning organization (MPO) for San Diego County in Southern California. It is bordered on the north by Orange and Riverside Counties and in the south by the state of Baja California in Mexico. It encompasses a land area of more than 4,200 square miles, with a population of approximately three million people.

SANDAG has a four-step travel demand model that has been operating on TransCAD® software since 2004, when it was converted from TRANPLAN. The TransCAD model is linked to ArcInfo® geographic information systems (GIS) software for enhanced data display, storage, and manipulation.

A unique feature of SANDAG's modeling program is its Service Bureau, a fee-based service that provides low cost, reliable travel modeling services to the public and private sectors. In addition,

the Service Bureau generates revenue for SANDAG's operations. Because many Service Bureau customers request a model run with very short turnaround time, SANDAG is very concerned about model run time, which currently varies between 3 and 21 hours depending on the complexity of the model run and the computer equipment used. SANDAG hopes that any model improvements will not lead to increased run time.

SANDAG's 2030 Regional Transportation Plan,[1] published in 2003, projects that total person trips in the region will increase by about 40 percent between 2000 and 2030, while transit trips will increase by about 160 percent during this same period. To meet this explosion in demand, SANDAG expects major changes in its transportation network over the next 25 years. The number of managed lane miles is planned to increase from 25 miles to 468 miles, while mixed-use freeway lane miles will increase from 2173 miles to 2553 miles. Future transit enhancements will focus on rail, bus rapid transit (BRT), and local bus service to replace the limited express bus service that currently exists. Rail vehicle miles are expected to more than double, and regional and corridor BRT service will be introduced.

SANDAG hopes to move to an activity/tour-based model in the future. However, realizing that this will take several years, it requested a peer review from the Federal Highway Administration (FHWA) Travel Model Improvement Program (TMIP) to provide suggestions on short- and medium-term improvements to its existing four-step model. SANDAG requested that the peer review panel address the following issues:

- Provide guidance on forecasting methodologies for evaluating new transit services and smart growth land use policies.
- Assess SANDAG's model with respect to the state of the practice.
- Recommend actions leading to an activity/tour-based model and micro-simulation
- Provide guidance and recommendations for incorporating smart growth land use policies into the travel demand model.
- Evaluate SANDAG's resource commitments for data collection, model development, and model application.

III. The Current Model

Various SANDAG staff gave presentations to the peer review panel describing the existing travel demand model and posing questions and concerns for the panel to consider.

1. Surveys and Validation Data
Presenter: Bill McFarlane

Much of SANDAG's travel data comes from its 1995 Travel Behavior Survey and the California Statewide Travel Survey. The Statewide survey was conducted in 2001 and included travel diaries and vehicles equipped with global positioning systems (GPS) that tracked their movement. Because GPS data showed significantly more trips per household, SANDAG corrects its trip rates for survey under-reporting. Non-work trips require the highest adjustment rates, while work trips were almost equal for the two types of data collection. Furthermore, SANDAG found that random sampling did not produce enough responses from some segments of the

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[1] Available at http://www.sandag.org/index.asp?projectid=197&fuseaction=projects.detail

population, such as regular transit riders and people who live and work in the central business district, to allow for statistical analyses. For its planned 2006 travel survey, SANDAG will over-sample these parts of the population to better understand and incorporate their travel behavior. SANDAG would like to improve the amount and accuracy of travel data by developing a more rigorous traffic count program and deploying automatic passenger counters on transit vehicles.

2. Highway Network
Presenter: Ziying Ouyang

SANDAG's model has a detailed highway network that includes functional classification, posted speed, number of lanes, intersection controls and geometry, and other characteristics. Much of the data comes from digital aerial photos. Data for alternatives analyses come from the regional transportation and capital improvement programs, Caltrans, and the long-range transportation plan. Roadway and intersection capacity are calculated in accordance with standards set out in the Highway Capacity Manual. Link travel time is determined using the link distance, posted speed, and a congestion delay adjustment factor. A minimum path algorithm finds the shortest generalized cost between zone pairs based on a time value of $21/hour and a distance value of $0.15/mile. Tolls (if any) are accounted for in the mode choice model.

3. Transit Network
Presenter: Tom King

The transit network includes transit type (e.g., express bus, commuter rail, etc.), stops, routes, and in-vehicle travel times. Transit walk access is limited to a one-half mile radius of the transit access point, with adjustments for walk barriers such as freeways, elevation change (since a steep hill decreases the distance people are willing to walk), and a straight line-to-actual walk distance correction factor based on type of street pattern (grid or curvilinear). Drive access to transit is capped at 30 minutes.

The transit network is coded using transit access points (TAPs), which are selected transit stops approximately one half mile apart. Transit paths and skims are based on TAP to TAP impedances rather than zone to zone impedances. This allows the mode choice model to explicitly consider sub-areas within each zone that may have different transit access opportunities. Drive access to transit is based upon the highway travel time on the highway network.

4. Trip Generation
Presenter: Bill McFarlane

The trip generation model uses 10 trip types—home-based work, college, school, shop and other; work-based other; other-based other; serve passenger; visitor; and airport. It also has six special generator categories: airport, military bases, universities, tourist attractions, casinos, and beaches. For non-residential land uses, trip rates are determined per acre by land use type, although SANDAG would like to change to trips rates based on square footage. Residential trips rates are determined by number of dwelling units and dwelling type (single family, multi-family, and mobile home), although SANDAG is considering changing this to household type to allow consideration of demographic variables. Regional control totals are used to adjust trip rates,

linking trip rates to changes in logically related variables. For example, home-college trips are adjusted for changes in the college age populations. SANDAG would like to improve the trip generation model by incorporating more socio-economic variables and by calculating trip rates for non-residential variables by building square footage rather than by acre.

5. Trip Distribution
Presenter: Bill McFarlane

SANDAG's trip distribution model uses a doubly constrained daily gravity model with multiple feedback loops, although SANDAG may consider changing to a destination choice model. The current model's feedback loop uses the impedance from the previous iteration, and then runs a gravity model, does vehicle factoring and trip assignment, and then feeds back the new impedance. To reduce model run time, it does not start with free-flow conditions, since these conditions rarely exist.

Each trip purpose is calibrated to match an average trip length that varies from three miles to 19 miles. Trip length differences are generated using a gamma function that generates friction factors. These friction factors determine the likelihood of a particular trip being made based on the cost increment.

6. Mode Choice
Presenter: Bill McFarlane, Bill Davidson

SANDAG has three different mode choice models at various stages of development:
  a. An **Estimated Model** that is being developed by PB Consult using San Diego survey data;
  b. An **Interim Model** that uses asserted coefficients with calibrated constants to match San Diego mode shares; and
  c. A **Market Research Model** that was estimated from a stated preference survey.

a. Estimated Model
Mr. Davidson summarized the estimated model that is currently being developed. The expected nesting structure will divide drive trips into drive alone, two person HOV, and three or more person HOV. Drive alone trips are further disaggregated into trips that use toll lanes and trips that use mixed-flow lanes. HOV trips are disaggregated into vehicles that use an HOV lane, vehicles that do not use an HOV lane, and vehicles that use a tolled lane. Transit trips are divided into local bus, express bus, commuter bus, light rail, and commuter rail. These are further segregated by access type (walk access, drive access, and drop off access). Non-motorized trips are split into bike and walk. Finally, Mr. Davidson mentioned difficulties with estimating reasonable time and cost coefficients.

b. Interim Model
Because the estimated model is taking longer than expected to implement, SANDAG currently runs the interim model that meets FTA New Start criteria. This model will be replaced when the new estimated model is complete. The interim model has the same nesting structure for auto modes that is being proposed for the estimated model. However, transit trips are first divided by the three access modes and then into an aggregated set of ride modes (local bus, express/commuter bus, rail/BRT).

In the estimated and interim models, TAZs are divided into smaller units called master geographic reference areas (MGRAs). Mode shares are calculated at the MGRA level to better represent transit access and non-motorized opportunities. Non-motorized trip distance is capped at six miles; transit auto drip distances are capped based on a ratio between the drive distance to transit access site, transit distance, and drive-only commute distance.

The interim mode choice model collapses the ten trip purposes into six categories by grouping home-based-shop and home-based-other into a single category, and by grouping work- and other-based-other, visitor, and airport trips into a single category. Additionally, all trips are stratified into three incomes and into two time periods: peak period (6:00 a.m. to 9:00 a.m. and 3:00 p.m. to 6:00 p.m.) and off-peak.

c. Market Research Model
The market research model connects traveler attitudes to demographic characteristics, and, through cluster analysis, segments the traveler market. It assigns trips into six market segments based on a combination of gender, age, and income, instead of the more traditional income or auto ownership market segmentation. A multinomial logit model, estimated using stated preference data, divides commute and non-commute trips for each of the six market segments into modes using time and cost coefficients that vary by market segment. Thus far, SANDAG has used the market research model for only some special purpose analysis, but the model developer (Cambridge Systematics) is encouraging wider use of the technique.

7. Traffic Assignment
Presenter: Ziying Ouyang

The traffic assignment logit model uses an iterative process to balance link volumes and capacity by minimizing an overall congestion index. First, the minimum cost assignment is calculated using a generalized cost function. The speed is then adjusted for congestion, based on mid-link and intersection V/C. The process is iterated until it reaches equilibrium. The model uses three time periods: morning peak, afternoon peak, and off peak; and a convergence of 0.01. Post-processing is used to adjust volumes based on empirical data. The model is validated using various categories of VMT and an extensive database of traffic counts.

8. Air Quality Modeling
Presenter: Limeng Yu

The San Diego area is currently in non-attainment for eight-hour basic ozone and particulates. SANDAG uses an EMFAC/BURDEN modeling package. SANDAG feels that it is simpler than other modeling packages, and it is well supported by the developer. The model inputs are emission factors, vehicle mile traveled (VMT), trip ends, and hourly speed fractions. The model generates regional total emissions and fuel consumption. Because of cleaner vehicles, SANDAG expects emissions to decrease over the next 25 years despite increasing VMT and fuel consumption.

IV. Recommendations

After the first day's presentations and discussion, the panel met in private to generate recommendations for model enhancement. Generally, the panel felt that SANDAG's model represented a good balance of theoretical elegance and practical model application, and that it did not need major revisions. The panel was particularly impressed with:

- SANDAG modeling staff, who are extraordinarily knowledgeable, motivated, responsive, and forward thinking;
- The multi-year and very detailed network coding;
- The detailed land use data;
- Its careful attention to demographic forecasting;
- Its arterial volume delay procedures influenced by intersection capacity;
- The consistency between region-wide and local studies; and
- The good representation of transit access and pathbuilding.

The panel felt that the big question for SANDAG is how much to invest in small improvements in the existing four-step model versus investing in a new activity-based model. The following section presents the panel's recommendations for enhancement to SANDAG's model. Some of the recommendations apply only to the current model, while others could be applied to the current model and to a new model, if SANDAG decides to develop one.

The panel was uncomfortable with the constraints place on the model to minimize run time. While they understood that SANDAG needs to focus on to provide quick turnaround for Service Bureau customers, SANDAG is probably sacrificing some model improvements to minimize run time.

The panel's recommendations are categorized as follows:
- Surveys and validation data
- Trip generation
- Trip distribution
- Mode choice
- Traffic assignment
- Long-term model enhancements

1. Surveys and Validation Data

The panel felt that future surveys should be designed to support the study of broader policy issues. SANDAG should identify the specific policy questions to be addressed, and develop survey methodologies that will generate data to apply to these questions. Further, the panel recommended that SANDAG's data collection efforts be coordinated with those of the Los Angeles area MPO to allow for inter-regional modeling. Finally, while good survey information will be useful for improvements to its current model, this information can also be applied to a new activity-based model, if that is the route that SANDAG chooses.

The panel felt that the model should include more market segmentation, especially in the trip distribution and mode choice models. FTA will probably require this for New Starts funding. When designing new surveys, SANDAG should consider the following points.

- Perform a household survey at least every 10 years and a transit on-board survey at least every 5 years.
- Consider conducting a workplace survey.
- Include at least 1 in 200 households in a general purpose and targeted household survey and use two-day activity diaries.
- Consider collecting more time-of-day information.
- Consider adding weekends to travel diaries; traffic on weekends is more concentrated during the hottest hours of the day, which increase ozone levels.
- Make sure the sample is sufficiently large to generate statistically viable sample sizes for the various demographic and socio-economic groups.
- Consider collecting more reliable transit and auto network speed data (by time of day), and time of day vehicle classification counts for each roadway functional class.

2. Transit Network

Because transit service in the San Diego area is undergoing significant changing with increased rail and express bus service and the development of BRT, coding the transit network must be done carefully. While there were no specific recommendations on how to best represent BRT service, SANDAG should carefully and comprehensively determine the characteristics of these new services before coding them into the transit network. Also, with various different transit services, the model will have to consider combined headway.

3. Trip Generation

The panel felt that SANDAG's should develop a truck model. Also, it felt that modifying home-based production rates to use households and persons rather than structure type is a good idea. Further, SANDAG might consider HBW demographic stratifications by, for example, income or auto ownership. Finally, trip attractions should be based on the number of employees for most land use types, using improved employment data (ES-202 clean up).

4. Trip Distribution

For trip distribution, the panel recommended that the model carry over the market segmentation from trip generation, at least for the work trip purpose. It also felt that the model should run all trip purposes to convergence. The panel felt that the model could be enhanced by changing to destination choice, but that this probably should not be a priority.

5. Mode Choice

While there was no specific recommendation on transit forecasts, the panel was uncomfortable with the dramatic forecasted increase in transit ridership since it far exceeds the predicted increases in the metropolitan areas represented on the panel. In addition, the panel felt that SANDAG's interim model needs more clarification and documentation for FTA New Starts, especially for the nesting coefficients, which seem reasonable but have no scientific basis. The panel also recommended that the new mode choice model, when completed, be compared against the interim model as a reasonableness check. Finally, SANDAG should conduct a sensitivity test on the model choice model to compare demographic and network changes. There was no consensus among the panelists that the market research model is an improvement over traditional approaches.

6. Traffic Assignment

The panel expressed concern about the post-processing volume adjustment procedures. It recommended that the volume-delay functions be revised using observed speeds as opposed to level-of-service volume/capacity calculations. In addition to the various VMT measures it uses to validate model volumes, the panel recommended that SANDAG also use root mean square error checks. Finally, the panel recommended that SANDAG consider adding a fourth time period for mid-day. This may be important for air quality modeling since ozone levels are higher during the day's warmest hours.

7. Long Term Changes

The panel supported a change to activity-based model. If SANDAG decides to do this, it will take several years to develop the new model. Therefore, it should expect to use the current model for the next four to six years. Generally, the panel felt that SANDAG should concentrate on regional modeling over site-specific modeling, which is often requested by Service Bureau customers. Also, as land use and travel patterns change, SANDAG may need to expand the model area.

SANDAG

401 B Street, Suite 800
San Diego, CA 92101-4231
(619) 699-1900
Fax (619) 699-1905
www.sandag.org

MEETING NOTICE AND AGENDA

SANDAG MODEL PEER REVIEW PANEL

Thursday, June 23 and Friday, June 24, 2005

SANDAG, 8th Floor Conference Room
401 B Street, Suite 800
San Diego, CA 92101-4231

Staff Contact: Bill McFarlane
                          (619) 699-1976
                          Bmc@sandag.org

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SANDAG MODEL PEER REVIEW PANEL

THURSDAY, JUNE 23, 2005

GENERAL INFORMATION

8 a.m.   **Welcome and Introductions**

Eric Pahlke, Chief Deputy Executive Director: SANDAG transportation issues

8:15 a.m.   **Peer Review Overview**

Ken Cervenka, Panel Moderator: Direction for the peer review process

8:30 a.m.   **Overview of Modeling Process**

Bill McFarlane: Transportation modeling framework, general modeling issues, travel indicator forecasts

9:30 a.m.   **Service Bureau Program**

Mike Calandra: SANDAG's program for providing modeling assistance to outside agencies and consultants

9:45 a.m.   **Break**

MODEL INPUTS

10 a.m.   **Surveys and Validation Data**

Bill McFarlane: SANDAG'S data collection program

Panel Issues: Data deficiencies, sample sizes, resource allocation, resource commitment

10:30 a.m.   **Highway Networks**

Ziying Ouyang: Network editing procedures, travel time and capacity computations, speed validation

Panel Issues: Highway capacity procedures, speed validation

11 a.m.   **Transit Networks**

Tom King: Network editing procedures, travel time computations, transit access procedures

Panel Issues: Coding BRT service, use of walk access networks

11:30 a.m.   **Growth Forecasting Process**

Jeff Tayman: Land use inputs and models used to produce regionwide and small area growth forecasts

Panel Issues: Near term vs. long term improvements

Noon   **Break for Lunch**

MODEL COMPONENTS/NEAR TERM IMPROVEMENTS

1 p.m.   **Trip Generation**

Bill McFarlane: Trip purposes, trip rates, regional control totals, model validation, planned improvements

Panel Issues: Additional household/person variables, trip purpose definitions; work trips by income level, commercial vehicle trips

1:30 p.m.   **Trip Distribution**

Bill McFarlane: Gravity model impedances, feed-back loops, validation results

Panel issues: Destination choice models, log-sum measures, commercial-vehicle distribution

2 p.m.   **Mode Choice**

Bill McFarlane: Transit modes, purposes, market segmentation, modal constants, validation results

Bill Davidson: Current mode choice model improvement project

Panel Issues: All of the above, forecasting ridership for improved transit systems

3 p.m.   **Break**

3:15 p.m.   **Highway/Transit Assignment**

Ziying Ouyang: Current highway and transit assignment procedures, validation results, post-processing, interactive mapping tool

Panel Issues: Additional time periods, time-of-day procedures, managed-lane procedures

4 p.m.   **Emissions Modeling**

Limeng Yu: California Air Resources Board's EMFAC model for calculating emissions and fuel consumption

4:15 p.m.   **Outside User Input**

Opportunity for SANDAG committee members and outside users to express concerns and issues

5 pm.   **Preliminary Panel Deliberations (Closed session)**

7 p.m.   **Dinner at Downtown Restaurant**

FRIDAY, JUNE 24, 2005

GENERAL INFORMATION

8 a.m.   **Traffic Simulation**

Mike Calandra: Pilot study to link travel model forecasts with CUBE's Dynasim traffic simulation software

Panel Issues: Experiences in other areas with traffic simulation software

8:30 a.m.   **Long Term Improvements**

Bill McFarlane: Framework for moving to more advanced urban simulation and activity/tour-based micro-simulation models

Panel Issues: Time frame, budgeting concerns, evaluation methodology, general work plan

11 a.m.   **Final Panel Deliberations (Closed Session)**

1 p.m.   **Presentation of Findings and Recommendations**

2 p.m.   **Discussion of Findings**

3 p.m.   **Adjourn**