A Snapshot of Travel Modeling Activities:

Atlanta Regional Commission (ARC)
Mid-Ohio Regional Planning Commission (MORPC)
North Central Texas Council of Governments (NCTCOG)
Puget Sound Regional Council (PSRC)

ADDENDUM

Helping Agencies Improve Their Planning Analysis Techniques

TMIP

Travel Model Improvement Program

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ADDENDUM

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Prepared for:
Federal Highway Administration

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Executive Summary

Purpose of Addendum

This Addendum updates the information compiled and presented in the August 8, 2008, report "A Snapshot of Travel Modeling Activities." The purpose of the original 2008 report was to summarize the use of travel demand models by five Metropolitan Planning Organizations (MPOs) chosen based upon their recognized leadership in the industry and a history of using travel forecasts generated by travel models to support the development of regional plans. At the time, each of these MPOs had indicated its commitment to continue to refine their current travel demand models and develop advanced travel demand forecasting tools to support the regional planning process. The purpose of this Addendum, three years later, is to check in with each MPO to gauge their progress in advancing their travel model tools and applying them in the planning process. This Addendum is intended to supplement, not replace, the 2008 Snapshot.

Progress in Implementing Activity-Based Modeling

A substantive finding of the previous report was the interest by these MPOs in investigating or proceeding with the wholesale redevelopment of travel models away from the traditional four-step model toward activity-based modeling. Each of the MPOs participating in the 2011 revisit has demonstrated continued progress in advancing their models to benefit their respective regional planning processes:

- The activity-based model (ABM) of the **Atlanta Regional Commission (ARC)** went on-line in 2010 and ARC is operating their ABM and trip-based models on a dual-track, comparing results and testing the ABM's applicability to various analysis needs; they may transition to using the ABM exclusively for their 2014 model update.

- **Mid-Ohio Regional Planning Commission (MORPC) (Columbus, Ohio)** was already using a state-of-the-art activity- and tour-based travel forecasting model. In 2011, MORPC continues to use this model, with updates.

- **North Central Texas Council of Governments (NCTCOG) (Dallas-Ft. Worth-Denton, Texas)** was using and making improvements to the four-step travel model while simultaneously planning for the incremental development of an activity-based travel forecasting model. Having completed the planned study area expansion, NCTCOG continues to conduct surveys and gather additional traffic counts and speed data necessary before moving into development of an ABM, anticipated in 2012 or 2013.

- The **Puget Sound Regional Council (PSRC)** has followed an incremental approach, implementing activity-based model components as appropriate into their trip-based model, as they continue to develop the actual ABM; they are currently estimating the ABM and anticipate rollout in late 2012.

While ARC and MORPC have proceeded in implementing an ABM model structure and are improving upon components as additional data and component improvements become available,

NCTCOG and PSRC are staging ABM implementation more deliberately. Both approaches have advantages and disadvantages.

Emerging Issues and the Evolution of Tools to Examine Them

Policy- and decision-makers continue to ask questions of travel models that are challenging for transportation professionals to address with current model tools. Of the five emerging issues identified in the Transportation Research Board Special Report 288, *Metropolitan Travel Forecasting: Current Practice and Future Direction* (2007), an activity-based model can substantially address three: time chosen for travel, travel behavior, and non-motorized travel behavior.

For a fourth, these MPOs still agree, as they did in 2008, that a future goal should be time-dependent network modeling, such as simulation or dynamic traffic assignment approaches, to fully address current policy issues, and yet each still runs a traditional traffic assignment procedure. Finally, improvements on modeling freight and commercial vehicle movements, the fifth issue, seem to have been somewhat hindered by the availability of data and lack of funding to conduct applicable surveys.

Most of these MPOs have only begun to consider the newer policy issues of sustainability, climate change, and livability. PSRC has some tools to examine climate change and ARC has included additional post-processing into its air quality analysis. With regard to sustainability and livability specifically, none of the MPOs are directly working on addressing these issues with their models at this time.

Incremental Approaches to Improve Travel Modeling Capabilities

A persistent theme in the discussions with these MPOs is the continual improvement to their models, whether trip-based or activity-based. Improvements are often incremental and the result of substantial planning, data gathering, and effort as part of a deliberate approach. Activity-based modeling seems to be addressing the policy questions that it was expected to, and the idea of transitioning completely away from the trip-based model has occurred for one MPO and appears to be a very real possibility for the other MPO with an ABM actively in use. For emerging issues such as climate change, sustainability, and livability, tools and methodologies are still in need of better definition. Integration of the travel models with land use modeling, time-dependent network modeling, and better freight models remain a realistic “next frontier” for advancement because the approaches to address these areas have been identified.

The next section of this Addendum presents profiles for each of the MPOs with respect to their modeling activities since the original 2008 report -- the model applications, support for the models, advances, and model applications for each MPO that participated in this update.

MPO Profiles

Atlanta Regional Commission (Atlanta, Georgia)

Background

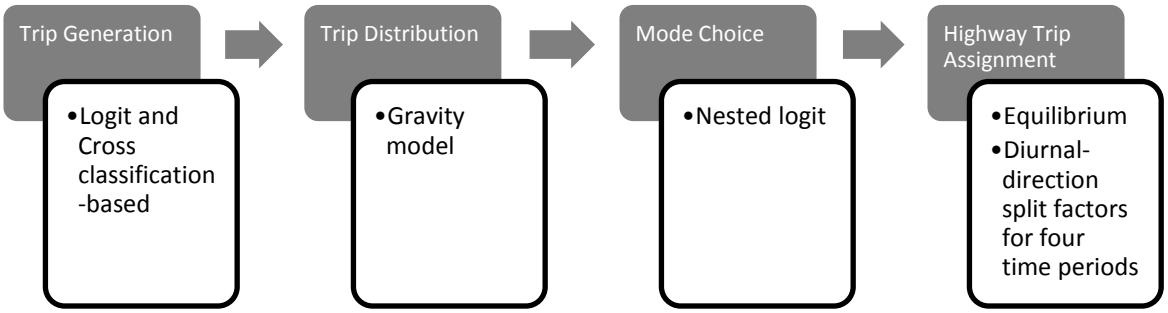
The Atlanta Regional Commission (ARC) is the federally-designated metropolitan planning organization (MPO) for 18 counties surrounding and including Atlanta, Georgia: Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale counties and part of Barrow, Bartow, Newton, Spaulding, and Walton Counties. Together with Carroll and Hall counties, this area has been designated an ozone non-attainment area by the U.S. Environmental Protection Agency.

ARC operates under a dual-track method to maintain its traditional four-step trip-based model and its activity-based model (ABM), which went into active use in 2010. The four-step model is used for long-range plan development and for air quality conformity. The ABM provides additional perspective for the plan process and notably has resulted in similar results to the four-step model for vehicle-miles of travel (VMT) and vehicle-hours of travel (VHT) at the regional level. They have applied the ABM for telecommuting analysis, roadway pricing, even studying differences between the genders in travel patterns. It also has enhanced capabilities for visualization of the results, which ARC has used to inform decision-makers of, for example, animating traffic patterns over time through the region.

Current Travel Forecasting Model Practice

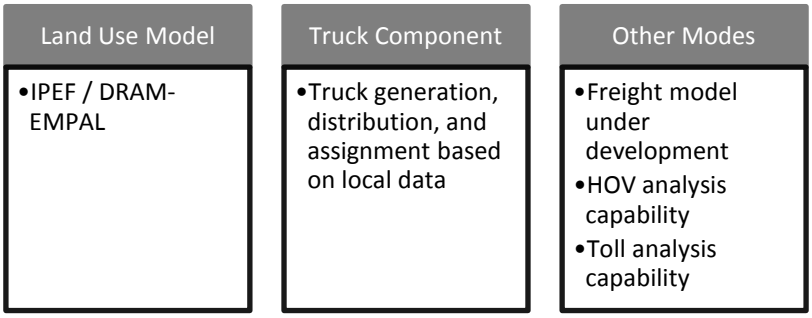
Four-Step Model

The four-step model, used for long-range plan development and for air quality conformity, is a traditional, sequential model, with the steps shown in the graphic below. ARC has considered a destination choice model, but chose to stay with the gravity model.



Mode choice considers premium versus non-premium modes; premium includes heavy rail and express bus. The four-step model does include a feedback loop based upon a convergence criterion. Congested travel times are fed back using an MSA approach.

Other model components are shown in the graphic below. For the four-step model, toll analysis occurs as a post-processing effort.



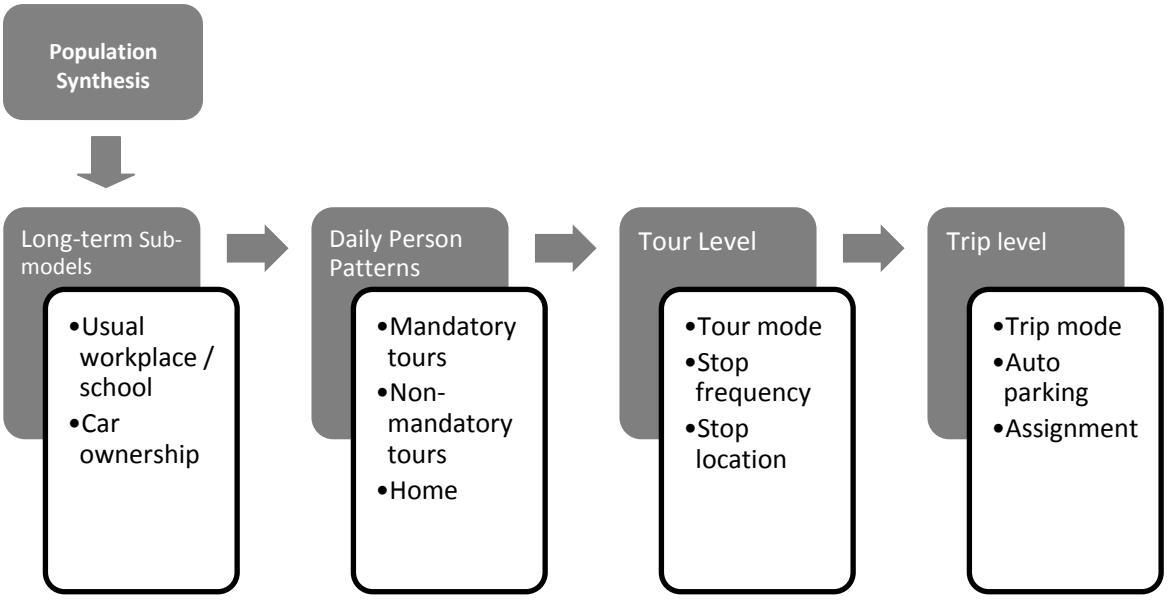
Interim improvements to the four-step model include:

- Conflating networks to NAVTEQ street centerline files
- Streamlining the facility types, reducing the total number and more accurately reflecting facility characteristics (not yet complete, but close)
- Revising the capacity and freeflow speed look-up tables
- Revising the volume-delay functions

Network updates are applicable to both the four-step model and ABM.

Activity-Based Model

The ABM is tour-based and is used to provide additional perspective for the plan process; as a basis for various analyses including telecommuting analysis, roadway pricing, and other factors influencing travel patterns; and as a visualization tool for policymakers and the public. The basic ABM structure is shown in the graphic below.



In comparison to the four-step model, whereby toll analysis occurs as a post-process, under the ABM, toll and non-toll nests are built into the mode choice model.

How the Models Are Used

As explained above, ARC maintains both its traditional four-step trip-based model and an activity-based model. The four-step model is used for long-range plan development and for air quality conformity. The ABM provides additional perspective for the plan process and supports more detailed policy analysis. ARC continues to use its models for the typical applications referenced in the 2008 MPO Snapshot (conformity analysis, project prioritization, environmental impact statements, long-range transportation plans, and New Starts). Additional activities the models are used for include: providing model information to others for toll revenue studies, land use scenarios including traffic impact analyses and studies of strategies in support of the long range plan process, transit route planning, transit alternatives analysis prior to major investments, and county thoroughfare planning. Using the ABM, ARC recently examined converting a corridor from high-occupancy vehicle (HOV) 2+ to HOV 3+. They determined that with the 3+ high occupancy toll lane, the community could potentially achieve a 45 miles per hour speed in that lane.

Project prioritization is even more applicable as a travel model activity than it was in 2008. ARC has just recently implemented use of TranSight, which is part of the REMI family of models. It is used to evaluate the economic return on transportation investments, resulting in benefit-cost type results for decisionmakers to consider.

Support for Travel Forecasting Models

Revisiting the data shown in the 2008 report, it appears that the figures shown for ARC for staffing include transportation planning staff not directly involved with travel model development, maintenance, and application. Since that time, there has been no substantial change in funding or support for travel model activities. For the upcoming two-year cycle, ARC is planning for the normal state match to be zero; to compensate, ARC staff will do more with less consultant assistance. Previously, this state match has been used for irregular expenses such as two recent survey efforts, an on-board transit survey and a household survey.

Primary Challenges and Emerging Issues

Besides implementing the ABM, continuing to perform comparative analysis between the four-step model and the ABM, and development of the freight model, the land use model is ARC's next most significant effort to advance their travel models. The current regional land use model for developing county control totals uses interactive population and econometric forecasting (IPEF) and the small area land allocation model (for TAZs) used DRAM/EMPAL. For the next plan update, the regional land use model will be upgraded to a Regional Economic Models, Inc., (REMI) process using IMPLAN. The small-area allocation model will be updated to the PECAS model (Production, Exchange, and Consumption Allocation System). Both REMI and PECAS will be integrated with the travel model.

ARC will feed the logsums out of mode choice into PECAS for the next forecast year. Previously, this was done for five-year increments, but the current approach will be 10-year increments. If an interim year is needed between the ten years, PECAS can be used to interpolate a value for the interim year. The reason for the change from five to ten years is because in recent

years there is less funding available for construction, so there is less going on to study to the five-year degree of detail.

Lack of data continues to be a challenge. Recently, however, ARC was able to access some data from a stated preference survey performed by a local toll authority; examples such as this represent some progress in addressing this issue. No establishment (employer) survey has been conducted since the 1990s and none is planned. ARC will assess the household survey results before deciding if an establishment survey is necessary, or if other types of surveys might serve. As behaviors such as telecommuting and flexible hours increase in popularity, an establishment survey decreases as a priority under a limited funding scenario.

Other areas cited as challenges in the 2008 report have evolved somewhat. ARC has made improvements in its analysis approach to managed lanes. Truck lane analysis tools are still available for use, but the call for this type of analysis has lessened, primarily because the state seems less interested in them presently. Toll lanes are still examined using a post-processor spreadsheet under the four-step model approach, but the ABM has addressed this analysis need even better. Ramp metering is still not examined by either model, but ARC is unsure about the applicability of analysis at a regional scale, so this is not a current priority. The ABM addresses peak spreading in a way that the four-step model, even with four time periods, does not. And finally, ARC modelers are still very interested in risk analysis and the issue of uncertainty in travel forecasts, and hopeful that the research community will continue to push this area forward.

For emerging and evolving concerns such as sustainability and livability, ARC has added additional post-processing into its Air Quality analysis in an effort to address climate change, primarily in its consideration of greenhouse gases. At present, the models do not directly address sustainability or livability concerns.

Future Plans for Travel Model Updates

For the near future, ARC will continue to develop and maintain both models, the four-step model and the activity-based model. At some point, perhaps for the plan update in 2014, they may transition entirely to the ABM. ARC accelerated its development of the ABM by using data existing and available at the time to establish a modeling framework. Household survey data should be available around the end of 2011 and work on updating the ABM coefficients and making other model adjustments will commence in 2012. Data from the 2009-10 on-board transit survey is already being analyzed for this purpose.

With regard to time-dependent network models, both the four-step model and the ABM are linked with traditional traffic assignment procedures. ARC is still working toward improvements in this area. They previously put in the effort to convert the networks to TRANSIMS under a pilot program. During that period, the effort was very active. Recently, this activity as slowed down, likely due to the attention being paid to the current plan effort, as well as a lack of additional federal dollars. In a separate effort, ARC looked into using Cube Avenue and Dynasim, but it was not deployed in the full model. These tools have been applied locally for site-specific analyses, however. ARC considers dynamic traffic assignment to still be under development as a future improvement.

ARC continues to watch developments regarding cloud computing. In the meantime, ARC has invested in about $20,000 worth of servers recently specifically to run the ABM.

Mid-Ohio Regional Planning Commission (Columbus, Ohio)

Background

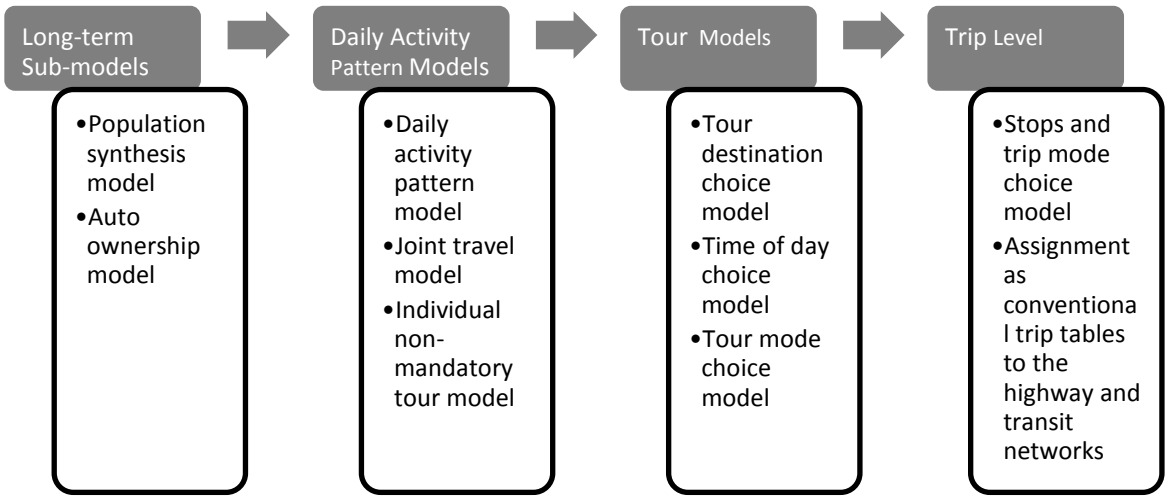
The Columbus, Ohio, Metropolitan Planning Organization (MPO) is comprised of the Mid-Ohio Regional Planning Commission (MORPC) and the Licking County Area Transportation Study. The MPO's transportation planning area includes Delaware and Franklin counties, the City of Pickerington and Bloom and Violet townships in Fairfield County, Etna Township and the City of Pataskala in Licking County, and the Newark/Heath urbanized area. The region's population is expected to grow by 500,000, to 2.5 million by 2030. MORPC is required to produce and maintain a Metropolitan Transportation Plan (MTP); work to update the current 2008 adopted plan to 2012 is already underway.

The travel demand model encompasses Delaware, Franklin, and Licking counties, and parts of Fairfield, Madison, Pickaway, and Union counties. Since 2004, the region has been designated a nonattainment area for ozone and for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) according to the National Ambient Air Quality Standards (NAAQS) of the 1990 Clean Air Act Amendments (CAAA).

Current Travel Forecasting Model Practice

Activity-Based Model

MORPC operates only an activity-based model to support MPO planning activities; use of the four-step model was discontinued in 2005. It is based upon zonal-level data versus parcel-level data and MORPC has no plans to change to parcel-level data in the future. The ABM is comprised of nine sub-models applied sequentially as shown below.



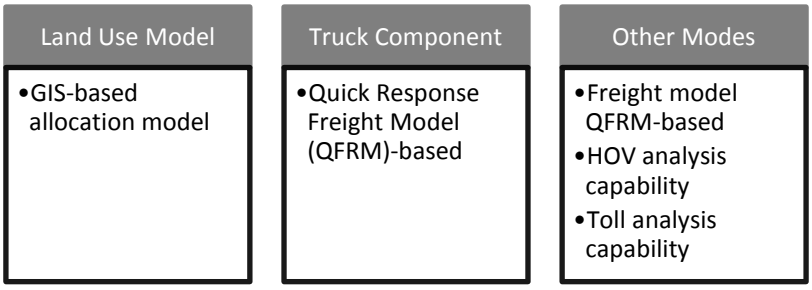
There have been no problems associated with the transition from the four-step sequential model to the ABM. The tour mode choice model has been updated based on the 2008 on-board survey data; the updated model is a two-level nested logit model. In addition, the transit skimming and assignment procedures have been converted from TRNBUILD to PT module in Cube Voyager.

The result is that a full set of time-of-day and direction-specific transit and highway skims are incorporated as part of the mode choice model application.

On the assignment side, a junction model is currently being adopted in the user equilibrium (UE) highway assignment procedure. This junction model refers to the intersection model available in Cube Voyager. Because most delay occurs at intersections, the premise is that this approach better represents congestion effects. This model allocates turning movements into lane groups, each lane group having its own capacity. HCM intersection modeling procedures are then applied to calculate the average delay per vehicle. This average delay is then applied as a turn penalty in the path building process in traffic assignment. MORPC has coded the necessary intersection details into its existing and future highway networks to support junction modeling. In addition, an assignment procedure has been developed specifically for MORPC's model. Current efforts are focused upon testing this assignment procedure and the networks to determine the number of iterations required for convergence. The goal is to adopt this junction model in the 2010 model validation.

The ABM still includes a feedback loop into tour generation, allowing trips to shift time period. As work on a TRANSIMS deployment effort continues, there may be an opportunity in the future to use skims derived from TRANSIMS to feed back into the tour model.

Other model components are shown in the graphic below.



As mentioned above, MORPC is currently working on a TRANSIMS Deployment Study to interface the current tour model with a TRANSIMS micro-simulation.

Model Role in the Transportation Planning Process

MORPC uses its ABM model for project prioritization and selection in order to allocate MORPC-attributable federal transportation funds and include projects in their Transportation Improvement Program (TIP). Other traditional activities the model is used for include: conformity analysis, the Long-Range Transportation Plan, the State Implementation Plan, New Starts studies, and Transportation System/Transportation Demand Management Programs. In addition, traffic projections from the ABM have been used in several Environmental Impact Statements and transit route planning. The model has not been used yet for county thoroughfare planning, but will be later in 2011. MORPC also uses the model for its Congestion Management Process.

Given the continued shortage of funding, MORPC continues to apply a more quantitative project selection process. In 2008, the agency noted that its model is often used for analysis of growth strategies and expansion of the transportation network (primarily through capacity expansion or new facilities) because of the growth confronting the Central Ohio region. Less emphasis was

placed upon traffic operations analysis or other congestion management approaches. This is still the case in 2011.

Support for Travel Forecasting Models

Annual allocations to maintain the model have remained substantially the same and are anticipated to continue. Additional expenditures have included the following:

- $500,000 – 2008 on-board survey data (2008 to 2009)
- $100,000 – model updates with the newly corrected on-board survey data (2009-2010)
- $389,000 – TRANSIMS Deployment Study (2010)
- $234,000 – additional tasks for TRANSISM Deployment Study (2011)

Primary Challenges and Emerging Issues

MORPC is not currently working on the issues of uncertainty or risk analysis. Neither are they making adjustments currently to address new emerging issues such as sustainability, climate change, or livability. As mentioned above, the current focus is upon integrating the TRANSIMS micro-simulation with the ABM model, which is anticipated to improve model capabilities with regard to traffic operations analysis. MORPC's overall focus is on overall traffic growth in the region, however, because this remains a primary issue.

For MORPC, the number of large distribution centers moving to the Columbus area remains a concern, with respect to their impact on travel in general. To enable MORPC to better examine freight in the region, they have installed the Ohio statewide model, with its freight component model, in-house. A likely direction for the near future is to use the statewide model as a tool for freight planning in the Central Ohio.

Future Plans for Travel Model Updates

With regard to computing needs, since 2008, MORPC purchased nine computers to support modeling (both MORPC's ABM and the statewide model). These were larger, more powerful computers. Because of the large size of the model files and the potential long waits associated with file transfer, MORPC is not currently considering cloud computing.

Again, the primary push forward currently for advancing the MORPC model is to integrate the TRANSIMS micro-simulation with the ABM model.

North Central Texas Council of Governments (Dallas-Ft. Worth-Denton, Texas)

Background

North Central Texas Council of Governments (NCTCOG) maintains the travel demand model to support decision-making by the MPO's Regional Transportation Council, the 43-member independent policy body of the MPO. The current long-range transportation plan, Mobility 2035,

is multimodal and financially-constrained. While the MPO covers 12 counties (Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise), the model study area includes an additional county, Hill. Hill, Hood, Hunt, and Wise are not non-attainment; the remaining nine counties are, based on the 8-hour standard.

Users of the NCTCOG travel demand model and model results also include numerous "customers" internal to NCTCOG, groups performing operations, air quality, and congestion management analyses, for example; as well as external to the COG, such as local governments, transportation and land use consultants, transit agencies, the Texas Department of Transportation, and the North Texas Tollway Authority.

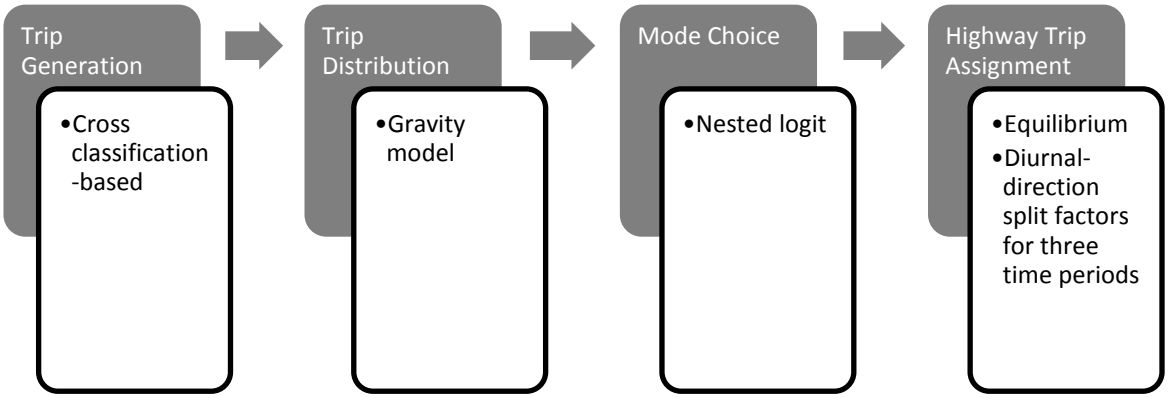
NCTCOG's interest in advancing their model stems from the need to be able to respond to modeling services requests not yet or only partially addressed in their current model. Areas of particular interest not currently addressed at all are: land use and demographic forecast integration, sustainable and transit-oriented development, parking studies, congestion pricing, transit revenue, and evacuation planning. Additional interest areas could be better addressed than they are in the current model.

The NCTCOG modeling team's approach for advancing their model is to use and make improvements to the four-step travel model while simultaneously planning for the incremental development of an activity-based travel forecasting model. This deliberate approach is intended to take advantage of other MPOs' experiences in developing activity-based models. NCTCOG modeling staff is integrally hands-on in their own model development, so that model development time is a trade-off with model application work in service to its many customers; model development time is necessarily directed and efficient.

Current Travel Forecasting Model Practice

NCTCOG continues to use and make improvements to its four-step travel model while simultaneously planning for the incremental development of an activity-based travel forecasting model. Since 2008, NCTCOG did accomplish its model expansion to full coverage of 13 counties, resulting in a model coverage area of approximately 5,400 traffic analysis zones and 10,000 square miles. NCTCOG maintains both a financially-constrained version and a version to support a needs-based plan required by the State of Texas.

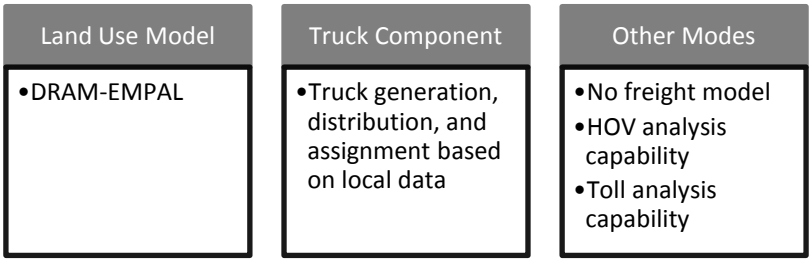
There have been no major structural changes to the model previously described. The four steps and their approaches are shown in the graphic below.



The only recent change to the model is that the land-use model is now a gravity-based model called "G-LUM", written in MathLab. Other more significant updates include:

- The model choice model has been re-estimated based on new data.
- For traffic assignment, NCTCOG has changed the volume-delay function to better represent both volume and speed. As a result of this improvement, NCTCOG was able to eliminate the speed post-processor previously used.
- The model does include a feedback loop. For feedback, the previous feedback loop stopped after 3 iterations (numbered 0, 1, and 2). Currently, NCTCOG runs 5 loops for a length of about 30-35 hours for a single run. One significant adjustment made was to decrease the relative gap in traffic assignment to 1/10,000 (previously the maximum number of assignment iterations was 50). Current efforts include working toward removing the 5-loop constraint and instead stopping feedback based upon convergence criteria; this approach has been implemented in their development model, but not the application model because of the time it would add to the model run.

Other model components are shown in the graphic here. NCTCOG has adjusted the underlying model code to add the capability to have time-of-day tolling, to allow for addressing policy-related questions regarding changing the amount tolled during different times of the day. It should be noted that this aspect of the model cannot be calibrated because there are not currently any facilities which operate with time of day tolling.



NCTCOG continues to apply their models for the same typical applications discussed in the 2008 report (conformity analysis, environmental impact statements, long-range transportation plans, state implementation plans, and New Starts). Although these are not necessarily new activities, additional activities the model is used for include revenue studies (toll and transit, the latter being more common), land use scenario analysis (including Traffic Impact Analysis), transit route planning, and county thoroughfare planning.

Support for Travel Forecasting Models

Table 4 in the original 2008 report categorized staff by model and related transportation planning tasks. Since 2008, transportation planning and modeling staffs have been subject to re-distribution, and the modeling group took on land-use modeling activities. Because of the amount of overlap between tasks, a better representation today would be a general figure of 18 staff persons across all these activities. The funding figures appear to have remained consistent.

The modeling group is understaffed, but NCTCOG is not hiring. Lack of current funding is not the issue, but rather the uncertainty of future funding to sustain higher staffing levels. Additional concerns in managing staff to support the model include:

- From a staffing perspective, modeling and data collection are continuous processes that need continuous support. It is important to maintain staff stability with respect to turnover – it takes 6-12 months for a new person, no matter how experienced, to be working at full capacity, two to three years for them to fully understand the model and become completely useful. The COG tries to improve staff retention by keeping the team small and focusing on morale.

- As a COG, the source of most of NCTCOG's funding is federal, so they appear to have fewer financial constraints than local planning peers. However, the COG's budgets and hiring are managed by local decision-makers faced with the reality of local budget shortfalls for public staff, so politically it can be very difficult to approve pay increases or hiring when other local agencies managed/overseen by the same decision-makers cannot. As a result, for example, salary adjustments for NCTCOG have been 0% for the last two years. This makes staff retention difficult.

Primary Challenges and Emerging Issues

The NCTCOG modeling team is constantly striving to improve their model to better address questions that local decisionmakers have and to support the different types of analysis their internal and external customers perform.

In re-examining Table 5 from the 2008 report, NCTCOG would change to a check (✓) the item "time-dependent changes in speed and volumes" based upon the current operation of the model. For instance, as mentioned above, NCTCOG has adjusted the underlying model code to add the capability to have time-of-day tolling, to allow for addressing policy-related questions regarding changing the amount tolled during different times of the day. Though this aspect of the model cannot be calibrated because there are not currently any facilities which operate with time of day tolling, it is a valuable step forward for conducting this type of analysis.

NCTCOG receives two types of questions regarding road pricing – pricing by time period, which they've addressed as described above, versus variable pricing – to guarantee, for example, a speed of 55 mph. Because of the latter type of questions, the Roadway Pricing cell in the original Table 5 should remain "partial" instead of a checkmark that the NCTCOG model fully addresses this type of analysis. A concerted effort is in progress to develop a reasonable solution within the current structure of the model to address congestion pricing with a regular UE method as a short-term improvement.

With respect to the emerging issues of livability and sustainability, NCTCOG already conducts non-modeling activities in support of these analysis areas. However, modeling short trips remains problematic, especially at the regional model level. Very short trips by walk and bike are not part of the current model. In current data collection efforts, specific attention is being paid to these trips in order to enable their inclusion under future model development efforts.

NCTCOG has been researching the potential for a region-wide Dynamic Traffic Assignment application. This research is currently paused because of the data needs – for the NCTCOG study

area, there are 20,000 count locations of data to sift through and examine for applicability, of which 10,000 may ultimately be usable. This research may resume as soon as Fall 2011.

Future Plans for Travel Model Updates

In addition to the shorter-term improvements under discussion above, NCTCOG is always considering longer-term updates, including most prominently implementation of an activity-based model (ABM).

Activity-Based Model Development

NCTCOG's approach for implementing an ABM is to develop the data needed and build the model structure based on the data, primarily because they do not have the staff resources to pursue data and model development at the same time. They conducted the transit survey in 2007-8, and will conduct the commercial vehicle and workplace surveys in 2011. Design of a household survey is on hold, since they have about 6,000 National Household Travel Survey samples they intend to use first. They will conduct other surveys (e.g., for the airport) in 2012. NCTCOG also needs to acquire some additional traffic counts and speed data, activities which will occur over the next two years. By 2012-3, the team will switch into development mode.

This approach has an additional rationale: the run-times for the existing 4-step model for the size of study area NCTCOG has (approximately 5,400 traffic analysis zones with network spanning 10,000 square miles) are already almost impractical; an ABM is assuredly going to run longer. NCTCOG uses a very tight convergence criteria because of the importance of stability at the link level being necessary for link analysis and other applications such as DTA application. NCTCOG spends approximately $30,000 per year on computer costs and their primary concerns are reliability and speed; more recently, they've been considering either a purchase of a $50,000 computer which can greatly improve run time or, alternatively, cloud computing. At least with these sorts of tools, ABM becomes possible. Thus, working on the data needs first allows for computational and structural developments which may shorten the ultimate ABM run-time.

A final brake on ABM model development, but one viewed positively by NCTCOG, is the COG's approach of in-sourcing model development. NCTCOG hires consultants for particular tasks, but they never outsource the coding. This results in a high degree of consistency for the models and therefore efficiency in model development, maintenance, and application. A paced approach to ABM development allows their staff to grow technically with the model.

Other Model Improvements

An additional model direction that NCTCOG is working toward is to standardize the consideration of risks in the model outputs. A move to an ABM will improve risk analysis, but definitely more attention will be paid to the risk aspect in the future.

Development of a commercial vehicle travel model awaits completion of the commercial vehicle survey.

Puget Sound Regional Council (Seattle, Washington)

Background

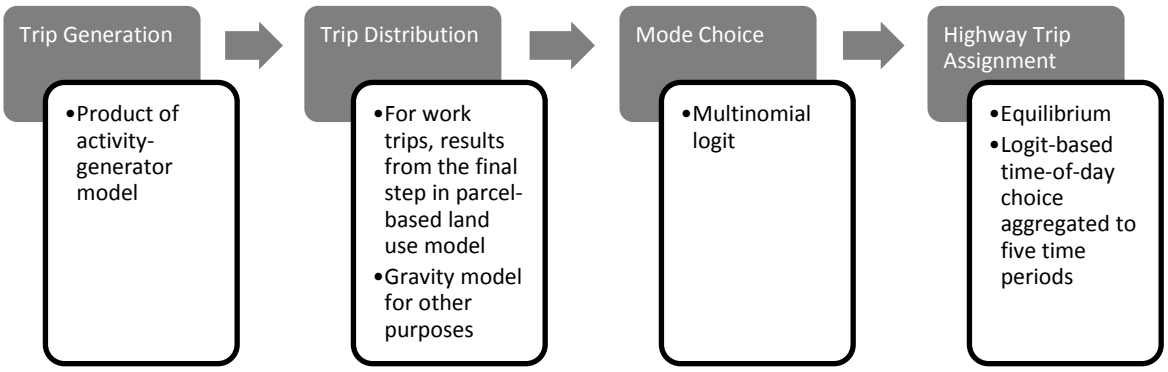
The Puget Sound Regional Council (PSRC) model encompasses the four counties—King, Kitsap, Pierce, and Snohomish—of the Seattle, Washington, area. According to *VISION 2040*, the area's regional strategy plan, the area is expected to grow by 1.5 million people and 1.2 million jobs from what it was in 2010. PSRC developed and maintains its travel model to support transportation planning for various planning activities, including the development of the current long range plan, entitled *Transportation 2040*.

There has been no change since 2008 with regard to the U.S. EPA designation of the region as a maintenance area for carbon monoxide (CO) and particulate matter of 10 microns in diameter or smaller (PM_{10}).

Current Travel Forecasting Model Practice

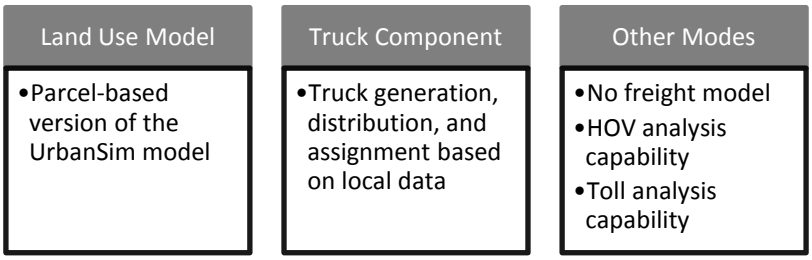
PSRC substantially revised its travel model process in preparation for updating the area's long range transportation plan, now adopted as the *Transportation 2040* plan. The over-arching themes are integration—of the various models—and a focus on individuals—to eventually simulate all individuals and vehicles at a parcel level. The purpose of integrating the models is to improve consistency and the focus on individuals is hoped to improve the analysis capability of the models to address current questions facing the PSRC region, for example regarding pricing and climate change.

Model development and improvements continue as PSRC continues its incremental transition from a four-step traditional trip-based model to an ABM. Structurally, an activity-generator model now serves the trip generation step instead of the previous cross-classification-based model. The activity generator, now used to feed the trip generation step of the current trip-based model, seems to provide reasonable responsiveness to changes in trip costs during the analysis of plan alternatives. For trip distribution, home-based work (HBW) trips were previously distributed the same as other purposes using a gravity model, now HBW trips result from the final step of PSRC's new land-use model, a multinomial logit choice model to predict usual workplace location. Another update to the model structure is that the mode choice model now includes a transit sub-mode choice nest.



Current activities include converting from 938 internal zones to approximately 3600. The impetus is the eventual full transition to the ABM, however the current trip-based model will be updated to this level of detail in the meantime as an incremental step. Because of the heightened

level of zonal detail, highway and transit networks are also being revised to a finer level of detail. For other model components, another significant change has been replacing the DRAM/EMPAL model with the parcel-based version of the UrbanSim model to forecast land use.



PSRC continues to improve upon its existing model. With respect to the land use component, previously, UrbanSim had been used to model alternatives for the long-range transportation plan. By the Spring of 2012, PSRC anticipates completing their first regional small-area forecast using the parcel model of UrbanSim. A complication of this approach is that individuals select locations within a large search space. To address this, PSRC is considering developing a general equilibrium economic model with sub-regional controls to simplify the location search process.

The new nested model choice model was used during the development process for *Transportation 2040*. For the plan, PSRC staff used an all-or-nothing transit assignment. For the future, staff is revisiting transit skimming and assignment procedures to improve consistency between these steps. Urban form variables are also now included in the mode choice model, with apparently only a small effect. As PSRC implements the parcel-level ABM, however, these variables may begin to play more of a role.

For the assignment step, PSRC made significant improvements to improve speed validation prior to the plan development, including value of time updates for most user classes, adding an unreliability term to the highway volume delay functions, and representing signal delay by changing the arterial volume delay functions. PSRC is also moving toward developing a bicycle network and bicycle assignment capability.

The current model does incorporate feedback. The model setup performs three full global iterations of the model steps. Used together with the UrbanSim land use model, the travel model accessibility variable is fed into UrbanSim every 5 or 10 years of the simulation and the UrbanSim model returns a new synthetic population to the travel model every 5 or 10 years.

The model is applied for many of the same purposes as it has been previously. Examples of additional types of studies include revenue studies, transit route analysis, and land use studies, typically only as a component of the technical analysis, however. PSRC continues to use its custom benefit-cost analysis software as a post-processor to calculate consumer surpluses for projects for project prioritization. The step of applying weights to the different planning objectives is still in the development process at present.

Support for Travel Forecasting Models

No change was identified for budget amounts for modeling since the 2008 report. PSRC staff noted the current period as a “dry spell”, and that funding for data development in particular is

challenging. They have worked to find additional funding through grants and contract work to sustain staff and development levels. However, the current effort for development of the ABM is fully funded, for anticipated deployment by the end of 2012. Other advanced efforts, for example exploring the development of DTA techniques, are budgeted with small amounts to support staff discussion, research, and efforts to leverage other funding resources.

Primary Challenges and Emerging Issues

Because of the growth management orientation of the Puget Sound region, as well as the previously noted concerns with pricing and climate change, PSRC staff has already been working hard for several years to advance its transportation model to address these issues. For PSRC, newly emerging issues include: analysis of greenhouse gas emissions, surface water effects on Puget Sound water quality, and the importance of neighborhood scale design on household activity patterns.

Specifically with regard to climate change, PSRC has developed specific techniques for estimating CO_2 vehicle emissions, for example, to emission rates by vehicle class by speed increment. These emission rates are generated using vehicle fleet assumptions within the EPA MOVES model. Emissions accounting is handled by the benefit-cost analysis software. Advanced modeling techniques have been pushed forward to provide a better spatial and temporal understanding of the region's traffic, which better supports improved analysis.

From a broader perspective, staff sees a need for a better understanding of the economic consequences of transportation and land use policy, especially in light of potential trade-offs between economic and environmental goals. The development of the ABM is intended to address some of these issues; the broadest assessments will likely necessitate, in the longer-term, the development of a systems framework that is integrated across, as PSRC staff describes it, "multiple scales of the urban development environment".

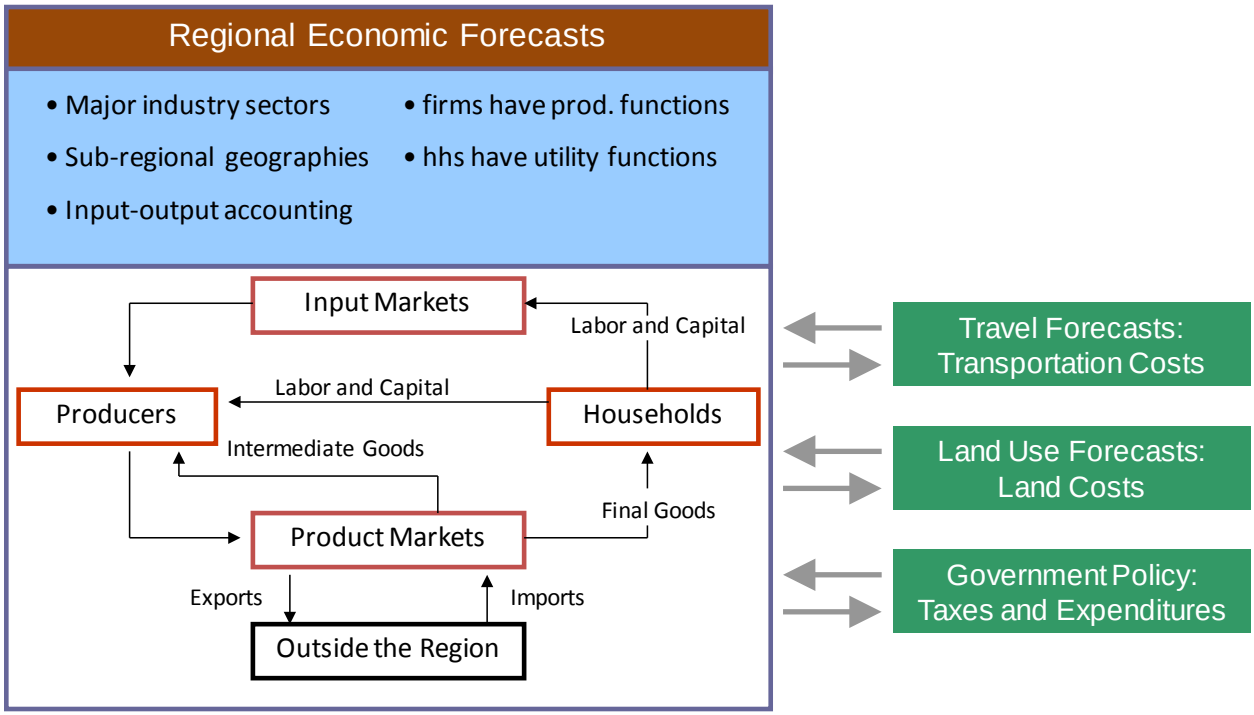
Regarding risk analysis and model uncertainty, PSRC has applied a Bayesian melding technique for the purpose of representing land use forecasts. That is, error estimates from the model validation step are used to estimate ranges of results for the land use forecast. On the travel model side, PSRC staff has applied the Black-Scholes formula to apply a penalty in the generalized cost assignment to represent known unreliability in the actual road network; otherwise, they are interested in other techniques to address this issue.

Future Plans for Travel Model Updates

As noted above, development of the full-scale ABM model is progressing as planned and is on track for implementation by the end of 2012. The model is currently being estimated and calibration and testing activities are scheduled next. PSRC plans on maintaining the trip-based models for the foreseeable future. A significant reason for this decision is that the ABM will require substantial computing power, as well as expertise that member agencies will likely not have in-house. A potential workaround is to provide member access to the ABM on PSRC hardware, but this is still under discussion for when the ABM is fully implemented.

PSRC staff discussion regarding future updates heavily emphasized the need to fully integrate land use and travel models into a system, all operating at a parcel-level with simulation of decisions by individuals. With this broader goal in mind, following the implementation of the ABM, staff intends to continue development of its models on two scales: micro-scale considering

time-of-day details for example using dynamic traffic assignment (DTA) techniques; and macro-scale modeling of the regional economy, enabling improved consideration of the links between the land use and transportation. PSRC provided the following graphic to represent how this systemwide economic model could look:



In the meantime, regarding specific model-component improvements:

- The region's truck model has not been updated, although PSRC has engaged in efforts to make short-term improvements. A long-term goal is to use the regionwide economic model described above to represent commodity exchanges explicitly. However, this type of model improvement requires better data than is currently available and the state's planned commodity flow survey is not yet funded.

- DTA techniques are certainly a discussion item in the region, with PSRC, the state DOT, and the University of Washington all involved. As mentioned above, there is little funding available in the PSRC budget to advance DTA, except to potentially leverage additional funding elsewhere.

- Cloud computing has been considered, but at present, PSRC plans to upgrade their in-house hardware as needed for ABM development and implementation.

Summary

This Addendum updates the information researched and presented for the report "A Snapshot of Travel Modeling Activities," August 8, 2008. As the above profiles demonstrate, travel model development and improvement is a continuous process and effort. Each of these exemplary Metropolitan Planning Organizations (MPOs) catalogued a range of enhancements to their existing models that have been incorporated in the relatively brief period since they were first interviewed in 2008. Each of the MPOs has an additional longer term vision of further advances they are working toward as well. Several themes emerged in discussing these models.

MPO Study Area Characteristics, Model Types, and Model Applications

For each of the participating MPOs, the MPO Study Area Characteristics, Model Types, and Model Applications have undergone varying levels of change over the past three years. Overall, the study area characteristics changed very little from what they were in 2008; more change is anticipated as Census 2010 data becomes available. As planned, NCTCOG did accomplish its model expansion to full coverage of 13 counties. To provide perspective on the model complexity and computational challenges, for this Addendum, the MPOs were asked for the number of Traffic Analysis Zones (TAZs) in their current model, shown in Table 1. In the discussion with NCTCOG, they noted, for example, the relatively large magnitude of their current four-step model being one factor in their deliberate approach in moving toward an activity-based model.

Table 1 Number of Traffic Analysis Zones (TAZs) by Area

Number of TAZs by Model Type	ARC	MORPC	PSRC	NCTCOG
Four-Step Model	2,000+	n/a	938	5,481
Activity-Based Model*	~5,000	1,877	~3,600	n/a

* existing or under development ~ implies the development of the TAZs are in progress

Approaches to Implementing Activity-Based Modeling

A substantial finding of the 2008 report was the interest by these MPOs in investigating or proceeding with the wholesale redevelopment of travel models away from the traditional four-step model toward activity-based modeling. The MPOs have substantially conformed to the plans they had previously for implementing an activity-based model (ABM):

- In 2008, the **Mid-Ohio Regional Planning Commission (MORPC)** was already operating its ABM exclusively and is still doing so. Their ABM operates at a zonal level instead of a parcel level and they have no plans to change to parcel-level data in the future.

- **Atlanta Regional Commission (ARC) (Atlanta, Georgia)** was, in 2008, using and making improvements to the four-step travel model while simultaneously developing an

activity-based travel forecasting model and updating the land-use forecasting process. By 2011, ARC continues to use and maintain the four-step model for long-range plan development and for air quality conformity. The activity-based model notably has resulted in similar results to the four-step model for VMT and VHT at the regional level; it provides additional perspective for the plan process and has been applied for various specific analyses. ARC may transition to using the ABM exclusively for their 2014 model update.

- **Puget Sound Regional Council (PSRC) (Seattle, Washington)** was, in 2008, using and making improvements to the four-step travel model while simultaneously planning for the development of an activity-based travel forecasting model. Currently, PSRC has a modified trip-based model with activity generator and workplace location choice models. Work on the full activity-based model is advancing as planned, with model calibration and testing scheduled for much of 2012.

- The **North Central Texas Council of Governments (NCTCOG)** continues its deliberate planning approach toward development and implementation of an ABM. They are monitoring the experience of other MPOs implementing ABMs as they work toward developing the data inputs necessary for an NCTCOG ABM.

It was clear in talking to the MPOs that there are different operative approaches at play influencing the advancement of ABMs. That is, some MPOs have proceeded in implementing an ABM model structure and are improving upon components as data and component improvements become available. Other MPOs are staging ABM implementation much more deliberately. A further issue is clearly the additional challenges faced in implementing an ABM for a more extensive study area: given the size of the NCTCOG model relative to many of the other models, they not only are pre-processing larger datasets, their computing needs to eventually run the ABM will be greater. Of note, ARC and PSRC, who are both maintaining their trip-based models while implementing their ABMs, both are continuing to develop and update model components of the trip-based model.

Emerging Issues and the Evolution of Tools to Examine Them

Policy- and decision-makers continue to ask questions of travel models that are challenging transportation professionals to address with current model tools. Of the issues identified in the Transportation Research Board Special Report 288, *Metropolitan Travel Forecasting: Current Practice and Future Direction* (2007), there were five identified that four-step models can only address indirectly and, in some cases, not even with post-processing tools:

- Time chosen for travel (expressly, traveler response to peak-period congestion)

- Travel behavior (change in travel decisions resulting from policy changes such as road pricing and land use changes)

- Non-motorized travel (change in behavior as a result of accessibility, for instance)

- Time-specific traffic volumes and speeds (supply-orientation)
- Freight and commercial vehicle movements

The move toward modeling of decisions at the agent level through simulation and tour- and/or activity-based models enables examination and forecast of the spatial and temporal effects of many policy-level decisions. Thus, an ABM can substantially address the first three of the above issues. The fourth issue group, time-specific volumes and speeds, is addressed below. Improvements on modeling freight and commercial vehicle movements seem to be somewhat hindered by the availability of data and lack of funding to conduct applicable surveys.

Somewhat newer and increasingly referenced issues in the policy arena include sustainability, climate change, and livability. As described above, PSRC was already trying to address the issue of climate change in 2008, the result of explicit direction by their board. In fact, PSRC included in their list of emerging issues the following: analysis of greenhouse gas emissions, surface water effects on Puget Sound water quality, and the importance of neighborhood scale design on household activity patterns. Perhaps related to these imperatives, staff at PSRC make a reasoned argument for an overarching and integrated system of land use and travel models to account for macro-level economic effects of policy decisions, in addition to on-going micro-level improvements. For climate change, ARC has added additional post-processing into its air quality analysis. With regard to sustainability and livability specifically, none of the MPOs are directly working on addressing these issues with their models at this time.

Time-Dependent Network Models

These MPOs still agree, as they did in 2008, that a future goal should be time-dependent network modeling, such as simulation or dynamic traffic assignment approaches, to fully address current policy issues. All four MPOs still run a traditional traffic assignment procedure. Under a previous pilot program, ARC had put in significant effort to convert their networks to TRANSIMS; currently a lack of funding and the distraction of the transportation plan cycle have slowed this effort. Separately, ARC explored using Cube Avenue and Dynasim, without deploying it in the regional model, however. MORPC has advanced its traffic assignment by incorporating junction analysis in the 2010 base year model, as described above. NCTCOG has put substantial work toward improving their assignment by addressing volume-delay and assignment convergence; they have also adjusted their underlying model code to enable time-of-day tolling in their model. PSRC has made value-of-time updates, incorporated signal delay, and added an unreliability term as a penalty to improve speed validation. These incremental refinements improve the existing tools while the MPOs strategize longer-term advances to address the supply side of network modeling.

Other Relevant Concerns

The need for data is only increasing, especially as models are becoming more detailed. At the same time, funding for data acquisition and surveys, items which have more-or-less been seen as irregular expenditures, has become more constrained. The development of freight and commodity-flow models in particular appear to have been delayed in several instances because of lack of data or funding to perform necessary surveys.

For the technical issues of risk and uncertainty of model results, each of the MPOs interviewed are interested in developing this area, but there has been similar lack of progress in advancing the state-of-the-practice in this respect, even for these advanced MPOs.

All of the MPOs are aware of advances with regard to cloud computing, but are focused at this time on enhancing their in-house computing resources.

Incremental Approaches to Improve Travel Modeling Capabilities

A persistent theme in the discussions with these MPOs is the continual improvement to their models, whether trip-based or activity-based. Improvements are often incremental and the result of substantial planning, data gathering, and effort as part of a deliberate approach. Activity-based modeling seems to be addressing the policy questions that it was expected to, and the idea of transitioning completely away from the trip-based model has occurred for one MPO and appears to be a very real possibility for the other MPO with an ABM actively in use. For emerging issues such as climate change, sustainability, and livability, tools and methodologies are still in need of better definition. Integration of the travel models with land use modeling, time-dependent network modeling, and better freight models remain a realistic "next frontier" for advancement because the approaches to address these areas have been identified.

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