The Travel Model Improvement Program

Summary Report

Omaha-Council Bluffs Metropolitan Area Planning Agency (MAPA) (Omaha, Nebraska MPO)

Travel Demand Model Peer Review

Omaha, NE
November 2010

Helping Agencies Improve Their Planning Analysis Techniques

TMIP
Travel Model Improvement Program

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Disclaimer

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Acknowledgements

The FHWA wishes to acknowledge and thank the peer review panel members for volunteering their time to participate in the peer review of the Metropolitan Area Planning Agency (MAPA) travel demand model and for sharing their valuable experience.

The Peer Review Panel Members were:

MaryAnn Waldinger (COMPASS)
Philip Mescher (Iowa DOT)
Stephen Lawe (RSG, Inc.)
Jeremy Raw (FHWA)
Eric Pihl (FHWA)

Brief biographies for each of the peer review panel members are presented in Appendix C.

Report Organization

This report is organized into the following sections:

- Overview of the purpose of this report, including an introduction to the peer review process and the objectives of the MAPA peer review;
- Planning responsibilities of MAPA;
- Introduction to the demographics, land use and transportation characteristics of the MAPA region;
- A brief history of travel demand modeling at MAPA;
- Discussion of how the MAPA travel demand model is used, concerns about the model identified by MAPA, a review of model inputs and each component of the model, and finally discussion of validation of the MAPA model. This section includes the majority of the discussion that took place during the peer review;
- Additional discussion of future enhancements to the MAPA model; and
- Peer review panel recommendations, including prioritized next steps.

In addition to the main body of the report, there are four appendices. Appendix A is a list of peer review participants, Appendix B is the peer review meeting agenda, Appendix C contains brief biographies for each of the peer review panel members, and Appendix D is a summary of responses to specific questions that MAPA raised prior to the peer review.

Report Purpose

This report summarizes the results of a peer review of the MAPA travel demand model. The peer review was supported by the Travel Model Improvement Program (TMIP), which is sponsored by FHWA. The peer review of a travel model can serve multiple purposes, including identification of model deficiencies, recommendations for model enhancements, and guidance on model applications. Given the increasing complexities of travel demand forecasting practice and the growing demands by decision-makers for information about policy alternatives, it is essential that travel demand forecasting practitioners have the opportunity to share experiences and insights. The TMIP-supported peer review provides a forum for this knowledge exchange.

MAPA applied for the peer review to obtain a better understanding of their current models capabilities and to help address new travel demand modeling needs in their region. In addition to their acquisition of National Household Travel Survey (NHTS) add-on data, the region is facing some major development issues. The City of Omaha is pushing for a downtown light rail/trolley system, several new interstate highway interchanges are being considered and a major regional beltway is under study. Added to this, the region may be placed in non-attainment status for Ozone and PM 2.5 pollutants. High speed rail connecting Omaha to Des Moines, Iowa City and Chicago is currently being discussed for potential study. The peer review was convened to provide guidance to MAPA so that its travel demand model can meet the ever growing list of challenges. The primary goals of this peer review were to:

1. Review the current model in the context of regional and local needs, and evaluate its ability to perform the analysis required to address those needs.

2. Assess the sufficiency of current data resources with respect to internal and external travel markets.

3. Indentify deficiencies and areas where improvements are needed and suggest changes to the structure and operation of the model.

4. Provide guidance on how to incorporate the "new" NHTS data into the model.

5. Provide guidance on the most reliable and cost effective validation/calibration techniques and methodologies.

MAPA Responsibilities

The Omaha-Council Bluffs Metropolitan Area Planning Agency (MAPA) is a voluntary association of local governments in the greater Omaha region chartered in 1967. MAPA performs planning and development work, especially to address problems that are regional in scope and that cross jurisdictional boundaries. MAPA's areas of work include community and economic development, environmental programs, transportation planning, mobility management for paratransit, among others. The MAPA region covers five counties in Nebraska and Iowa. These counties include Douglas, Sarpy, and Washington Counties in Nebraska, and Pottawattamie and Mills counties in Iowa.

However, MAPA serves as the Metropolitan Planning Organization (MPO) for a smaller region that encompasses only Douglas and Sarpy Counties in Nebraska and the western-most portion of Pottawattamie County. As the MPO for this area, MAPA is charged with creating and maintaining a regional long-range transportation plan (LRTP) that coordinates and prioritizes regional transportation improvements, and performing other planning functions such as allocating Federal funds to selected projects through shorter-term programming documents such as the Transportation Improvement Program (TIP). MPOs with a population over 200,000, like the MAPA region, are deemed Transportation Management Areas (TMAs). MAPA's travel demand model, which covers the extent of the TMA, is used by MAPA staff and contracted consultants for the development of the LRTP, the TIP, and various transportation studies.

Regional Characteristics

The population of the MAPA TMA has increased from 540,000 in 1970 to 740,000 in 2008, and is forecast to increase to

950,000 by 2035. The majority of the population of the MAPA TMA, 500,000 in 2008, lives in Douglas County (which includes the City of Omaha). The forecast growth adopted by MAPA is conservative compared to growth forecasts produced by the Bureau of Economic and Business Research at the University of Nebraska. Sarpy County has had and is forecast to continue to have the highest population growth rate amongst the counties. The development pattern there has been predominantly suburban. Pottawattamie County is growing modestly. Analysis of residential building permits shows that the highest recent growth in new housing is in west Omaha, and the northern and eastern parts of Sarpy County. There has been some multiuse development downtown close to the river, and some suburban growth on the Iowa side of the river. The allocation of forecast growth tracks closely to recent building permit growth. In recent history there has not been much growth (redevelopment) in the urban area, but it is starting to occur so some of the forecast growth is allocated as additional redevelopment in the urban area.

The largest employers in the region are the Air Force Base in Sarpy County, Alegent Health (multiple sites), Omaha Public Schools (multiple sites), First Data, and Union Pacific. Total employment for the region is 453,000 in 2010. Growth in employment is forecast to occur in similar locations to residential development.

Average commute time is relatively short; Omaha is considered to be a “20 minute city” where it is relatively easy to get around. The region does not experience severe levels of congestion on its roads, and the freeway system performs well. Most travel to work is in single occupant vehicles (84%), with less than 1% by transit. Overall traffic levels have not grown recently. Automatic traffic counters show a slight decline since a peak in 2006, with volumes currently similar to 2004 and 2005.

Travel Demand Modeling at MAPA

MAPA has a long history of developing, maintaining, and applying its travel demand model. This began with MAPA using the FHWA’s PLANPAC software in the 1970s. The model was transferred to the Quick Response System II (QRS II) software in the late 1980s. More recently, in 2002, MAPA converted the model to TransCAD as the modeling software platform. TransCAD continues to be the modeling software of choice for MAPA.

The first large project for which the MAPA travel demand model produced forecasts was the rebuilding of the Interstate Highway System on the Nebraska side of the region in the 1980s. This included the impacts of ramp closures on arterials. The forecasts validated well against studies conducted after construction. In the 1990s, HDR, a consulting firm, used the model in planning work for Interstate Highway System reconstruction in Iowa. More recently, forecasts were produced for the West Side expressway study. This opened 4 years ago. MAPA has not participated in any validation of the forecasts for the project. Historically (prior to the development of the QRS II model) the MAPA travel demand model has consistently under-estimated traffic volumes. MAPA staff believes this is due to under-estimating socioeconomic factors that affect travel demand, such as labor force participation.

Prior to the development of the QRS II version of the MAPA travel demand model, the allocation of socioeconomic forecasts to traffic analysis zones (TAZs) was carried out using expert judgment with committee review and approval. A Land Use Activity Allocation Model (LUAAM) was developed to perform this task at the same time as the QRS II travel demand model was introduced. A version of the LUAAM is still in use by MAPA today.

As the travel demand forecast modeling practice has continued to progress, MAPA staff have recognized that the agency's model system needs to be upgraded to keep pace with recent developments, and to provide the policy sensitivities required by decision-makers. A primary purpose of the MAPA peer review was to develop a list of recommended improvements to the travel demand model and provide guidance on which would be of greatest value to MAPA. Upon receiving the feedback from the peer review panel, MAPA will begin to implement the prioritized improvements as funding and staff time allow.

Current MAPA Model

Model Applications

The MAPA travel demand model is expected to be used primarily for the following purposes:

- during the development of the LRTP;
- for project level forecasting at two scales: intersection level analysis and larger scale projects;
- and it is anticipated that a future use of the model will be for air quality conformity analysis.

The model was recently used by consultant HDR to produce forecasts in an alternatives analysis for a significant project, a beltway around the metropolitan area. The analysis for this project required model revisions and adjustments to expand the model beyond the TMA area. The model revisions expanded the model's coverage, and developed new socioeconomic data and roadway network for the planning area. Additional transit corridors were added to the model; a mode split of 5% was asserted for locations with good transit access. Those trips were then removed from TAZs around LRT stations.

The model is used for producing forecasts in Nebraska for non-state system Highway Performance Monitoring System sample sections. The model output is post-processed as part of this forecasting exercise. Similarly for project level forecasting, the Nebraska Department of Roads does not use raw model output, but instead takes model output and uses it as an input into a subarea model. MAPA uses a post processing procedure to adjust forecasts based on recommendations in NCHRP Report 255. For evaluation and comparison of the impact of projects in the LRTP process, MAPA converts volume-to-capacity ratios output by the model to an equivalent level of service.

Concerns Identified by MAPA

Interaction between Land Use and Transportation

The recent analysis of beltway alternatives raised the issue that, while land use pattern changes (such as targeted density) may reduce the need for this type of project, the model used a rudimentary approach to represent the interaction between land use and transportation.

MAPA has recognized the potential for inconsistency when producing future forecasts and has conducted analysis to identify whether it was necessary to vary land use allocations based on future transportation alternatives. They compared land use allocations for the base and future year networks developed during the 2035 LRTP process. They found that the LUAAM was not very sensitive, even to the addition of all of the LRTP projects, and therefore have just used the LRTP network to develop a single land use allocation. MAPA does not vary the transportation network and develop new land use allocations for specific project tests as the network change would be much smaller than the large change between the base and future year networks.

Experience in the region has shown that, except for construction of I-80, transportation projects have followed development rather than inducing land use changes; land development appears to follow sewer access.

Balanced Transportation Investments

During its long-range plan updates, MAPA has been faced with modeling and prioritizing transportation investments and land use policy changes that threaten to exceed the capabilities of their model. Examples of these projects include road diets (where a four lane arterial is converted to three lanes to provide more space for pedestrians and bicyclists), other complete street projects where road space is reallocated away from motorized vehicles, and land use policy changes that promote redevelopment instead of new development at the periphery of the urban area.

Project Level Forecasts: Pflug Road

The Pflug Road project was a proposal for a new interstate interchange outside the urban area that would have been partially property developer funded and partially funded by a congressional earmark. The analysis of the project highlighted some deficiencies in the MAPA travel demand model. The FHWA reviewed the model as part of the Interchange Justification Report process. They found that much of the traffic that was predicted to use the interchange was in fact through traffic, re-routed from more direct interstate facilities, an outcome which seemed implausible. As a result of the Interchange Justification Report, the project is no longer in the LRTP.

Transit Forecasting

The presence of two potential transit projects in the region, high speed rail connecting Omaha to Des Moines, Iowa City and Chicago and a downtown Omaha transit system, has highlighted the lack of a transit forecasting capability in the MAPA travel demand model. The high speed rail project is being discussed for potential study, and a forthcoming alternatives analysis will test potential transit investments in downtown Omaha, including a streetcar alternative. The funding for the alternatives analysis includes a grant for MAPA to develop a mode choice model to incorporate into their modeling process..

Air Quality Conformity Analysis

The region may be approaching non-attainment for ozone due to the potential forthcoming standard reduction by EPA. Non-attainment is a new issue for both of the states in which the region is located: there are currently no non-attainment areas in either Iowa or Nebraska, and hence MAPA has not begun to use EPA's new MOVES software

Traffic Growth

Recently, MAPA staff have observed that traffic growth in the region, as in many other parts of the country, has leveled off. It is not clear whether this is for the short term or indicative of a long term trend. Understanding this trend is important for confidence in long term forecasts; MAPA is concerned about whether this change means that re-evaluating 2035 travel and socio-economic forecast assumptions is necessary.

Peak Hour Traffic Volumes

MAPA has been receiving more frequent requests from member agencies for peak hour volumes as part of planning work for smaller projects. Currently, MAPA is unable to provide these forecasts because the model is a 24 hour daily model.

Model Update

In reaction to these concerns, MAPA is planning a model update, which will include moving the model base year to 2010. The elements of the model update being considered include:

- Incorporating 2010 Census Data
- Developing a new land use allocation model

- Incorporating 2008 NHTS Add-on Sample Data
- Adding a transit component
- Dealing more explicitly with freight movement and trucks
- Modeling peak hours in addition to producing 24 hour traffic volumes

In addition to these issues and concerns highlighted by MAPA, they provided a list of specific questions for the peer review panel. These questions are shown in Appendix D of the report, with answers from the panel.

MAPA Model Inputs and Model Components

After introducing the history of their travel demand model, its current uses, and their concerns, MAPA staff presented information about the inputs to the model and each of the individual model components currently in use. The following sections summarize the information provided by MAPA staff, as well as comments from peer review participants. MAPA provided the peer review panel with model documentation. The "MAPA 2035 Travel Demand Model Documentation" describes all of the model components and input data and presents a summary of model validation results.

Highway Network

The MAPA travel demand model covers the MAPA TMA, which includes all of Douglas and Sarpy Counties in Nebraska and the western third of Pottawattamie County in Iowa. There is not much growth in land development or any existing large communities immediately outside the model boundary. Within the urban area boundary, the network consists of all roads that have a federal function classification as well as some roads that are not classified but that are important for network connectivity. In the rural area, the network consists of federally functionally classified roads, plus a number of non-classified facilities such as section line roads.

The network is based on a GIS file of centerlines with various network attributes that describe the roadway characteristics. The network has posted speeds and daily capacity. The daily capacity is based on the hourly ultimate capacity, that is, the point at which the Level of Service (LOS) changes from an "E" to an "F" as defined by the Highway Capacity Manual. To support the daily model, the hourly capacity is multiplied by a factor of 10, which represents a typical ratio of peak hour to daily traffic. Capacity varies by functional class, presence of turn lanes, the number of lanes, and whether the road is divided or undivided. The capacities are based on those used in Des Moines, Iowa. The capacities vary by side friction to take into account differences in driveway density. MAPA is currently comparing the capacities with other sources such as the capacity tables developed by the Florida DOT. The model does not include intersection delay separately from link delay. MAPA has attempted to represent intersection delay using downward adjustments to free flow speeds.

Panel Discussion

The panel discussed the importance of consistency between the capacities and the volume delay function (VDF) used in the model. The Bureau of Public Roads (BPR) VDF is often used with capacities based on level of service D, the point at which speeds start to deviate from free flow. It is common to set capacities at level of service F and then adjust the VDF so that delay occurs correctly at different levels of service. It is important to capture the differences between functional classes, for example interstates are different than arterials. For calibration, the panel suggested starting with adjustments to the VDF first, before other penalties were added to the model.

The panel commented on the larger number of counts included on the highway network, which MAPA staff confirmed are a mix of observed counts and interpolated counts. The panel recommended selecting only real counts, not interpolated counts, for validation as the goal of validation is to take points with a known answer (an observed traffic volume) and compare estimated values to them. Use of interpolated values, which are not independent observations, is not valid statistically. In addition, the panel cautioned that care should be taken when using old counts; one approach is to compute two sets of statistics, one using just the most recent counts, and a second set based on a larger count set that includes older observations. Typically 15-20% of links have counts, with variety across functional class and geography. It is important to identify gaps in real count locations and to collect additional counts at those locations. One approach for spotting missing count locations is to assign a matrix of one's and to observe locations where many paths overlap but no count is available.

Zone Structure

The MAPA travel demand model, as is typical, uses traffic analysis zones (TAZ) as the base geographic unit. MAPA forecasts the number of employees (retail and non-retail), number of households and average household income to determine the number of trips generated in each zone. The MAPA model has 697 TAZs (not including external station TAZs), which approximates a modeling guideline of one TAZ per 1,000 persons. TAZs are derived from census tracts, some of which are subdivided as necessary. In creating TAZs, MAPA's goal was to represent how traffic enters and exits a particular TAZ. Therefore, major roads, creeks or other features that create barriers between adjacent land uses are normally used as TAZ boundaries. There are examples in the zone structure of recently built limited access facilities dividing TAZs. It will be important to resolve this issue in the TAZ-UP process where MPOs submit new zone structures to the Census Bureau for the Census Transportation Planning Products program. The model includes special generators in four TAZs that "shadow" (i.e. are overlaid on top of) the other land use in a TAZ.

Many of the zones in the MAPA model are connected to the highway network using multiple centroid connectors. Many additional centroid connectors were added during conversion of the model from QRS II to TransCAD. Unfortunately the base year was updated at the same time and there is no direct comparison of how much impact adding the centroid connectors produced. The centroid connector travel times are varied to adjust loadings to certain connectors and improve model calibration.

Panel Discussion

The panel discussed zone sizing and design. On zone size, the panel commented that the TAZ structure is very refined at the center of the region, which means maintaining a lot of data. The level of disaggregation is great enough that it may have passed the point of diminishing returns compared to the level of spatial and temporal detail in the rest of the model. It is not desirable to split TAZs such that the zone system is finer than the highway network. In these cases it is necessary to add network detail in addition to splitting TAZs. Smaller TAZs provide useful detail for modeling transit access, and can also be important if the model is being used for project development to represent additional detail in the vicinity of the project. Smaller TAZs are also helpful if that can increase the homogeneity of zones. The example of a suburban square mile with a shopping center in one corner was discussed. In this case, the panel recommended splitting the zone with the shopping center in one zone and the residential area in another zone. As zones get smaller the variability in trip generation rates becomes important. This can be evaluated by, for example, doing local counts in an area. The distribution model is also affected by TAZ size: an exponential friction factor function does not capture the lack of short trips, i.e. a non-zero peak in the trip length distribution. In summary, it is important to ensure that all parts of the model have a sufficient and similar level of detail to handle small zones, including trip generation, trip distribution, and the highway network.

The panel commented that the use of multiple centroid connectors can lead to the loading of traffic moving to different connectors between the base and future model runs. This type of effect is a particular issue when developing intersection turning movements from model output. A reason for using multiple centroid connectors is not knowing much about how land use in a zone results in loading on to the highway network, but if this is understood, it is preferable to split or realign the TAZ; this will get the loading right and add stability between base and future model runs. An important consideration is that centroid connectors are chosen depending on where trips are going on the network, as a trip is from loading point to loading point rather than centroid to centroid.

The panel recommended the removal of weights from centroid connectors, as it reduces the model's natural forecasting capability in order to get better base year calibration. Leaving connector choice to the model will allow the model to respond better to land use changes in the future; land development in a zone can cause the distribution of trips from a zone to change, sometimes significantly..

The panel emphasized some additional details about centroid connectors:

- The proximity of counts to centroid connector loading points is important and can affect calibration. It is important to verify that their relationship is correct. For example, verity that a count location is not being flooded with traffic that in reality may use multiple access points.
- Centroid connectors from adjacent TAZs should not load at the same point. If two driveways that provide access to the land use in a TAZ are opposite each other, then stub streets can be coded into the highway network.
- Centroid connectors should not load at intersections.

Socioeconomic Data

MAPA prepares their base year household location information using Census data, and has updated that database with building permit information. Their employment data are address based data that are geocoded. The data are based on Quarterly Census of Employment and Wages (QCEW) data, which has been refined to disaggregate business headquarters to multiple sites. It is kept up to date and cross checked with other sources.

MAPA develops control totals for housing, population, and employment in the future year (2035) for the entire MAPA region and then allocates these to the TAZs based on the availability of land for development and the attractiveness of the TAZ based on a number of factors. MAPA uses their own LUAAM, an in-house model developed by MAPA staff that has been calibrated to be reflective of local development patterns. Various factors that influence development are assigned weights that reflect the relative importance the factor has in locating development within the MAPA region. Vacant land available for development in each TAZ, based on information from each municipality's comprehensive plan, competes for the development from regional control totals. Development is assigned based on the attractiveness of the factors including accessibility to population and employment, availability of utilities (sewer, water, etc.), availability of transportation facilities, socio-economic factors (income, etc.), and proximity to recent residential and commercial development. There is some interrelationship between where housing and employment are allocated.

The MAPA LUAAM model is calibrated by comparing the current regional activity forecast to observed data. After the base year is calibrated, future forecasts are developed, including the current 2035 forecast year for the MAPA travel demand model. The LUAAM model generates the number of households, average income, and number of employees (retail and non-retail) for each TAZ. The LUAAM model was a response to the subjectivity of early attempts at land use allocation using a Delphi approach. However, local partner agencies are still presented with an explanation of the process and the results, and asked to review, comment and accept the allocation results. MAPA has gone through the process three times, and has found that, since change is small and steady, the process is not controversial.

The LUAAM model does not assign development to land that is not currently vacant and so it does not reflect redevelopment in areas such as the urban core. Historically, the MAPA region's developed areas have remained stable or declined, but this trend appears to be changing. MAPA has collaborated with local partners to manually forecast future redevelopment in the urban core.

MAPA explained that the LUAAM model is poorly documented and is no longer available in a readily usable software format. MAPA is considering either recreating the LUAAM in a modern software platform, or developing a new process.

Panel Discussion

The panel offered several comments and recommendations. They strongly emphasized the importance of documenting either the LUAAM process or a new process if that is selected, so that the process is clear to a technical reader and so that forecasts can be recreated. It is important to clarify how model parameters are developed, for example whether they are statistically estimated based on a dataset of historical change, or they are asserted. Regardless of how the parameters are developed, it is important to show the process of model development, to review results in comparison with observed data, and to show how the model was adjusted. It is also important to develop an approach that is sensitive to transportation system changes. The panel discussed the continuum of models and approaches available, from very complex models such as PECAS and URBANSIM (which the panel considered to be unnecessary for a region with low growth such as this), to formally estimated land use allocation models such as LUSTR (developed by Oregon DOT), to more subjective models such as UPLAN that rely on professional judgment, and finally to expert panel/Delphi approaches. The panel recommended retaining and systemizing the existing process. This would include developing thorough documentation, moving the model to a spreadsheet or a modern software language, and incorporating GIS so the creation of the indices used in the model can be automated. The panel also recommended not directly using raw output from the model, but instead using the model as a tool to create land use allocations that can be the subject of discussions with local partner agencies.

Trip Generation

The Trip generation model estimates the number of trips that each TAZ produces or attracts, and MAPA implements this process in a spreadsheet program. Productions for each TAZ are generated using trip rates that are based on five categories of average household income. These rates are based on a variety of sources, including NCHRP Report 365 and those used in other communities. MAPA is planning to update the trip rates using the NHTS add-on data from this region. After the total productions for each TAZ are generated, they are split into the three trip purposes – home based work trips (HBW), home based non-work trips (HBNW), and non-home based trips (NHB) – based on percentages that vary by income level.

The MAPA travel demand model uses different trip attraction rates for different area types. There are four unique area types in the model: 1, Central Business District; 2, Omaha Inner Core (essentially pre-WWII development areas); 3, Suburban (essentially post-WWII development areas); and 4, Rural (outside urbanized area). MAPA varies attraction rates by area type in an attempt to better reflect observed traffic. In the future year, population and employment forecasts were evaluated in each TAZ to determine whether the area type should be changed. There are separate attraction rates for each of the three trip purposes and for each of retail and non-retail non-residential land uses and for households.

Panel Discussion

The panel noted that there are very few TAZs where the average income falls in the low income categories; almost all TAZs are concentrated in the central income categories, which means that the trip generation model is not particularly sensitive to income. The panel explained that it is important to make sure that the model is sensitive to how able people are to access the transportation system, i.e. how their mobility is affected by their income, vehicle ownership, etc. For forecasting it is necessary to think about change in a TAZ over time, e.g. urban redevelopment may change an area and increase household income.

The panel suggested converting trip production rates to rates based on a cross classification by vehicle ownership and household size, as it provides more sensitivity in the trip generation model to change over time. This type of cross classification is used in most Iowa MPO models. A classification could be 0, 1, 2, and 3+ vehicles, and 1, 2, 3, and 4+ people in the household. The number of households in each cell in the cross classification for each TAZ can be built using Census data, while the trip rates can be based on NHTS data. If the NHTS sample is small for particular cells in the cross classification, data from similar sized areas can be added to enhance the sample. Forecasting vehicle ownership is somewhat difficult, but model parameters could be borrowed from other Iowa models. Vehicle ownership models typically include land use density and transit accessibility. Understanding the location of zero vehicle households is important in a mode choice model.

The panel did not support the variation of attraction rates by area, and suggested adding extra stratification of employment types such as using the same categories as in the LUAAM: commercial, industrial, and office. It is important that the stratification be based on activity. For example, high intensity retail locations, such as drive through restaurants, attract a lot of customer activity, professional offices attract some customer activity, and offices attract primarily employee trips.

The panel discussed the distinction between the current model, which generates person trips by auto, and a true person trip model that generates trips by other modes as well. Generating all person trips provides the flexibility for modeling transit and walkability in the future. There are several approaches to allocating trips to the transit and walk modes. A mode choice model subdivides trips into vehicle trips (by occupancy), transit, walk, and bike, but implementing this type of model is a substantial effort. The FTA has some recommended mode choice model parameters that can be borrowed and the model can then be calibrated to control totals, such as observed walk shares and transit shares. A very simple approach to handling walk trips is to remove them immediately after trip generation by removing a fixed percentage of trips from all TAZs. A slightly more refined approach is to remove a higher percentage of trips in certain areas based on observed data such as high pedestrian counts downtown. A simpler variation on the mode choice model that still takes into account the length of the trip is to use diversion curves after trip distribution to remove a higher proportion of walk trips from short trips.

Special Generators

Offutt Air Force Base is modeled as a special generator, with elements of trips to and from the base added as a fixed trip table. Some generated trips are removed from the TAZs in and around Offutt Air Force Base and adjacent base housing to reflect lower trip generation than would be expected given the quantity of land use in the area. The high amount of traffic traveling between the base and the base housing is represented using a fixed trip table that is added after trip distribution.

Special attractors exist for the University of Nebraska-Omaha, Creighton University and Eppley Airfield, as those locations attract an unusually high number of trips. In the MAPA travel demand model a separate TAZ is used for the special attractors because the other productions and attractions are adjusted through the balancing process, whereas the special attractions are held constant.

Panel Discussion

The panel thought the approach for modeling Offutt Air Force Base was acceptable in the base year, but is potentially a problem in forecasting if base housing changes over time. The panel recommended considering simplifying the model by adding an air force base trip purpose rather than using this separate special approach, and also recommended getting better data from the base if possible by engaging them in the local planning process. For the Universities, the panel recommended that MAPA review their representation of group quarters housing, given the importance of accounting for group quarters residents when allocating population control totals, and the mobility differences, e.g. lower trip rates, of students living in group quarters. The panel suggested asking the Universities for student home locations by TAZ, and either adding a static table for students or a trip purpose specific to student travel to Universities with its own set of friction factors to distribute those trips.

External Travel

The MAPA travel demand model contains 25 external stations. MAPA works with the Nebraska DOR and Iowa DOT to develop external forecasts. The forecasting approach averages a linear and exponential extrapolation of recent growth, and then switches to just linear extrapolation in out years. Observed growth has been lower recently, so MAPA considers that external forecasts might need to be revised down. For internal to external and external to internal trips, county to county flow data from the Census Transportation Planning Products journey to work data are converted to work trips at each external station based on which facility would be used for that movement, leaving the remainder of external volumes as non-work trips. MAPA does not have counts of external to external traffic, and therefore the external to external trip table is developed using a Fratar approach with illogical movements prohibited. Attractiveness factors are used to increase the number of I-80 to I-80 and I-29 to I-29 trips. The external to external trips are added after distribution as a fixed vehicle trip table.

Panel Discussion

The panel considered the approach used by MAPA to be reasonable and thorough and suggested that any changes to this element of the model are a low priority. The panel suggested considering growth in the spheres of influence of externals in order to improve forecasts at external stations. A more complex approach could involve pushing the model boundaries out to encompass towns outside the region and capture a lot of what is now external traffic within the model, but this is a lot of work that would only be justified if traffic between those areas represented a significant fraction of external-external trips.

Trip Distribution

The trip distribution model matches the productions and attractions of each TAZ with productions or attractions from other TAZs using a gravity model. The intra-zonal travel times used in the gravity model are an average of the travel time to the four nearest TAZs. The gravity model uses an exponential function to develop friction factors, and all trip purposes are doubly constrained. Different gravity model parameters are used in the base year model and in the future.

Panel Discussion

The panel questioned the use of different gravity model parameters in the future, and explained that they should either be carefully justified or avoided. The panel recommended changing from an exponential function to a gamma function, and explained that a shortcoming of the exponential function is that it makes very short trips appear to be highly attractive, whereas a function like the gamma function is maximized at a non-zero travel time and reflects observed travel behavior more closely. Use of a gamma function is particularly important with small TAZs so as not to over-represent short trips. The panel suggested that a singly constrained gravity model was more appropriate for non-work trips than the doubly constrained model. The panel also noted that the average trip lengths for HBNW and NHB trips appear to be long. The panel recommended that the gravity model parameters should be updated when new NHTS data is available. Data for HBW and HBNW trips are easy to get from the NHTS, but NHB trips are more difficult as this trip purpose accounts for commercial trips too; other sources in addition to NHTS are needed. NCHRP Report 365 explains how to fit gamma function parameters. The current practice at many Iowa MPOs is to use gamma functions with the default parameters shown in NCHRP Report 365.

Mode Choice

Non-motorized and non-transit traffic comprises a small portion of the total trips in the Omaha region. In 2006, the local transit provider, Metropolitan Area Transit (MAT), was averaging an estimated 12,000 daily trips, compared to five million vehicle trips. Therefore the MAPA travel demand model does not include a mode choice model (as was described earlier in the report, the model generates person trips by auto rather than all person trips). However, as part of the forthcoming Omaha transit alternative analysis MAPA will potentially have a budget to implement a mode choice model.

Panel Discussion

The panel suggested several ideas for consideration during the development of a mode choice model. The panel emphasized the importance of good data. For example, collecting boarding and alighting counts and an onboard origin destination survey would allow MAPA to find out about existing travel patterns, the demographics of existing riders and the reasons that they are riding transit. If the demographics of existing riders are understood, the number and location of similar riders can be indentified and their future populations can be forecast. For choice riders it is important to understand what motivates people to ride transit. For example, who would ride a new street car service? Is there a congestion constraint or a parking constraint that will make the service attractive? For captive riders, who likely form a large proportion of existing riders, it is important to allocate them correctly spatially, for example by locating zero vehicle households. Obtaining these types of data will help build a model that is sensitive to the factors that affect ridership; it is important to know characteristics of the population to allow for market segmentation before parameters can be borrowed from other models. The panel discussed the different approaches to implementing a mode choice model. A full blown mode choice model, including data collection and model estimation, is expensive to implement. Other areas, such as Fort Collins, Albuquerque, and Tucson, have successfully applied asserted mode choice models. Des Moines is currently moving forward with the development of a mode choice model, and that effort will potentially provide a local source for borrowing a model specification and parameters.

Highway Assignment

The MAPA travel demand model uses stochastic user equilibrium (SUE) traffic assignment and the BPR VDF. The calibration of the alpha and beta coefficients of the BPR VDF began with the coefficients provided in NCHRP Report 365, which were then adjusted separately for freeways, collector-distributor ("CD") roads alongside freeways, and for all other roads, to produce three sets of coefficients.

Panel Discussion

The panel recommended changing from SUE to simple user equilibrium (UE), as stochasticity is unnecessary in models of regions where there is relatively little congestion. Typically, if a model uses SUE, then the model should perform multiple assignments and average the results. Stochasticity tries to explain random variation between routes (e.g. day to day variation), and averaging is needed to use the technique properly. It is more important to get stability in the model (by using UE) so that the effects of small input changes can be observed. The panel recommended removing river crossing penalties and ramp penalties prior to any work to adjust the VDF. MAPA staff explained that the ramp penalties were added to reduce interstate over assignment, but the panel recommended adjusting the VDF and highway capacities, as well as looking closely at network coding to correct differences between interstates and lower functional classed roadways. If ramp penalties still seem necessary, they should be based on documented issues with ramp configuration, weaving areas, etc..

Feedback and Convergence

The MAPA travel demand model includes a feedback loop from assignment to trip distribution and uses the method of successive averages (MSA) to average results from each iteration with the average of previous iterations to reach convergence.

Panel Discussion

The panel noted that the MAPA model currently applies a very relaxed convergence criterion and that it appeared that the model is not converged at the point when a run is typically stopped. The panel recommended removing that criterion and allowing the model to run more iterations to ensure convergence. The panel also discussed the merits of removing the feedback loop entirely. Feedback loops are important if the model includes a peak hour assignment and congestion is more widespread. If congestion is limited to a few bottlenecks (which appears to be the situation in Omaha), comprehensive feedback to distribution is probably not essential. An approach to testing the need for feedback is to run the model without feedback and then manually to compare the free flow distribution with a distribution based on congested travel times after the first assignment. Calculating the root mean squared error (RMSE) of the two matrices will show the magnitude of the redistribution due to congestion. The panel recommended exploring the need for feedback empirically and considering a model with only one loop (free flow travel times – distribution – assignment – congested travel times – distribution – assignment), to ensure that the trip distribution reflects the travel times that travelers commonly experience.

Validation

MAPA staff and the panel discussed the validation of the model, and the panel made several suggestions and recommendations relating to model validation.

Traffic Counts

There was extensive discussion of traffic counts, and the panel again emphasized using only actual counts and just recent counts where possible. The panel recommended using care when adjusting counts that are not separated by much land use to ensure count consistency as substantive differences might be real (i.e. not just due to count variation) and centroid connector loading points can be adjusted accordingly. Inspecting the history of counts at a location can help identify anomalies, e.g. incidents on a particular count day that caused it to be atypical. The period that is being modeled is also an important consideration. Generally, it is recommended to explicitly model an average Tuesday, Wednesday, or Thursday during months when school is in session, such as March or October, and therefore counts are factored to adjust for seasonal differences (rather than using annualized daily counts). This adjustment can improve count consistency. In addition, since the source of counts varies, e.g. the state DOT/DOR for the state highway system and municipalities for local roads, it is important to understand whether counts are provided raw or factored, and to factor them in a consistent manner.

Error Checking

The panel offered some advice on error identification during model validation. They suggested reviewing network links with zero or very low volumes and outliers where model volumes and counts are very far apart. Assigned volumes of zero usually mean that there are network coding errors. Outliers can be identified using a scatterplot of counts on one axis and model volumes on the other axis. Outliers can be caused by a count error as well as a model error. Correcting large outliers will greatly improve the RMSE. Producing scatterplots by functional class, geography, and corridor helps to identify problems that are specific to a functional class, geography or a corridor. Select link and select zone analyses provide another way of checking problem locations and identifying why errors are occurring. The panel recommended that tables of assignment statistics presented in the model documentation should include the number of counts to put RMSE values and correlations into context. The panel described two other validation statistics that are useful in guiding adjustments to the model: the first is the ratio of modeled traffic volumes to counts (high volume facilities should have a ratio close to one). The second is the percentage of count locations where error is +/- 10%, +/- 20%, etc., to understand the amount of dispersion, i.e. is RMSE due to outliers or general dispersion? These statistics can help to identify particular facility types, regions, and corridors for additional study that can guide model adjustments.

Trip Generation and Trip Distribution

The panel emphasized the importance of screenlines for validating trip generation and trip distribution. A hierarchy of types of screenlines to consider is cordon lines, which circle around an area (external stations are like a giant cordon); screenlines, which bisect an area along significant barriers such as rivers or rail lines; and cutlines, which can be used to verify that the trip distribution is correct by checking the total volume across sets of substitutable routes. It is important to get flows across these various types of screenlines correct before moving on to assignment adjustments to calibrate the share amongst routes. Setting up screenlines is also a good way to identify missing traffic count locations. An example of a validation test using screenlines is to screen a corner of the model to test trip generation. The Missouri River would make a good screenline as there are a limited number of crossings and it would allow the distribution of trips between Iowa and Nebraska to be validated. A cordon around Offutt Air Force Base would allow trips to the base to be validated.

While MAPA used CTPP data as the basis for work trips, they have not used the data for validating district to district flows. The panel recommended creating 12-24 districts (starting with jurisdictional boundaries to make aggregation of the CTPP Part 3 data easier) and comparing estimated and observed work flows from district to district to ensure that the travel to work market is well represented.

The panel also suggested using matrix estimation techniques to synthesize a trip table using traffic counts in order to check trip generation and trip distribution. This is particularly helpful for identifying anomalies, such as badly modeled special generators where particularly high trip generation rates have not been adequately captured.

Calibrating without Penalties

The panel advocated removing special penalties wherever possible. They recommended adjustments to the VDF to deal with over or under assignment to interstates rather than ramp penalties. The shape of the VDF can also be adjusted to correct for errors such as under assignment on congested sections of facilities and over assignment on freeflowing sections of facilities.

The panel discussed several alternative approaches to modeling the travel behavior that motivated the model's bridge penalties. They explained that high bridge penalties lead to problems with trip distribution; they skew the trip length distribution of trips using the bridge so that relatively too many short trips use the bridge. The bridge penalties allow the model to match traffic volumes correctly but the origin/destination patterns of trips using the bridge will be wrong.

The panel discussed the possibility of using a separate trip distribution for each side of the river. Given that there is a relatively small developed area on the east side of the river and a large area on the west side, the trip length distribution might be very different on each side of the river. NHTS data might help to identify if trip rates and trip distribution are different. A less desirable alternative would be to apply region to region "K factors". The panel recommended investigating the balance of productions and attractions on either side of the river, considering the impacts of zone resolution on the trip distribution model (zones are considerably larger on the east side of the river), and looking at variations in trip distribution by trip purpose. It is possible that many trips to work do cross the river, but relatively few non-work trips. The panel recommended implementing a screenline along the river to assist with validation of the trip distribution. It was noted that one bridge is a toll bridge and in this case the penalty is acceptable as it represents the disutility of the toll. However, the size (in minutes) of the bridge penalty should be based on a reasonable value of time used to convert the cost of the toll from dollars to minutes.

Land Use Sensitivity Tests

The panel recommended using land use sensitivity tests to examine the reasonableness of the model's response to land use changes. A set of tests might involve comparing the response of the model to adding (and removing) one, 10, 100, and 1000 households to several dense urban areas and low density rural areas. The model response should be directionally correct and of reasonable magnitude. Also, back casting is a way to test the forecasting ability of the model: can it forecast the old base year? A successful forecast indicates that the model's sensitivity to land use changes is appropriate.

Project Level Validation

The panel emphasized the potential value of project level validation approaches (for real or hypothetical) projects that may reveal valuable insights about travel behavior, including route and destination shifting that may occur as the result of an investment decision. An example of this form of validation that the panel discussed was an examination of "before and after" data to take a closer look at how the model has replicated travel patterns for either a network disruption (e.g. facility closure), or a transportation investment.

Future Enhancements

Following the discussion of the current model and its components, MAPA staff and peer review panel members had a conversation about planned and potential future enhancements to the MAPA travel demand model that had not been covered earlier in the peer review.

National Household Travel Survey

MAPA has purchased an NHTS add-on sample of 1,200 households. MAPA has software such as Excel and Access available for processing the NHTS data, but does not have packages such as SPSS or SAS. The Iowa DOT owns a SAS license, and the panel also suggested R, an open source software package with extensive statistical capabilities. The panel explained that there are nuances to using the data. For example, linking trips together and understanding the threshold when a stop is significant enough to break a trip is important. There are also some issues with NHTS data that need to be understood, such as different coverage in some neighborhoods compared to others. This must be identified to infer correctly the differences in trip lengths, and reweighting might be necessary. In general, it is important to get to know the survey data. The panel recommended starting by processing the data for trip rates, trip length frequencies, and other basic analysis. Then conduct a more in depth investigation of the data once these basic elements are included in the model. The panel suggested contacting agencies in similar areas and obtaining their data for comparison.

Time-of-Day

The panel discussed the potential benefits of converting the model from a daily model to an hourly model. The recommended approach is to use a diurnal profile to break down daily trip generation and trip distribution into single hour productions and attractions by trip purpose. Assignment can be done with four one hour slices, and then the application of the diurnal profile is reversed to factor assigned traffic volumes up to 24 hour volumes. The diurnal profile is obtained from survey data such as the NHTS as a separate profile is required for each trip purpose. The assignment hours chosen depend on the use of the outputs; for example if AM peak hour results are not needed, just a PM peak hour and an off peak hour could be enough. It is important that the model accounts correctly so that, when factored up, the 24 hour totals are correct. The model still uses the same trip generation and trip distribution. The diurnal profile is added, and then the same assignment is used, except that it is run multiple times. The benefit of converting the model to using hourly assignments is a much more realistic process. For example, the route choices in the model are now able to reflect differences between travel in peak (congested) periods, and travel in off peak (uncongested) periods. This effect cannot be captured in a daily model. For validation, time period or hourly traffic counts are needed, in addition to still comparing 24 hour modeled volumes to 24 hour counts. This model structure also has the benefit of allowing segmentation between peak and off peak travel in the mode choice model.

School Travel

MAPA explained that the model currently struggles to accurately model school travel. The panel suggested that developing a school trip purpose can be helpful, particularly in a peak hour model when there are a high number of school trips. It is typical to model K-12 and University separately. The average trip length of school trips is often short, suggesting that a separate trip distribution would be helpful.

Peer Review Panel Recommendations

Following the discussion of model enhancements, the peer review panel convened separately to discuss specific model development goals. Following this panel caucus, the panel presented a summary of their recommendations to MAPA staff and other attendees at the peer review.

The panel gave advice on assistance. Panel members Jeremy Raw and Eric Pihl from FHWA are available to assist MPOs. For complex tasks like mode choice model implementation, they recommended initially asking for guidance from FHWA. The panel recommended considering hiring a consultant for guidance with NHTS data analysis but that MAPA staff should attempt to do the majority of the work themselves to build internal skills and raise familiarity with the data. The panel also recommended considering outside help for making large changes to the model so that it happens quickly, but that MAPA staff should stay closely involved. The panel suggested attending conferences such as the Transportation Research Board's Planning Applications conference and Small and Medium-Sized Communities conference; they are good for seeing applications of similar models and for networking with peers. In addition, the panel recommended asking peer communities how they use their models in the planning process and reviewing their model documentation.

Model Enhancements

The panel summarized recommended enhancements for each of the model components, including documentation, general model structure, land use allocation, trip generation, trip distribution, mode choice, assignment, and validation and reasonableness checking.

Documentation

1. Review model documentation from peer MPOs (such as COMPASS).
2. Clearly define at the beginning of the documentation key information about what is represented in the model (for example, AADT, 2006 base year) and provide a brief model history.
3. Describe all input data, where it was obtained and how it was manipulated (for example, how counts were factored to a consistent year, month and day of the week).
4. Justify the values used for model parameters. For statistically estimated parameters, the estimation procedure should be described and shown, including relevant model fit statistics. For borrowed parameters, the analysis that was performed to justify the suitability of the parameters should be documented.
5. The documentation should include the results of any model sensitivity tests that were performed.

General Model Enhancements

1. Consider changing the model from a daily model to a time of day model with three or four time periods modeled. A three time period model would have assignments for the AM peak and PM peak, and one off peak assignment representing the rest of the day. A four time period model would have assignments for the AM peak, noontime off peak, PM peak, and the evening/nighttime off peak.
2. Consider defining the model as an average weekday daily traffic (AWDT) model rather than an AADT model, and represent an average Tuesday, Wednesday, or Thursday in a period when school is in session (for example March or October). This removes the complication of having to also represent weekend trips as well as weekday trips.

3. Consider converting the model from representing person trips using auto to representing all person trips including walking, bicycling, and transit trips.

Land Use Allocation

1. As a point of comparison, review examples of good practice such as the LUSTR model develop by Oregon DOT.
2. If MAPA decides to retain its LUAAM, it should:
   a. Document how the weights are developed and applied.
   b. Document the overall allocation process.
   c. Transfer the model to a software platform such as Excel or ArcGIS or a modern programming language.
   d. Automate the development of some of the land use and accessibility indices in GIS.
   e. Perform sensitivity testing by varying each index and analyzing their impact on the land use allocation.

Trip Generation

1. Consider using a cross classification model with trip rates for each combination of household vehicle ownership and household size.
2. Separate production trip rates could be developed for single family, multi family and group quarters housing.
3. Expand the number of land uses for which attraction trip rates are developed; for example develop rates for commercial, industrial, and office to be consistent with the LUAAM.
4. If the model is converted to representing all person trips, the trip rates in the trip generation model should be altered accordingly to represent all productions and attractions rather than just auto based productions and attractions.
5. Consider adding trip purposes to the trip generation model (and subsequent model steps) such as school trips and military base trips to represent these trip purposes in the standard model framework rather than with an alternative approach that uses special generators, extra TAZs, and fixed trip tables, which adds unnecessary and unhelpful complexity to the model.

Trip Distribution

1. Validate the trip generation model against the new NHTS data, including comparing trip length frequencies by trip purpose.
2. Use a gamma function instead of an exponential function in the gravity model.
3. Use the same gamma function parameters in the base year and the future year models.
4. Singly constrain the gravity model for non-work trips.
5. Doubly constrain the gravity model for work trips.
6. The average trip lengths for two of the trip purposes appear to be too long in the current version of the model: HBNW trips average 12.4 minutes, and NHB trips average 13.4 minutes. The NHTS data will provide data against which to validate the trip lengths for these trip purposes.
7. Evaluate whether developing a separate set of gamma function parameters for the Iowa and Nebraska regions of the model would be helpful in removing the need for river crossing penalties.

Mode Choice (short term recommendations)

1. A mode choice model can be implemented if MAPA converts their travel demand model to a person-based model that models all person trips instead of only person trips by auto.
2. If the model is converted to a person-based model, evaluate how non-motorized trips should be handled. Consider using a diversion curve to remove shorter trips.

Mode Choice (longer term recommendations)

1. An efficient way to implement a mode choice model is to borrow a logit model and parameters from another region with similar characteristics.
2. The borrowed model can be calibrated to regional control totals (transit system boardings) using FTA approved methods.
3. Consider whether to develop a transit network in the model, or as an initial step, to develop TAZ level transit attributes.
4. Conduct an on board origin destination survey of existing transit riders.

Highway Network

1. Use consistent capacities and speeds across the region.
2. Remove centroid connector weights.
3. Remove turning movement and ramp penalties. Adjust the VDF so that choice between facilities of different functional classes is captured correctly without the need for interstate ramp penalties.
4. Verify turn prohibitions.
5. Consider reducing or eliminating river crossing penalties and document the rationale for any remaining penalties.

Assignment and Feedback

1. Only use observed counts adjusted to the model year, season, and day of the week, and only use recent counts.
2. Review counts for consistency and location relative to the loading points of centroid connectors.
3. Review and resolve outliers where there are large deviations between assigned volumes and counts.
4. Drop the "Stochastic" from SUE and run a User Equilibrium assignment.
5. Consider preloading the external to external trip table if those trips do not follow major facilities across the region, but deviate on to lower functional class facilities.
6. Remove the RMSE break from the model's assignment code so as to allow enough iterations to ensure that reasonable convergence is reached.
7. Consider the need for the MSA feedback approach; possibly run a single feedback loop and then use the final assignment results.

Validation and Checking

1. Develop refined cordon lines, screenlines, and cutlines, for checks on trip distribution and trip generation. The screenlines should include a screenline along the Missouri River.
2. Define districts for district-to-district comparisons, e.g. with CTPP Part 3 flows for travel to work.
3. Explore additional validation techniques described in the literature (e.g. see TMIP Travel Model Validation and Reasonableness Checking Manual[1]) and those used by peer MPOs.
4. Identify sources of error and find outliers, using techniques such as scatterplots by functional class, geography and for specific corridors. Look for patterns of outliers and also for isolated outliers (which often indicate coding errors or anomalous counts). Attempt to explain what is leading to the presence of the outliers.
5. Conduct sensitivity tests to test changes in households and jobs, changes to assumed parameters, and changes to highway capacities, to confirm that the model behaves in a logical manner and that the magnitude of changes are reasonable.

Prioritized Next Steps

The panel prioritized their recommendations into three groups of tasks: understand the existing model, prepare for the new model, and develop the new model.

[1] Available online at: http://tmip.fhwa.dot.gov/resources/clearinghouse/1397

Understand Existing Model

Start by making some changes to the existing model. Take notes on what was done so that the effects of each step can be understood and documented. These steps should be carried out incrementally so that the effects can be seen independently.

1. Remove the early break code in the feedback loop to allow the model to reach convergence.
2. Change assignment by moving to User Equilibrium. The convergence criterion in the assignment algorithm should be set at 0.001, with the maximum iterations increased from 20 to 100 iterations. For diagnostic purposes, try tests with a convergence criterion of 0.0001.
3. Remove turning penalties and ramp penalties, but possibly keep bridge factors in the short term. Review and maintain turn prohibitions, however.
4. Convert the trip distribution gravity model to using a gamma function.
5. Review and modify counts to improve the comparison set, keeping only recent actual traffic counts.
6. Diagnose very low assigned volumes, very high (over assigned) volumes, and major outliers, compared to traffic counts.
7. Identify and develop a set of statistical reports to be produced automatically by the model after a run is completed.
8. Add validation checks such as district to district flows and screenline and cutline analyses.
9. Improve the model documentation.

Prepare for the New Model

Once the existing model is better understood and some of the key issues identified by the panel have been addressed, there are several tasks to perform in preparation for the development of a new version of the model.

1. Perform additional in-depth tests with the existing model. These should include sensitivity tests on land use changes and changes to other model attributes such as transportation supply (e.g. highway capacity), and tests on production and attraction balancing (global and by district).
2. Analyze the new NHTS data. This can be done both from the perspective of the existing model and also by considering what the data means for the structure of an updated model (for example, a trip generation cross classification of trips by auto ownership and household size).
3. Study factors that may be important in the new model such as diurnal distribution of traffic at count locations
4. Conduct an on-board transit survey to get additional information about the demographics and travel patterns of transit users.
5. Make friends with the special generators in the region, by inviting representatives to meetings of the MPO or appropriate technical committees, and by generally engaging them in the planning process. This may lead to a better understanding of how travel generated by these institutions functions, and to possible collaboration on travel survey data collection.

Develop the New Model

This long term task involves taking some of the significant recommendations from the panel and accomplishing an update and upgrade to the capabilities of the MAPA travel demand model.

1. Define the model structure. This involves potentially converting the model from an AADT model to a time of day model as recommended by the panel. The model could also be converted to represent all person trips, as recommended by the panel. The benefits of these changes include better representation of peak hour travel and the ability to incorporate a mode choice model.

2. Determine what additional model features may be required, such as a mode choice component or additional trip purposes.
3. Revisit the zone structure and the highway network.

Appendix A

List of Peer Review Panel Participants

Peer Review Panel Members:

MaryAnn Waldinger	Community Planning Association (COMPASS)
Phillip J. Mescher	Iowa DOT
Stephen Lawe	Resource Systems Group, Inc.
Jeremy Raw	FHWA Transportation Systems Performance Team
Eric Pihl	FHWA Resource Center

Local Agency, DOT and FHWA Division Staff:

Paul Mullen	MAPA
Greg Youell	MAPA
Paul Hunt	MAPA
Nick Weander	MAPA
Kaine McClelland	Nebraska DOR
Rodger Tomasek	Nebraska DOR
Jason Huddle	Iowa DOT
Adam Shell	Iowa DOT
Scott Suhr	Iowa DOT
Jonathan Wiegand	FHWA NE Division
Nick Finch	FHWA NE Division

Consultant Staff:

Courtney Sokul	HDR
Jason Carbee	URS Corp

Supporting Staff to Peer Review Panel Members:

Ed Christopher (Moderator)	FHWA Resource Center
Colin Smith (Peer Documenter)	Resource Systems Group, Inc.

Appendix B

Peer Review Panel Meeting Agenda

Metropolitan Area Planning Agency (MAPA) Model Peer Review
2222 Cuming Street
Omaha, NE 68102-4328

November 17 and November 18, 2010

November 17, 2010

8:00 - 8:20 a.m.	I. Welcome, Introductions, and Peer Process Overview
8:20 - 8:30 a.m.	II. Peer Review Key Objectives
8:30 - 9:00 a.m.	III. MPO Organization Structure, Model History, and Concerns
9:00 - 10:00 a.m.	IV. Model Uses and Application
10:00 - 10:15 a.m.	Break
10:15 -12:00 p.m.	V. Travel Demand Model Infrastructure: Study Area, Network Development, Data Inputs and Structure, Economic and Demographic Forecasts, External Travel
12:00 -1:00 p.m.	Lunch
1:00 - 2:30 p.m.	VI. Travel Demand Model Investigation and Discussion: Trip Generation, Trip Purpose, Trip Distribution, Mode Choice
2:30 - 2:45 p.m.	Break
3:00 - 5:00 p.m.	VII. Travel Demand Model Investigation and Discussion Continued: Trip Assignment, Daily/Peak Hour, Transit Assignment

November 18, 2010

8:00 - 8:30 a.m.	Welcome Day Two
8:30 - 10:00 a.m.	VIII. Travel Demand Model Investigation and Discussion Continued: Validation, Reasonableness Checking, Other Issues
10:30 -10:45 a.m.	Break
10:45 -12:00 p.m.	IX. Current Model and Future Enhancements
12:00 - 1:00 p.m.	Lunch
12:00 - 1:00 p.m.	X. Question and Answer
1:00 - 2:30 p.m.	XI. Panel Caucus
2:30 - 3:00 p.m.	Break
3:00 - 5:00 p.m.	XII. Panel Report Out and Wrap Up

Appendix C

Peer Review Panel Biographies

MaryAnn Waldinger (COMPASS)
MaryAnn Waldinger is a Principal Planner with COMPASS, the MPO for Ada and Canyon Counties, Idaho. She has been with the MPO for 15 years and is responsible for the regional travel demand model, air quality conformity and congestion management system. She has been primarily responsible for the development, maintenance and application of the regional model since 1999 with most work being done in-house.

Phillip J. Mescher, AICP (Iowa DOT)
Phil Mescher is currently the Traffic Forecasting and Modeling Team Leader in the Office of Systems Planning at the Iowa Department of Transportation in Ames, Iowa. Phil began his career with the DOT in August of 1997. He is a graduate of Iowa State University with a Bachelor of Science degree in Community and Regional Planning and a Master of Science degree in Transportation Planning. Phil is also an Adjunct Lecturer in Community and Regional Planning and Civil, Construction, and Environmental Engineering at Iowa State University. Courses taught focus on Transportation Planning, Transportation Policy Planning and Travel Demand Modeling. Phil is a Certified Planner through the American Institute of Certified Planners. He is the Department’s technical representative for the AASHTO Standing Committee on Planning and has been involved with recent efforts to provide a CTPP product based on the 2010 Census. Phil is a member of the AASHTO sponsored CTPP Oversight Board and is also active with NCHRP, SHRP 2, and TMIP projects.

Stephen Lawe (Resource Systems Group, Inc.)
Stephen Lawe is the Managing Director of RSG's Travel Demand Modeling practice and a modeler with over 20 years experience. His technical focus is in advancing the state of the practice in transportation demand modeling, land use modeling, and the resulting impacts in areas such as air quality and global climate change. Mr. Lawe has worked over the years to ensure that the state of the modeling practice supports innovative and reasonable transportation policy. This requires a balance between model complexity and the necessity to understand, communicate, and act on the results. In addition to his work with RSG, Mr. Lawe is an assistant professor at Vermont Law School.

Jeremy Raw (FHWA Transportation Systems Performance Team)
Jeremy Raw is a travel demand forecasting specialist with the Federal Highway Administration. Prior to joining FHWA in 2010, he worked for several jurisdictions and an MPO in North Carolina, and for the Virginia DOT where he developed and supported travel demand models for several small and medium MPOs. Jeremy is a licensed professional engineer (Virginia) and has a degree in Urban Planning. Prior to becoming a transportation professional, he worked as a software developer and consultant, and he served on numerous citizen transportation advisory committees in North Carolina.

Eric Pihl (FHWA Resource Center)
Eric began his career with the Atlanta Regional commission where he supported the development and application of regional passenger and freight models for long range transportation and air quality planning. Later with the Federal Transit Administration he provided technical assistance to local agencies on suitable forecasting methods for transit planning and

project development. Eric is currently a member of the FHWA Resource Center Planning team, where he provides training and technical assistance related to passenger and freight forecasting and analysis methods for state and local agencies. Eric holds an MS in transportation engineering and a Master of City Planning from Georgia Tech.

Appendix D

Summary of Responses to MAPA Questions

The following questions were posed by MAPA for discussion during the peer review. Most of the issues raised by the questions were covered during the discussion and recommendations phases of the peer review. Brief summaries of those discussions and recommendations, and selected additional responses are provided in this Appendix.

Travel Model Reasonableness and Quality

1. What are the recommended improvements to our trip generation?

   Convert the trip production rates to a cross classification of vehicle ownership and household size. Add additional land use types to the trip attraction rates. Consider adding trip purposes such as school trips.

2. How should we deal with over-assigning and under-assigning problems? (“freeway” effect, under and over-assigning areas of town, etc.)

   Use adjustments to the VDF rather than ramp and turn penalties. Carefully check the count set and diagnose outliers during model validation. Also check the trip distribution against NHTS data. The current distributions appear to require some attention.

3. How should we model unique travel characteristics in rural towns/villages and overall under-assigning in the rural areas?

   Identify characteristics of the households in these areas that can be profiled in NHTS data and represent these characteristics in the trip generation model. Test the trip generation and trip distribution of rural areas using screenlines and cutlines. If necessary, trip rates can be varied by area type (rural, downtown, etc.) but this approach should only be used after assuring data integrity.

4. How should we model travel at our military base, universities, and other special locations?

   Add trip purposes for these types of travel, such as student travel and military base travel, and review the approach used to represent group quarters housing.

5. How do we model travel in urban, lower-income areas with different travel characteristics from suburban areas?

   Look for differences in these areas that can be profiled in NHTS data and represent these differences in the trip generation model. For example, if vehicle ownership is lower in urban, lower income areas, the lower trip rates of these households can be captured using trip production rates that depend on vehicle ownership.

6. What are recommended guidelines for TAZ size and development?

Size TAZs consistently, and use natural boundaries such as highways and physical barriers such as rivers. Try to separate different land uses such as shopping and residential into separate TAZs. The size of TAZs should correspond with the level of detail used in the highway network. Finally, consider future areas of interest that may require unique focused analysis (zoned commercial parks, etc.).

7. What are best practices for centroid connector locations, particularly in larger TAZs?

   Centroid connectors should not load at intersections, should not meet another TAZs centroid connector, and (in the case of TAZs with multiple centroid connectors) should not be differentially weighted. If most traffic from a TAZ is known to access the highway network at one point, a single centroid connector should be used instead of multiple centroid connectors. Splitting TAZs rather than using multiple centroid connectors is preferable if the land use in the TAZ can be disaggregated to avoid instability between base and future model runs.

8. What are best model practices for dense areas such as office parks with dense street network (frontage roads, etc.)?

   These may safely be summarized as single zones if the overall traffic volume is appropriate, if loading patterns are simple enough, and if there is not extensive through traffic. If these areas are mixed use and have high "internal capture rates" then this should be represented in trip generation. Try to collect data in these areas to explain driveway counts and internal trip making. If these land uses have high levels of non-motorized trip making, consider generating a pedestrian environmental index if there are data to support this. If there are only one or two unique land uses they might warrant being modeled as special generators.

9. Recommendations and best practices for calibrating BPR functions (alpha, beta coefficient)?

   Calibration of the VDF should be performed prior to adding turning penalties and ramp penalties.

10. Recommendations and best practices for modeling external traffic?

    This starts with good data. Performing external OD surveys and distinguishing between cars and trucks is a good start. This provides both external to external and external trips with an internal origin or destination. If these data are not available, the next best way is to back into this by making assumptions about through trips (external-to-external) and then using trip generation to express I-E and E-I to match ground counts on external links. Usually there are only a few freeway or interstate roads that will be carrying sufficient through trips to require modeling. The current approach used by MAPA appears to be sufficient.

Socio-Economic and Travel Forecasts

1. What recommendations are there for improving our demographic allocation model and developing a new land-use forecasting model, including the software options available and their various strengths and weaknesses?

An example of good practice is the LUSTR model developed by Oregon DOT. Software platforms such as Excel or ArcGIS can be used, as can modern programming/scripting languages such as Python, R, or C#. More important than the choice of platform is producing good documentation, ensuring that the process is repeatable, automating the development of some of the land use and accessibility indices in GIS, and performing sensitivity testing to thoroughly exercise the model before it is used.

2. Given that traffic counts in the MAPA region have stabilized since 2006, do we need to re-evaluate 2035 travel and socio-economic forecast assumptions?

   Not necessarily. The decision to re-evaluate forecasts should be driven by the needs of the policy board. It is quite reasonable to evaluate alternative growth scenarios, such as low, medium and high growth.

Model Uses

1. How can we connect model better to micro-simulation models?

   The panel suggests that, if MAPA is interested in micro-simulation, it should be used as a post-process rather than trying to integrate micro-simulation into the model stream. The process usually involves creating a micro-simulation network with the necessary detail and then assigning the trip table. This will mean developing a time-of-day trip table out of the current daily trip table. Given that the model is in TransCAD, MAPA should at least review TransModeler, but there are other options as well. However, it is recommended that many of the enhancements discussed throughout this document are implemented before MAPA move to a micro-simulator. Attention to network details, particularly at intersections and interchanges is important. It is also important to thoroughly validate distribution and assignment if the regional model will be supplying background traffic estimates to localized microsimulation projects.

2. How can the model be used to evaluate road diets (e.g., changing a 4-lane arterial to a 3-lane and adding bike lanes)?

   For testing the impacts of road diets on motorized vehicle traffic flow, the capacity of the road can be reduced. The updated Highway Capacity Manual will include lists of adjustments to account for traffic calming, on street parking, etc., to allow better representation of supply.

3. What visualization techniques can better communicate to Board, committees, and public?

   Which visualization techniques to use will require investigating what works for the MPO Board and the public (that is: experiment). Many examples of possible visualization techniques have been published in model and plan documents produced in other areas. A key to successful visualization is to begin with clear, comprehensible performance measures from the model, and to figure out how best to communicate them to each particular audience. The question to first ask is what are you trying to convey. Confidence in the model would suggest comparisons against ground counts and other observed data. Future outcomes suggests a different form of analysis and presentation. FHWA has a visualization web site associated with their capacity-building program that *has some additional recommendations and examples: http://www.fhwa.dot.gov/planning/vip/index.htm*

Future Development

1. Are there peer MPOs in regions of similar-size and characteristics that we should look to as examples of best practices?

   Participate in regional model user groups to engage with peer MPOs, and attend conferences such as the TRB Planning Applications conference and the TRB Small and Medium Communities conference to see what peer MPOs are doing. TMIP is also a resource, and FHWA staff such as Jeremy Raw and Eric Pihl can provide advice.

2. What improvements need to be made to test different land-use scenarios?

   Update the LUAAM and identify whether its sensitivity to transportation system changes is reasonable. Similarly, test the sensitivity of the travel demand model to addition, subtraction, and change in land use.

3. What is necessary to properly test other transportation options (street car, tolls, increased bike/ped traffic, etc.)?

   Conversion of the model from representing only person trips by auto to representing all person trips. Implement a mode choice model in order to test transit alternatives.

4. What is necessary to develop a freight/truck model, and how do other regions use them?

   Adding a truck model could be important if there are major transshipment locations, but truck movements are probably adequately modeled in the NHB trip purpose if most truck movement is retail servicing and interstate through trips. Data, such as truck count data and origin destination data, and commodity flow data are important. Additional classified counts are likely to be required, and it is particularly important to supplement counts at heavy trucking locations. The panel suggested using a Quick Response Freight Model (QRFM), but noted that the parameters are too high for most regions and are generally reduced. QRFM represents medium and heavy trucks. Adding a freight model effectively adds another trip purpose. If a truck model is added, the trips must be removed from the NHB trip purpose. Truck routing is typically not too sensitive to congestion; trucks can be assigned all or nothing using free flow travel times.

5. Do other regions use travel models to analyze local distribution (e.g., farm to market) systems?

   None were noted.

6. What are the most important short term improvements for this model?

   These recommendations are summarized in the final section of the report.

7. What long term improvements are recommended, and can those be prioritized in terms of biggest bang for the buck?

These recommendations are summarized in the final section of the report.