Transportation Model Improvement Program (TMIP)

Report on Findings of the Peer Review Panel for the North Carolina Department of Transportation (NCDOT)

Location:	Raleigh, North Carolina
Date:	February 10-11, 2004
Exchange Host Agency:	North Carolina Department of Transportation (NCDOT), Transportation Planning Branch
Peer Review Panelists:	Ken Cervenka, North Central Texas Council of Governments (NCTCOG) Kuo-Ann Chiao, New York Metropolitan Transportation Council (NYMTC) Berry Ives, Middle Rio Grande Council of Governments (Mid-Region COG) Danny Lamb, Florida Department of Transportation (FDOT) Guy Rousseau, Atlanta Regional Commission (ARC)

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Executive Summary

The following report summarizes the results of a Peer Review Panel held through the Travel Model Improvement Program (TMIP), which is sponsored by the Federal Highway Administration (FHWA). The North Carolina Department of Transportation (NCDOT) Transportation Planning Branch (TPB) hosted the two-day Peer Review. The primary focus of the Peer Review was to provide NCDOT with an independent assessment of its travel demand modeling system and to compare the model with industry standards.

The Peer Review session focused on six main issues: organizational, data (e.g., socioeconomic, travel survey), trip generation, trip distribution, mode choice and assignment, and calibration/validation issues. After joint discussions between NCDOT staff and peer experts, the Peer Panel prepared a summary of recommendations for the following categories:

- Strengths of the NCDOT Modeling Staff and Approach
- General Opportunities, Challenges and Recommendations
- Data/Surveys
- Trip Generation
- Trip Distribution
- Mode Choice
- Traffic Assignment

After preparing the recommendations in a closed session, the Peer Panelists presented their feedback to NCDOT staff for further clarification and discussion. The findings of both the intermediary discussions and final recommendations are summarized within the ensuing report.

Participants in the Peer Review included transportation model experts from the Florida Department of Transportation (FDOT), Atlanta Regional Commission (ARC), New York Metropolitan Transportation Council (NYMTC), North Central Texas Council of Governments (NCTCOG), Middle Rio Grande Council of Governments (Mid-Region COG), FHWA headquarters, and the Volpe Center. The Peer Review was held February 10 through February 11, 2004 at the NCDOT offices in Raleigh, North Carolina.

I. Background

NCDOT has traditionally been a progressive leader within the modeling world. Since the 1990s, NCDOT has shifted from developing travel models exclusively for MPOs and trend line analyses for all other areas, to developing travel demand models for most areas in the State. The increased demand for completed studies and travel demand models has posed a new challenge to NCDOT's Transportation Planning Branch (TPB). The challenge has been further exacerbated with the loss of knowledgeable staff.

The state underwent a formal evaluation of different platforms such as EMME2 and TP+, but determined that TransCAD would best fit North Carolina's modeling needs. The main challenge for NCDOT is the diverse set of users. While other packages may have been more robust,

NCDOT found TransCAD to be the most user-friendly for less experienced modelers. Additionally, the GIS component and scripting capabilities that could transfer with GIS were recognized to be both beneficial and desirable for current and future modeling practices. All new (outdated base year or completely new) models are developed with TransCAD, while existing models are being converted to TransCAD as needed.

While almost 80 percent of the roads in North Carolina are owned, operated and maintained by NCDOT, no statewide model is currently in place. NCDOT is responsible for three regional models: Metrolina, which is the largest regional model that covers ten counties and four MPOs; Raleigh-Durham-Chapel Hill (Triangle) that covers five counties; and the Triad, which includes four counties. A variety of trip generation and loading techniques are currently used. NCDOT has begun a "sketch planning" methodology for all areas with a population under 8,000, called the Hand Allocation Methodology. This methodology involves developing a travel demand model, but relies on the application of traffic flow theories and concepts, and the use of volume trends, roadway capacities, and basic socio-economic data. The Hand Allocation Methodology as helps to train people on flow theories which ultimately need to be understood to develop travel demand models.

NCDOT has demonstrated its commitment to travel demand modeling by creating a new unit dedicated to travel modeling. Tasks of the seven person Model Research and Development Unit are to include:

- Develop complex multi-modal regional models and assist with the development of the other MPO and small urban area models
- Assist staff on the theory and practice of travel demand modeling
- Perform research into the best practices of modeling
- Combine GIS functions and travel demand modeling to enhance products

In addition, the TPB has developed employee workplans, model software tutorials and trainings to foster basic modeling knowledge for each employee in the branch.

The Model Research and Development Unit has begun a preliminary assessment of TPB's modeling processes and outputs. The TMIP panel review was one of the initial steps towards improving the modeling processes. Convening this panel of peer experts would provide feedback on the acceptability of the TPB current processes in relation to industry standards. In particular, NCDOT sought peer input in the following areas:

- Information on travel modeling best practices at all stages of TDM development
- Guidance and recommendations on types or levels of travel demand modeling
- Prioritized recommendations for travel demand modeling improvements
- Recommendations on organizational questions, such as the role of MPOs and staffing capacities
- Suggested timeline for goals

II. Presentation and Discussion

A. Peer Panelist Agency Overview

The Peer Review Panel began with panelist presentations on the modeling programs of their respective agencies, including descriptions of the

- Area/organizational context
- Model components
- Next steps

The overviews are summarized below.

1. North Central Texas Council of Governments (NCTCOG)

Ken Cervenka

NCTCOG serves as the regional planning agency for a 16-county area and the MPO for a 5,000 square-mile nine-county area.. The transportation department is organized into six program areas:

- Administration
- Air Quality Planning and Operations
- Information Systems
- Strategic Initiatives and Community Outreach
- Transportation Planning
- Transportation Programming and Operations

The Information Systems area oversees the development, maintenance and support of the travel demand forecasting tools, management of transportation data and vehicle operations.

NCTCOG current uses three travel model software packages.[1] The mainframe-based regional multimodal model has been developed as a series of FORTRAN Programs, while TRANPLAN is used for subarea traffic modeling. NCTCOG has gradually migrated to a four-step TransCAD-based modeling process over the last year. The NCTCOG TransCAD model retains 4874 zones for all the modeling steps, from trip generation to assignment, in which the trip tables have 23.8 million zone-to-zone pairs. The year 2025 model includes over 36,000 coded roadway links, 22,000 network nodes, 410 coded one-way bus lines, 36 rail lines, 14,500 bus stops and 171 rail stations for the NCTCOG region.

With the TransCAD model now developed, Mr. Cervenka identified a series of future steps that need to be made at NCTCOG. While the full TransCAD model is in place at the agency, the model has not been fully transferred to staff for all model applications work because of the need to continue legacy applications and limitations on current staff capability. NCTCOG seeks to train both in-house transportation planning staff, and planning staff from other agencies to better

[1] For more detailed model description, see http://www.dfwinfo.com/trans/program_areas/travel_forecasting.html.

understand the development and operation of the TransCAD model. In particular, NCTCOG desires to train several "TransCAD model application champions" who have a strong understanding of GIS and travel model theory, are experienced in working directly with TransCAD, and can spend the majority of their professional time on model applications projects.

In addition to a high priority on training, NCTCOG will also concentrate efforts on the preparation of additional roadway/transit "supply and demand" performance reports and the documentation of the four-step modeling process. Mr. Cervenka noted that the documentation will be crucial, as it will include a description of the model components and how they operate, as well as a detailed description of the reasoning behind how the model works. Additional next steps include ongoing improvements to the modeling procedures, greater coordination with TxDOT on the Statewide Analysis Model, and use of traffic microsimulation for detailed vehicle operations analysis.

2. Atlanta Regional Commission (ARC)

Guy Rousseau

ARC is the MPO for the Atlanta region, and is responsible for a 10-county planning area. The 2000 Atlanta region Urbanized Area Boundaries (UAB) however, include 19 counties, 13 of which were classified by the Clean Air Act Amendment to be in Serious Ozone Nonattainment. The ARC jurisdiction will likely expand to include 18 counties in the near future. 20 counties are proposed for an 8-hour nonattainment area. With a population of 2.0 million in 1980 projected to grow to 6.0 million by 2030, and a corresponding rise in employment from 1.2 million to 4.2 million, the greatest challenge confronting Atlanta is growth.

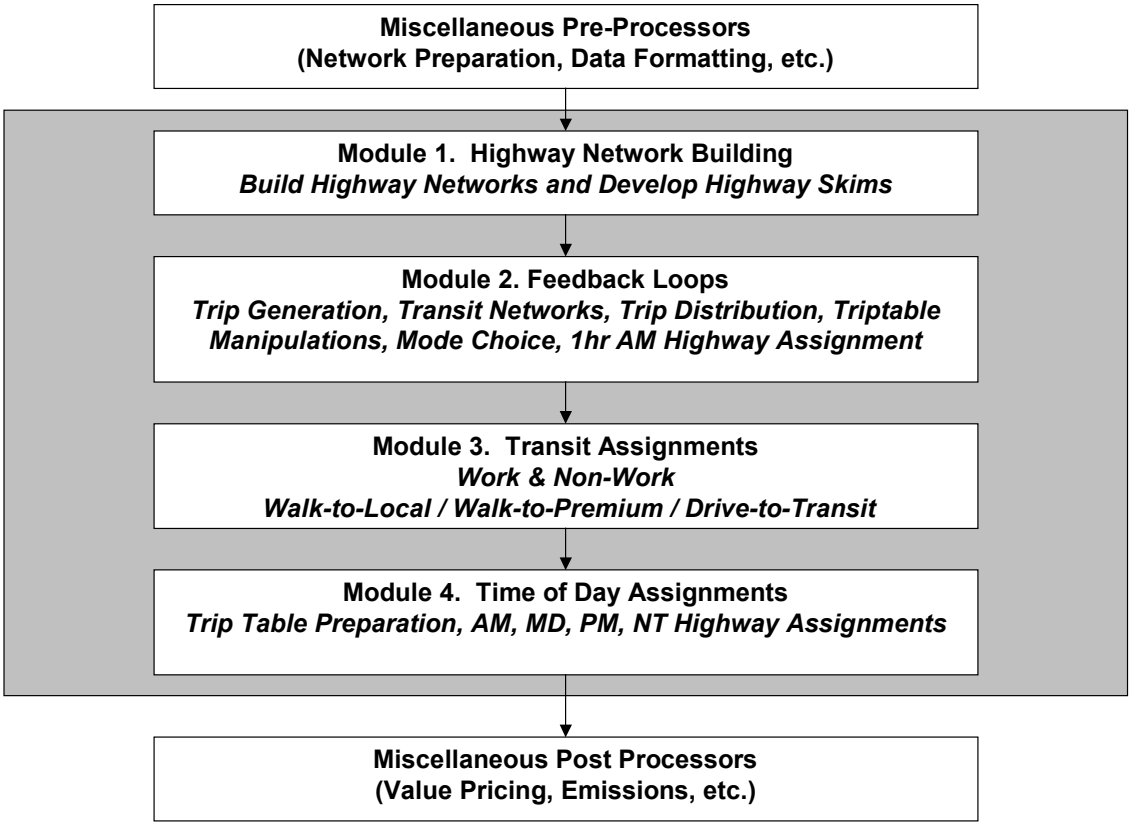
The ARC transportation planning department is divided into

- Long Range Planning
- Short Range Planning
- Modeling, Analysis and Data
- Air Quality

The Travel Demand Modeling Team consists of one model development and applications program manager and five planners who are responsible for highway and transit network coding, surveys and studies, database implementation, GIS-T, Census and socio-economic (SE) data, performance measures, and development of regional impact (DRI).

ARC generates its travel demand forecasts through the traditional four-step process. The process begins with various pre-processors. As part of its pre-processing step, ARC conducts pen sketches of the highway network, then codes the sketches with TP+. ARC first builds the highway network, then processes the feedback loops, makes transit assignments, and finally makes time of day assignments. After the four steps are complete, ARC also conducts a variety of post-processors. (See Figure 1 below).

Figure 1: ARC 4-Step Process



Source: ARC TMIP presentation at NCDOT, February 11, 2004.

The ARC land use forecasts are the result of a two-step process. First, ARC produces a forecast for the entire 13-county area using the Interactive Population and Econometric Forecasting (IPEF) model. This large area forecast is then disaggregated into smaller areas using the Disaggregate Residential Allocation Model/Employment Allocation (DRAM/EMPAL).

ARC recently convened a TMIP Peer Review Panel to study its current modeling processes and to identify areas for improvement. Mr. Rousseau indicated that the primary activities to be conducted in the near future include the following:

- Conversion to Cube's Application Manager, Scenario Manager/Flowchart Approach
- Refinement of environmental justice performance measures
- Refinement of evening/night time of day (TOD) models for five periods
- Summarization of model output by activity centers and town centers (i.e., Livable Centers Initiative sites)
- Review the Externals Model
- Refinement of transit coding/modeling and commuter rail with "externals" input
- Refinement of sketch modeling methods

- Perform commercial vehicle/truck survey and use Transearch Reebie data
- Develop a freight model

In the longer-term, ARC has hired consultants to research prospects for conversion to an Activity/Tour-based Model.

3. New York Metropolitan Transportation Council (NYMTC)

Kuo-Ann Chiao

NYMTC is the MPO for the New York Region, including 28 counties in New York, New Jersey, and Connecticut. NYMTC has established a 50 person model user group that meets monthly. Each month's meeting focuses on a particular modeling theme, and is hosted by a different consultant in a different location. The monthly meeting provides NYMTC with the opportunity to disseminate information about the latest patch and any new documentation on the latest developments in the model. The consultants use the opportunity to describe various applications of the model to other users.

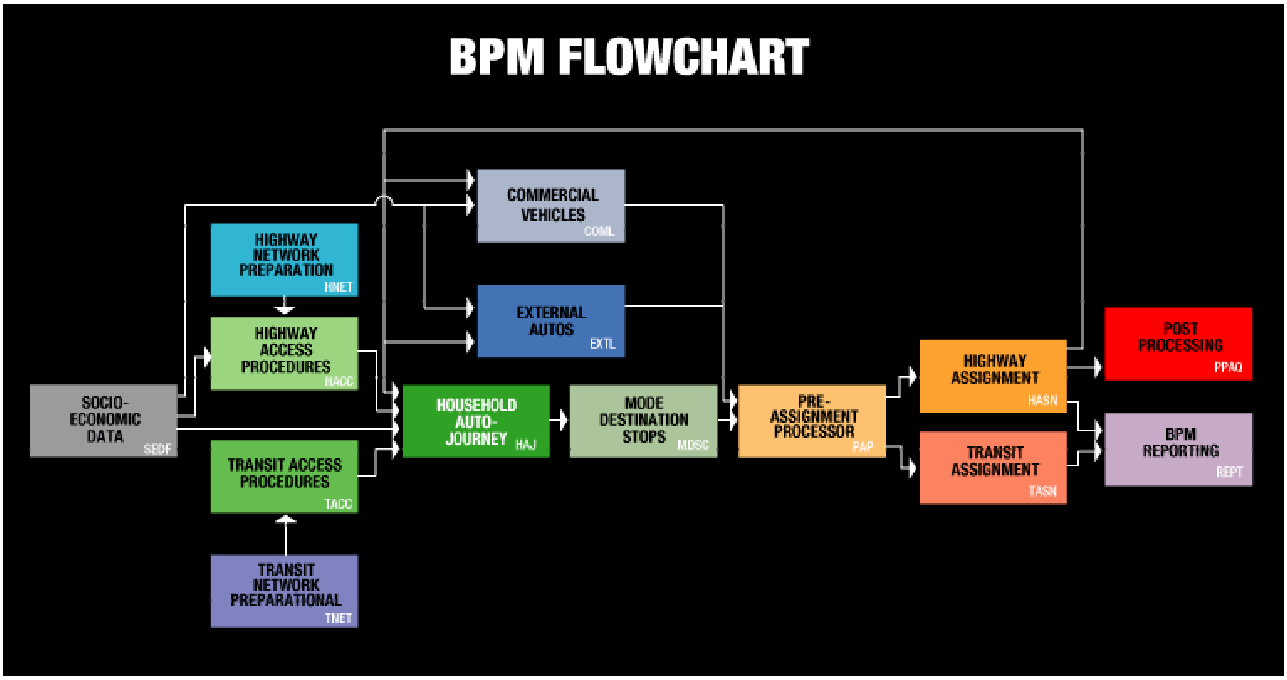
NYMTC has developed the Best Practice Model (NYBPM) [2] to determine future travel patterns resulting from changes in demographic profiles and transportation systems in the region. The model is a GIS-based model using TransCAD as the platform. Key features of NYMTC's BPM include:

- Journey-based, not activity-based, tour-based, or trip-based
- Microsimulation choice models are used until trip assignment, at which point journeys are converted back to trips
- Population synthesis and intra-household travel interactions are captured
- Stop frequency and locations are modeled
- Mode destination choice is a nested logit model
- Non motorized mode is analyzed separately
- Full multimodal analysis is conducted

The study area is comprised of 3,500 transportation analysis zones. The highway network model incorporates all types of road facilities, starting with minor arterials. The transit network database represents all types of public transportation at the individual route level. The majority of data comes from a major household travel survey conducted in 1997, land-use inventories, socioeconomic data, traffic and transit counts, and travel times.

[2] For more model description details, see http://www.nymtc.org/BPM/bpmindex.html.

Figure 2: NYMTC Best Practice Model



Source: http://www.nymtc.org/BPM/bpmmodel.html#

Mr. Chiao indicated that NYMTC would like to concentrate future model development work on the integration of their land use model, which has already been calibrated, with their travel model. Additionally, NYMTC is investigating more web-based application options for running the model.

4. Florida Department of Transportation (FDOT)

Danny Lamb

The FDOT Systems Traffic Modeling Section provides technical guidance, training and assistance on modeling to the districts, MPOs, cities, counties and other government agencies in Florida. Representatives from these various agencies coordinate with the Systems Traffic Modeling Section to establish standards, procedures and the future direction for the development and use of traffic models within the state.

FDOT established the Florida Standard Urban Transportation Model Structure (FSUTMS)[3] to provide formal guidelines, standard procedures, datasets and definitions for travel demand forecasting throughout the state of Florida. All but two of the MPOs in Florida are single county MPOs that have developed separate traffic models. Florida also has seven regional models and two statewide models.

[3] For more model description details, see http://www.dot.state.fl.us/planning/systems/stm/stmhome.htm.

5. Mid-Region Council of Governments (Mid-Region COG)

Berry Ives

The Mid-Region COG, which is the MPO for the city of Albuquerque, New Mexico, covers 9,700 square miles in five counties. Most of the population of 800,000 is within the travel modeling area, and the population is expected to grow to about 1.1 million by 2025. The core urban area is currently transitioning from a carbon monoxide (CO) Maintenance area to a Limited Maintenance area, but with ozone problems on the horizon. Most of the travel modeling is done by two planners, although much of the socioeconomic data preparation is done by additional staff, including a full time demographer and a programmer analyst. MRCOG manages the traffic counting for the region, and counts every traffic section in the region on a 3-year cycle, as well as counting turn movements on over 500 intersections for the City of Albuquerque.

The travel model includes nested logit mode choice with feedback of congested travel time to trip distribution (6 iterations). BPR functions are used in the equilibrium assignment (up to 70 iterations). Trip tables for nonmotorized modes including walk and bike are estimated in the model, although they are not assigned to a network. Transit modes include walk access and drive access (both park-and-ride and kiss-and-ride). A consultant is currently working on an accessibility model which will hopefully evolve into an improved method of estimating walk access to transit.

Currently, the modeling software is emme/2, although trip generation, park and ride, and mode choice are performed using C programs. Network building and post processing of emme/2 databanks is facilitated with M2Probe, an Arcview-based software. MRCOG is investigating alternative travel model software.

Long range population control totals are forecasted for all the counties of the state by University of New Mexico Bureau of Business & Economic Research, using a cohort-survival-migration model. MRCOG produces long range employment forecasts using REMI, and assures consistency with population controls. TAZ level travel model inputs are generated with the help of a land use analysis model (LAM).

B. North Carolina Department of Transportation

Mike Bruff, Rhett Fussell, Dan Thomas, Tim Padgett, Leta Huntsinger

The staff of the Transportation Planning Branch at NCDOT presented information and facilitated discussion about organizational issues and specific components of the travel modeling process. The following section summarizes the main highlights of the presentations, questions, and relevant discussion points.

1. Organizational Issues

The state of North Carolina currently houses 17 MPOs that serve populations ranging from 50,000 to over 200,000. North Carolina state legislation enabled the development of Rural Planning Organizations (RPO) to represent any area having three counties or more that also has a population over 50,000 but that is not included within the jurisdiction of a MPO.

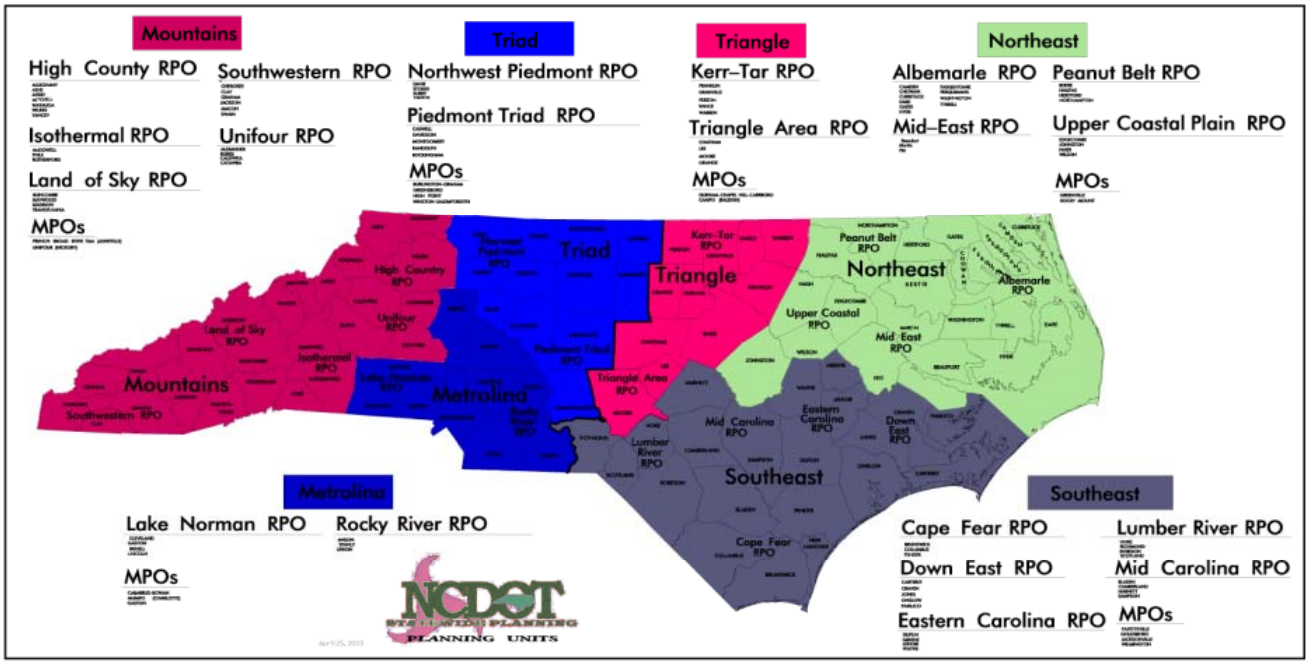
The NCDOT TPB staff members are responsible for most of the planning and modeling efforts for the MPOs and RPOs located in their assigned geographic area.

The NCDOT TPB is divided into the following groups:

- Western Planning group
- Eastern Planning Group
- Technical Services Group

The Technical Services Group is responsible for all traffic forecasts.

Figure 3: NCDOT Planning Areas



Source: NC DOT TMIP Peer Review Presentation, February 11, 2004.

Because many of the MPOs do not have full time staff dedicated to travel modeling, NCDOT staff are called upon to provide their technical modeling expertise to varying degrees. For the Triad regional model, NCDOT carries primary modeling responsibility. For the Triangle regional model, however, the Triangle Service Bureau, housed at North Carolina State

University's Institute for Transportation Research and Education (ITRE), partners with NCDOT and its other planning partners in the development of the model. In addition to assisting MPOs with their modeling efforts, NCDOT staff develop comprehensive transportation plans for all areas that serve populations that range from 3,000 to 50,000.

The varied level of modeling and planning responsibility of the Transportation Planning Branch is exacerbated by decreasing staff capacity. The Branch is losing many of its experienced modeling staff to management positions, the private sector, or other career changes.

NCDOT generated a variety of organizational questions to be addressed:

- How small of an area should NCDOT develop a model? Is there a minimum population where such modeling efforts are unnecessary?
- What are more cost and time efficient ways to model for smaller areas?
- Should the TPB staff be comprised of modeling specialists or planning generalists?
- Should the NCDOT Technical Services Group be divided into dedicated expertise areas, or into geographic responsibilities?
- What responsibilities should the modeler have (i.e., create the model, run the model, apply the model, etc.)?

The panelists agreed that the key to addressing the issue of an appropriate staffing mix is to maintain a core of modeling specialists who can then be dispatched to assist the generalists with any specific questions or issues that could arise. While one panelist suggested better utilizing University Transportation Center resources, all panelists agreed that NCDOT should consider the use of consultants for modeling expertise. The panel offered the following comments and suggestions regarding small area modeling and the use of consultants:

- *Before asking if a model is appropriate, step back and ask a few fundamental questions first.* What are the issues that create the rationale for a model? Who are the customers? Given the categorized issues, what tools are available to address those issues? Do not feel bound to a mathematical model, but consider other analytical planning processes and tools such as a growth factor process, pivot point, etc. Often, the purpose behind a regional model is to create forecasts for a Transportation Improvement Program or other planning document.

- *The purpose of a travel model is to test ideas, compare alternatives, and often, to offer justifications for transportation decisions.* A model is usually challenged in court for three issues: 1) validity, acceptability, reasonableness of sound data; 2) acceptability of the practice, and if not, demonstration of the validity of the process; and 3) equal treatment of similar situations. Demonstrate consideration of efforts and evaluation of national best practices when determining model processes or alternatives to models for travel forecasts.

- *Consider conducting a sub area analysis from a larger regional or statewide model instead of creating a whole new model for a specific county or small area.* NCTCOG

had an instance where a county requested that a full model be developed specifically for them because only a portion of the county was included within the Texas statewide model. The county had a bypass running through it, which would make such a narrow focus on the county alone yield inaccurate results. NCTCOG created a sub area origin-destination assignment and sub area origin-destination table that provided the base for the county's consultant to develop an appropriate model. Another low cost alternative to developing a full model is the development of a travel demand trip table.

- *Consider creating a statewide model, or a few relatively broad regional models to account for all the smaller areas for 2-3 geographic regions.* While developing a statewide model would be a good way to account for small areas, clarify that the statewide model is only a good indicator to show broad movements within the state. Do not oversell the statewide model.

- *When developing a statewide model and/or statewide techniques, build buy-in from partners by creating a statewide model task force*. In Florida, the FDOT statewide model task force is open to everyone, including consultants, MPOs and RPOs. The meetings present a forum to discuss and disseminate information and subcommittees to further study particular issues. Voting is only allowed from the member agencies. Although not every MPO participates in FDOT's statewide model task force, 12-15 of the 25 MPOs within the state are represented. The task force meets 2-3 times a year over a two or three day period. Many MPOs attend to learn and network with state cohorts, making the task force an education opportunity.

- *Maintain the public agency modeler as the generalist and the private consultant as the specialist.* The benefit of such a model is the opportunity for a generalist public servant to learn and distribute good practices across the state. The drawback is that concentrated expertise within one firm makes access to that knowledge vulnerable to disappearing, should that firm not win the next contract, etc.

- *Create a consortium of contractors.* Intentionally build enough redundancy in order to avoid concentration of expertise in one firm/agency. By incorporating three or four firms into one contract, more personnel become available.

- *Create task-driven contracts to incorporate involvement from public agency modeler and key stakeholders at crucial points to maintain quality control and build important stakeholder support.* In particular, including data validation and calibration functions into consultant tasks to ensure the quality of data collection and methodology. Incorporating public agency modeler input at strategic points also serves as an important educational opportunity for the public agency counterpart.

2. Data Issues

The discussions surrounding data issues focused on socioeconomic (SE) and travel survey data collection. NCDOT performs 100% field surveys of SE data for the smaller models, single class for some of the current models, and cross class for the three regional models. The field surveys

are conducted by having individuals drive around to hand count the number of houses and businesses within a given area, and rate/classify them into a trip making category. Some MPOs also utilize this method. NCDOT has found the labor intensive field surveying method to be beneficial for maintaining current data, instead of waiting for a census update. The last surveys conducted by NCDOT for the regional areas were 1995 for the Triangle region, 2001 for Charlotte region and 1994/5 for the Triad region. There are two medium sized MPOs that have surveys being completed presently. No recent surveys available for areas under 50,000 in population.

By relying on MPOs for SE data collection, NCDOT modeling is contingent upon the timing of MPO data collection and data submittals. This dynamic poses a particular challenge when plan updates are scheduled for a specific time frame, yet the modeling updates can not progress without the new data from the regional partners and/or MPOs. NCDOT staff expressed that they are not perceived as having legitimate authority to press MPOs in meeting data deadlines. As a smaller staffed statewide organization, NCDOT has had to utilize cost-effective methods for modeling that larger MPOs may not have had to consider. NCDOT would like to partner with MPOs to conduct more data collection improvements

NCDOT generated a variety of data questions to be addressed:

- What is the proper role for NCDOT in dealing with regional partners and MPOs, such as for data collection? What standards and guidance efficiencies exist?
- How often should travel surveys be conducted for regions? What cost-sharing methods for travel surveying exist?
- How transferable is data for non-MPOs? Should a statewide travel survey be used for non-MPO models?
- Are workplace surveys or other types of surveys beneficial? Are workplace surveys, cordon surveys, external-internal (E-I) surveys, or other kind of survey preferable for capturing nonhome based trips for nonresidents in the region, since they often make intermediary trips?
- What are the benefits and recommended approaches for conducting commercial vehicle surveys?

The panel offered the following comments and suggestions regarding data collection challenges:

- *Encourage coordination and cooperation among MPOs*. In Florida, the business community has provided a strong impetus for mandating coordination between strong local MPOs to ensure that regional plans and issues that extend beyond a MPO's jurisdiction are still addressed. Key factors for FDOT have been a coordinated update schedule and a common database system accessible by all MPOs.
- *Networking and cooperation between the modeling agency and partners is crucial*. With a service area covering 31 counties, NYMTC has established an understanding with their local agency partners. While NYMTC does not develop a separate model for each partner, NYMTC has access to the network and data files of each local

agency. Consistency in assumptions, such as the same street network, the same zones, allows for the transference of local data to the larger regional model.

- *Conduct an intensive effort to collect base survey data with subsequent minor surveys as necessary*. The same level of effort and scale is unnecessary for all travel surveys. Similarly, consider conducting a broad statewide survey to ensure good stratification and transferability; make minor adjustments for different regions. A sample of a few small areas instead of a specific survey for each small area is sufficient.
- *Conduct surveys for a small sample size in typical areas in order to develop a baseline.* Integrate NHTS and census data (CTPP) and other supplemental data wherever possible, then conduct an additional survey to create sensitivity tests.
- *In order to create an economy of scale, attempt to conduct surveys in coordination with census efforts*. ARC conducts travel surveys every 10 years, approximately in line with the timing of the census. NCTCOG also attempts to conduct a travel survey every 10 years.
- *Because funding for survey work is erratic, conducting smaller, more frequent surveys may be feasible alternative to a larger, more expensive effort*. One panelist suggested that during each plan update cycle, funds should be allocated to travel surveys.
- *Draw funding for surveys from a variety of sources*. In addition to the use of general Surface Transportation Planning (STP) funds, ARC has used Congestion Mitigation Air Quality (CMAQ)monies for household surveys. ARC has also partnered with a nearby university, Georgia Tech, to both create and fund surveys. In New York, the state DOT uses STP funding for surveys while NYMTC uses PL funds. NCTCOG strictly used planning funds for their last survey. FDOT retains the increased Planning(PL) funds to invest into the model instead of increasing grants to MPOs. FDOT also allocates State Planning Research (SPR) funds for research into model improvements. Some areas are using National Science Foundation funding to test issues such as how to use land use research in transportation modeling.
- *Workforce and establishment data is helpful in determining attraction factors*. NCTCOG uses workplace survey data for nonhome based visitors, household survey data for trip rates/household, employee survey data for trip rates/employee. They found that the non home based trips from employee surveys yield a higher ratio than the same trip categorization ratio from household surveys.

  FDOT differentiates between work based nonhome based travel and traditional nonhome based travel. Home based work trips were found to be shorter and include multiple trip links. Additionally, FDOT has used cordon surveys to distinguish between noncompetitive and competitive external-internal (E-I) trips and internal-external (I-E) trips. FDOT categorizes for two types of trips: 1) trips for a special purpose are categorized as noncompetitors for attractions within the model area, because those travelers usually are not familiar enough with an area to consider alternative routes; and 2) residents who have lived in the model area for a certain period of time are categorized as competitors. If trips are made once a week, that trip is considered to be a regular trip and therefore an internal trip. If the trip is less than

once a week, then the traditional E-I or I-E trip categorization is made and proportionally distributed across all other attractions. These categorizations have significantly improved the FDOT model.

- *A variety of methods exist for surveying commercial vehicles*. ARC assigns trips separately, which lends itself to the development of a freight model. Single Occupancy Vehicles (SOV), High Occupancy Vehicles (HOV) and trucks are distinguished in three separate trip tables. NCTCOG created trip rates based on employment related to REEBI commodity flow data, then created vehicle trip tables. The NCTCOG truck model was developed without conducting a truck survey. Instead, NCTCOG used the responses to a question within the workplace survey that asked for the number of trucks arriving at a workplace to generate a "quick response" truck forecasting model. They then used a gravity model to generate truck trip vehicle miles. One panelist also pointed out that in addition to REEBI commodity flow data, a tremendous amount of intelligent transportation systems (ITS) data for operational needs is also available to construction of a truck model.

3. Trip Generation and Distribution

For Trip Generation, NCDOT uses a variety of methods. The housing classification system (field survey), single class using Persons/household and workers/household and cross-classification using primarily persons/household, income, vehicle ownership as the variables. Rates are determined for each of the methods described.

NCDOT uses the gravity model for trip distribution. The TMIP calibration and validation document and FHWA 1990 guide to calibration (yellow book) are major references for NCDOT. Uncongested and congested impedance is broken up by trip purpose. Travel impedance, travel time, and friction factors are generally borrowed from similar models and matched to trip length distribution. This is problematic for smaller areas where no trip length frequency/distance data is available. NCDOT has not really used the Gamma function to generate friction factors.

The unusual development patterns of certain communities within North Carolina may not be well captured within the current model outputs. NCDOT continues to struggle with urban to rural streams and the university communities. The Chapel Hill area emphasizes transit, and insists upon using smaller zonal areas for their model. Yet, the University of North Carolina and associated hospital are large attraction areas that generate trips from outside the smaller zones. The Triangle region has considered using a destination-choice mode because of difficulties with the gravity model. Research Triangle Park is not a central city, but is a research campus that houses the vast majority of higher level jobs in the Triangle area. This causes the model to attract trips from lower income areas to the higher paying jobs. This is one reason for why the Triangle model was thought to be better served by a destination choice type model.

NCDOT generated a variety of data questions to be addressed:

- How should NCDOT consider travel impedance, travel time and friction factors?

- Is the destination-choice model a good option to consider? Would a destination-choice element help address the unusual development patterns such as those experienced within Research Triangle region?
- How appropriate are smaller zones accounting for large attraction points, such as UNC in Chapel Hill?

The panel offered the following comments and suggestions regarding trip generation and distribution challenges:

- *The gravity model is still the common practice of many MPOs.* If there is reasonably good calibration with friction factors and the gravity model and no other compelling reason exists, staying with the accepted practice of the gravity model is sufficient.
- *In a gravity model, friction factors would be better to consider than a gamma function.* FDOT calibrates with the gamma function, then adjusts back into friction factors to generate trip lengths that would otherwise be too short. The Mid-Region COG uses a log sum instead of generalized cost for impedance value. ARC typically assigns 2 minute penalties for river crossings, and other potential time factors.
- *Before going into destination-choice model, invest in household travel surveys to create a gravity model.* The usefulness of a destination-choice model depends on the size of the model area. Destination-choice models are usually not applicable for nonurban areas. Destination choice models require extremely robust survey data which does not currently exist for North Carolina. Because destination –choice models have not yet been proven and NCDOT currently gets good results with their modeling, the current model is most likely sufficient.
- *Minimize the use of K factors. FDOT uses a travel time penalty instead of a K factor to represent the psychological perception of travel time when necessary.* Many people perceive certain trips to be longer than they actually are.
- *Model for a larger zone with a step-in simulation model or other process, or consider increasing terminal time to reflect unique variations within travel patterns.* When using small zones, model assumes people are driving straight into work. Many of those travelers do not park in the same zone as the final attraction. By increasing accuracy of parking spots to zones, then accuracy is actually diminishing.

4. Mode Choice

NCDOT has not taken a lead role in transit modeling. The Metrolina, Triangle and Asheville models have incorporated a predictive choice mode into their models. Raleigh has a transit-on-board survey and a nested mode choice model, which includes HOV and commercial vehicles.

Agencies across the state of North Carolina are increasingly becoming interested in gaining the ability to test for transit options within their communities to include in their long range planning

efforts. NCDOT created a premium nest for their mode choice model by approximating against a one rail service option within the state.

NCDOT generated a variety of data questions to be addressed:

- What wisdom and guidance can you offer regarding transit mode in modeling?
- How deal with mode choice for smaller and midsize MPOs?
- Question of whether FTA would accept borrowed coefficients
- Going into future, what is an alternative method to calibrate a mode choice model than to calibrate against just one rail service route?

The panel offered the following comments and suggestions regarding mode choice challenges:

- *Access and use transit choice information sources.* Panelists offered examples such as a National Transit Institute course on transit operations training, preference survey or other survey results, the NCHRP 1987 report, FTA canned analysis tool, or a FTA regional representative.
- *When considering transit options, simple techniques are often adequate.* In order to consider transit options for a small city, a complicated modeling effort is not always necessary. Often, looking at a city with comparable characteristics to arrive at a rough estimate on bus service may be adequate. A sequential binomial or simple binomial may be sufficient.
- *Adjust any borrowed values to fit the model, and use a reasonableness test.* When FDOT underwent a mode choice exercise for the Tallahassee area, they referred to Miami's coefficients and visited their FTA region representative. FTA advised FDOT that using borrowed coefficients was acceptable so long as justification on the appropriateness of the borrowed figures could also be provided.

5. Trip Assignment

NCDOT was interested in learning of how each of the peer panelists conducted trip assignment within their regions. The following summarizes the characteristics of the trip assignment methods described by each of the Peer Panelists.

NCTCOG

- Three time of day increments: 1) AM peak period assignment for a 2.5 hour period (6:30-9am); 2) PM peak period assignment for a 3.5 hour period (3:00-6:30 PM); and 3) Off-peak period assignment for an 18 hour period.
- NCTCOG considered using User Equilibrium (UE)assignment in TransCAD, but decided that the non-stochastic User Equilibrium assignment was satisfactory.
- Although perfect convergence is nearly impossible, TransCAD allows for the use of a convergence factor. NCTCOG sets 30 iterations for each standard time-of-day assignment.

- Four vehicle class tables are assigned simultaneously: drive alone; two versions of shared-ride vehicle classes; and trucks (identified as all vehicles with six or more tires). The vehicle classes are important for generating specific forecasts, such as number of trucks on a certain facility, projections for standard HOV lanes, and projections for managed HOV lanes that are tolled for drive-alone vehicles.

NYMTC

- Use stochastic equilibrium assignment procedure
- Preload truck and bus data
- Four time period networks in addition to the base 24 hour network are developed: 1) AM peak (6-10AM) peak; 2) midday (10 AM – 3 PM); 3) PM peak (3-7PM); and 4) night (7 PM – 6 AM)
-
- Model is calibrated against screenline counts. Three tiers of screenlines have been defined for the 10 counties that comprise the NYMTC region, representing about 2,200 links. Hourly counts for 24 hours are estimated and maintained only for those links on a screenline.
- Use adaptive assignment to match scheenline data closer for conformity analysis.
- Match Highway Performance Measurement System (HPMS) data in post-processor for conformity analysis
- Use 21 "physical link types" (PLTs). These PLTs are used as an index (along with area type) to look up the free-flow speed and capacity values for each link.

ARC

- Four time of day increments: 1) 6-10AM; 2) 10AM-3PM; 3) 3-7PM; and 4) 7PM-6AM
- Equilibrium assignment
- Trucks, SOV and HOV included
- Toll diversion model built in for toll facilities and considering managed lanes and hot lanes
- Usually able to reach closure within 22-23 iterations, although ARC will sometimes do as many as 30 iterations
- ARC conducts a post process to match up with HPMS data.
- Upward adjustment factors are based on facility types for vehicle miles traveled to demonstrate to the Environmental Protection Agency and DOT that ARC is following guidelines.
- ARC conducts hourly counts, not daily counts, and uses state coverage and local input.

FDOT

- FDOT allows up to 30 iterations to complete the model.
- System wide RMS 2 with 28-29 percent
- FDOT is currently revalidating its four vehicle classifications. Traditionally, FDOT has used 1) drive alone; 2) shared ride; 3) light trucks; and 4) heavy trucks. Trucks were preloaded but have not yielded optimal results. FDOT is currently considering the addition of special use lanes for HOVs, long distance trips, or some combination of the two.
- Most modeling is conducted for a 24 hour period, but FDOT has also developed models for the peak periods of 6:30-9 AM and 4-6:30PM
- FDOT calibrates to daily volumes to account for some anomalies, such as a retiree-heavy communities where the peak period is mid morning. The statewide model is calibrated to the winter peak season. Telemetry stations are used to develop weekly seasonal adjustment factors.
- Centroid locations and centroid connectors (i.e., where is center of development and where are the major access points?) are important to accurately determine.

Mid-Region COG

- Three time periods: 1) 3 hour AM peak period; 2) 3 hour PM peak period; and 3) remaining 18 hours of the day.
- Traffic counts are conducted at all intersections within the city of Albuquerque. Manually set tube counts tally at 1200-1300 locations/year. Ramp balancing is used to estimate freeway volumes.
- EMME/2 software is currently used for equilibrium traffic assignment. Only one vehicle mode is assigned, although HOV trip tables are estimated. No trips are preloaded.
- VDFs are BPR-styled with various coefficients and exponents.
- Mid-Region COG calibrates to peak period and daily directional volumes (AWDT), mean speeds by functional class, total transit ridership.
- Model completed with up to 70 iterations by time period for each of the 6 feedback loops.
- Adjustment factors for conformity analysis match model output to traffic counts based VMT for the base year. MRCOG estimates AWDT on many freeway locations using ramp balancing techniques.

6. Calibration/Validation

Brief discussion of the data calibration/validation checks that are used in North Carolina. They are outlined in the Model 101 documentation that the TPB produced. They follow the FHWA guidelines in the TMIP Model Validation & Reasonableness Checking Manual .

Calibrating a statewide model for North Carolina would be a difficult because of the variance in peak periods among the three major regions within the state. One panelist suggested that if seasonal fluctuation is confined to one area, worst case scenarios could be modeled simultaneously, followed by the use of an average condition or seasonal adjustment factors to scale down for individual areas. Another panelist suggested getting involved with the National Highway Study and American Community Survey (ACS) in order to validate the model. It was also suggested to have 3 sectional models (that tied back into each other) to represent the three different characteristic areas in the state.

III. Summary of Panel Recommendations

The following is a summary of the TMIP Modeling peer review recommendations to NCDOT:

A. Strengths of NCDOT Modeling Staff and Approach:

- Well-qualified young pool of modeling talent, energetic staffing resources, with great attitude, forward-thinking group (TMIP initiative), open to questions, discussions and constructive criticism
- Good understanding of validation/calibration criteria
- Very good documentation for modeling training (Modeling 101 documents)
- They know their customer-base (MPOs), good understanding of regional issues
- Adaptive and flexible in responding to changing needs and opportunities
- Good survey database for the 3 largest metro areas
- Have already settled on a modeling software package that serves as a solid base for modeling needs

B. General Opportunities, Challenges and Recommendations:

- Create a statewide task force / model users group to build partnership and regional /statewide relationships to address issues such as data collection techniques and to provide the opportunity to train and update modeling partners on current efforts
- Discuss the merits (issues to be addressed) of a multimodal statewide model / analysis tool within that newly created task force / models users group, involving all planning partners and stakeholders (MPOs). If developing a statewide model go through a formal Request for Proposal (RFP) process. In selecting consultant, create a separate objective/deliverables or task work order in the RFP that ensures good user interface and requests two kinds of documentation: 1) user guide, 2) technical notes that include comments, to help understand the source code.

- Make better use of consultant services in modeling, and remain involved in that process (specialist vs generalist). For instance in the calibration of a mode choice model, and such specialized tasks, use consultants resources. Consider hiring a general consultant to assist in the general administration process, and select specific sub consultants to conduct more specialized work. Investigate options for increasing specialist abilities at TPB.
- NCDOT is having difficulty in obtaining experienced travel demand modelers at salary levels equivalent to Engineering I pay, because planners with that level of experience can get much more money in the private sector. Consideration should be given to establishment of salary levels for travel demand modelers that are closer to their true market value.
- Focus on managing the modeling process (technical requirements and specifications) in model development, and integrate model applications (provide technical services), and coordinate with other agencies on modeling issues.
- Take advantage of opportunities to add diversity to the staff resources in the Model Research and Development Unit, and in the Transportation Planning Branch (demographers, geographers, economists, planners, etc…)
- Keep an open mind to the proven emerging modeling methods , even if they are not yet widely practiced. Encourage staff to attend national modeling application conferences and Transportation Research Board (TRB) committee sessions, etc. to stay abreast of emerging trends.
- Consider a freight model (trucks for urban models, trucks or commodity flow / goods movement for statewide model) with use of software such as REEBI
- Come up with some analysis tools for small MPOs and rural areas (technique toolbox), look at what is done in other states and what is being provided by USDOT

C. *Data / Surveys:*

- Create a data collection strategy for surveys and studies (household travel surveys, transit on-board surveys, GPS speed studies and travel times as done in Albuquerque and Atlanta, floating car method as done in Baltimore, etc…), and regional control totals for land use and socio-economic data
- Take advantage of all available datasets (such as NPTS, and CTPP 2000 datasets and ACS), and participate in add-ons surveys such as NHTS Consider REMI for forecast and regional control totals, especially for an employment model
- Regional control totals: recognize the importance of reasonableness, consistency and defensibility of forecasts, by using a set of forecasting tools and Delphi Panel (broadly defined stakeholders) if needed, and/or independent consultants, in conjunction with other statewide datasets and forecasts. Conduct sensitivity analyses for specific areas when generally transferable outputs from another model are used.
- Coordinate with all agencies and MPOs on data collection, sharing resources and come up with consistent standards (data formats, etc…)

D. Trip Generation:

- Stay away from subjective variables, and the ones difficult to forecast, such as quality of dwelling units and housing units (classification)
- Keep the special generators to a minimum, by stratifying trip purposes (such as Home-Based Education, into home-based grade school, home-based university, etc…)
- Reconsider some variables used currently in trip generation (such as lifestyle, retirement, etc…), and what makes sense for NC in productions and attractions. In addition to traditional variables, consider others such as area types, lifestyles, income quartiles, etc …

E. Trip Distribution:

- Friction factors vs gamma function: Use survey data when available and select the most appropriate one.
- Destination choice trip distribution: Have a consultant/university look into it in terms of research and assessment

F. Mode Choice:

- Identify a menu of varying techniques, model and off-model (sketch modeling), and identify appropriate situations and uses for each technique (nested logit, pivot point, binomial, sequential multinomial, etc…)
- Look into FTA's New Starts requirements (Summit program) and recommended available methods for new transit services. Also consider NTI resources

G. Traffic Assignment:

- Avoid AON assignment in the larger metro areas, except for special situations, and consider user-equilibrium assignment
- Centroid connectors: Review those using aerial photos to make sure they represent true center of activity and connectors represent actual access points
- Use TOD assignments in larger metro areas
- Speed studies and travel time studies to support new VDF curves and free flow speeds

Appendices

List of Participants

- Berry Ives, Mid-Region Council of Governments
- Beverly Williams, NCDOT Transportation Planning Branch
- Brian Gardner, Federal Highway Administration (FHWA)
- Dan Thomas, NCDOT Transportation Planning Branch
- Danny Lamb, Florida Department of Transportation (FDOT)
- Esther Lee, U.S. DOT Volpe Center
- Guy Rousseau, Atlanta Regional Commission (ARC)
- Ken Cervenka, North Central Texas Council of Governments (NCTCOG)
- Kuo-Ann Chiao, New York Metropolitan Transportation Council (NYMTC)
- Leta Huntsinger, Institute for Transportation Research and Education (ITRE), North Carolina State University
- Lydia McIntyre, NCDOT Transportation Planning Branch
- Mei Ingram, NCDOT Transportation Planning Branch
- Mike Bruff, NCDOT Transportation Planning Branch
- Rhett Fussell, NCDOT Transportation Planning Branch
- Tim Padgett, NCDOT Transportation Planning Branch

Agenda

Tuesday February 10th

8:00 am – Introductions of Peer Review Panel & NCDOT participants

Expert Panelists- Where from?

Experience in modeling
How organization does modeling
What works well in your modeling program/needs improvement

9:15 am – How We All Got Here & Our Panel Goals –(Rhett)

9:45 am- 10:00 am - Break

10:00 am- 11:00 am - TPB Organizational Structure – (Mike & Dan)

11:00 am – 12:00 pm-Modeling Effort, Part 1-Data Issues

SE Data- what data we are collecting/using -(Various)

Travel Survey Data –(Leta)

12:00 pm-1:00 pm -Lunch

1:00 pm-1:30 pm - Modeling Effort Part 1-Data Issues (Con't)

Highway Data – (Rhett)

Transit Data- (Leta)

1:30 pm-1:45 pm - Questions from Panel on Data Issues Or Organizational Structure

1:45 pm-3:00 pm -Modeling Effort Part 2-Trip Generation –(Rhett)

Trip Generation Methodologies for models!

3:00 pm-3:15 pm - Break

3:15 pm-3:30 pm - Q& A's from panel on Trip Generation

3:30 pm- 5:00 pm - Modeling Effort, Part 3-Trip Distribution –(Tim)

Wednesday February 11th

8:00 am – 8:30 -Summary from Tuesday

8:30am-10:00 am- TPB Modeling Effort, Part 4-Mode Choice & Assignment –(Leta)

10:00 am-12:00 pm – Interactive Dialogue-All panel members (Rhett)

Open Discussion on Other Issues
time of day modeling for all MPOs?
Typical schedules for models?
How do you treat capacity in Equil loading if you have a daily model?
How do others forecast future data?
Manual of best practice-for their areas?
Users groups-statewide are they effective?
Etc…..

12-:00 pm – 2:45 pm - Lunch / Panel Caucus-closed session to discuss recommendations

2:45pm- 3:00 pm – Break

3:00 pm- 5:00 pm - Recommendations & Dialogue Session

Panel discusses recommendations
Interactive Dialogue between panel & TPB

Presentations

Travel Demand Modeling at NCTCOG *<NCTCOG>*
The Atlanta Regional Commission Transportation Model *<ARC>*
The Best Practice Model in New York *<NYBPM>*
NCDOT Organizational Issues *<NCDOT Organization>*
NCDOT Data Issues *<NCDOT Data Issues>*
NCDOT Trip Generation *<NCDOT Trip Generation>*
NCDOT Calibration/Validation *<NCDOT Calibration Validation>*

Questions Posed

- What processes are we using that might not be Best Practices in travel demand modeling?
- Should we change our housing classification system (how we get data for models) used for our smaller areas? If so, how?
- Where should we get housing & employment data instead? What do other areas use?
- Should we be building travel demand models for all our areas? or for areas larger than a certain population? What is that threshold?
- What other travel demand methods can/should be used in the smaller areas?
- Are certain traffic assignment loading techniques better for certain types of areas? What should we be using?
- How much field data collection is necessary?
- What are typical schedules for developing travel demand models?
- Are there checks/balances that we are not performing that should be performed?
- Should we be doing time of day modeling for all our MPOs?
- Is the gamma function or some other function more widely accepted than friction factors tables in trip distribution?
- Should we dedicate more staff to developing travel demand models? Should all our employees be expected to build models or are some just end users?
- Are there organizational changes that can facilitate our process?
- Free flow vs. posted – rules, pro's/con's; how do we get free flow if we don't have survey information? Is there some way to take posted and make assumptions about free flow speeds for the area?
- How do they collect the data for roads?
- Maintenance of roadway data?
- What roads should be included in network?

- What besides Logit for Mode Choice?
- How do you determine trip rates assuming no data?
- What variables should we be using in Trip Generation?
- Our Trip methodologies for smaller urban areas? What to use (single, cross, rating system)?
- Capacities – should we use hourly and factor to daily?
- LOS E/F capacities for loading o.k.? Use D for V/C?
- Non-Home Based by Non Residents – How are they accounted for?
- Special Generators – how do they define them, rates for them??
- Person trips?/DU trips?/ HH trips – what should we be using?
- Assuming you use the gravity how do you get factors (gamma function? - but what are common values-pro/cons for gamma)
- How do you determine if trip length is accurate assuming no survey?
- Gravity vs destination choice – Why would you want to do destination choice? When?
- Recommended loading techniques?
- Suggested parameters for stoch equil or other loadings
- Should we be loading through trips & commercial using AON then load other trip tables in equilibrium?
- Surveys – Why should we be using them? How often? Which surveys help us the most? Benefits to them.
- Recommended checks for Calibration/Validation
- Should we be doing time of day modeling for all MPOs?
- Typical schedules for models?
- How do you treat capacity in Equil loading if you have a daily model?
- How do others forecast future data?
- Is there a manual of best practice-for their areas?
- Users groups-statewide are they effective? How setup?
- Forecasting of data – best/recommended ways, control totals for State? Regions? MPOs – some guidance here on how its done elsewhere
- Specialist vs. Generalist – should we have people doing MPO coordination and then let them be end users? Should we have our specialists build all MPO models, some internally some with consultants? Why is it important for specialists?
- Commonality between our regional models – how do/can we get the building of those models to be similar, functioning similar.

- Are our Validation/Calibration checks on the model o.k.?
- Gamma function – should we use the function for our smaller models with no survey data? What are the general parameters we should use?
- Rules of thumb for trip length assuming you have no data?