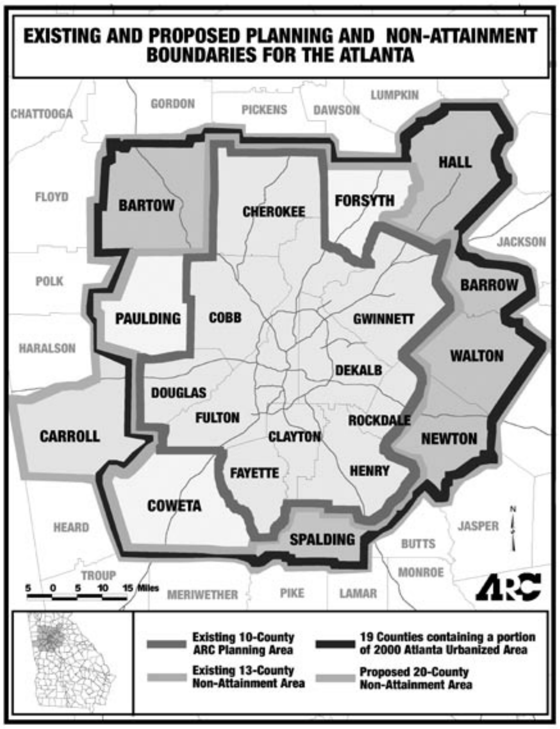
SUMMER 2005

TMIP Connection

The Travel Model Improvement Program Newsletter

Traffic Modeling for Air Quality Conformity: the Atlanta Story

By Guy Rousseau, Modeling Manager, Atlanta Regional Commission



It is now official, as of June 14, 2005, the USEPA has determined that the Atlanta area has attained the 1-hour ozone air quality standard. This determination has been made on three years of quality-assured ozone monitoring data from 2002 to 2004. As of June 15, 2005, the 1-hour standard was revoked at the national level, so we made it just in time, it appears. It has been a long, hard road and here is how it got achieved, from a travel demand modeling perspective.

The Atlanta Regional Commission (ARC) travel demand model is designed to, at minimum, represent the state of the practice and to meet all modeling requirements specified in the US EPA Transportation Conformity Rule (C62 CFR 43791-43795). Since 1990, a full consultation process, peer reviews and the ARC strategic travel demand model enhancement program have guided all modifications to the travel demand model. As a result, all elements of the travel demand model are designed to support all technical and policy decisions that are required in developing multimodal planning and program under Intermodal Surface Transportation Act of 1991 (ISTEA), and the 1990 Clean Air Act Amendments (CAAA). The model improvement program was designed to produce an updated and improved model that would meet all federal requirements. Priority was given to those model improvements essential for the creation of a travel demand model that met all federal planning and air quality requirements and sufficiently represented all transportation modes in the Atlanta region. The transportation and air quality planning process relies heavily on a strong technical foundation to support development of state air quality plans and transportation plans, as well as transportation conformity analyses. Computer modeling is a fundamental tool used in the planning process to determine the demands on the existing and planned transportation system and its impact on the environment. Travel demand modeling and mobile source emissions modeling processes are needed to develop air quality plans and transportation plans, as well as the relationship between the various modeling systems.

Transportation conformity is intended to ensure that transportation activities do not worsen air quality or interfere with the purpose of the State Implementation Plan (SIP). Therefore, any adopted Regional Transportation Plan (RTP) and/or Transportation Improvement Program (TIP) must be found to conform to the SIP. This is done, in part, by demonstrating that the plans and programs in the relevant RTP and TIP do not exceed the appropriate approved Motor Vehicle Emissions Budget (MVEB) limits.

There are two necessary steps for demonstrating that an RTP and TIP do not exceed the appropriate MVEB. The first is to estimate the future traffic volumes and the speeds of traffic on the transportation system in the non-attainment area. The ARC currently houses and maintains a travel demand model for 13 counties (now being expanded to 20 counties) that is used as the tool to estimate traffic volumes and speeds. The second is to estimate the emissions (for all pollutants for which an approved motor vehicle budget exists) that would be generated, given the estimated traffic volumes and speeds on the modeled network. The emissions process is currently accomplished through the use of MOBILE 6.2, which is a model developed and provided (and required to be used for conformity determinations) by the USEPA.

The Transportation Conformity Rule established a regulatory requirement that includes minimum specifications for travel models used to forecast vehicle activity for regional emission analyses in certain non-

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U.S. Department of Transportation
Federal Highway Administration

MODEL CITIZEN

Modeling Life at FHWA Resource Center

By Supin L. Yoder, Planning Modeling Specialist, Federal Highway Administration, Resource Center - Planning Team

After eleven years working at the Chicago Regional Transportation Authority and four years at Wilbur Smith Associates in its Chicago office, I joined the Federal Highway Administration Resource Center in July 2004. Over the past year, I have realized this job combines many attractive elements found in both public and private sectors. The customer oriented service approach, marketing, billable time and performance measures are similar to those I encountered in my consultant years, yet I don't need to be constantly tracking project profits/budget constraints that have been taken care of by my boss! The IT and administrative support from FHWA and the Resource Center have been timely, allowing me to focus more on the modeling work. I believe I have passed my honeymoon period and I still enjoy every moment of my current job very much!

The most important aspect of my job is that I have been given many opportunities to serve the modeling community in the country and to continue to grow professionally. My job has given me exposure to a wide range of passenger and freight models developed in this country, including statewide, regional and corridor models. During the past year, I have been intrigued by many unique or resource-constrained modeling techniques designed to address local modeling issues. As an FHWA modeler, one of my activities is to participate in TMA model certification reviews.

In the spring of 2004, FHWA and FTA issued the Certification Checklist for Travel Forecasting Methods, which has received a great deal of attention by MPOs and their consultants. Since then, FHWA and FTA have developed internal guidance/training in how to incorporate the Checklist into the current triennial TMA certification reviews. I have participated in several certification reviews and would like to share with you some observations and thoughts.

• Documentation. As listed in the Checklist, key areas of inventory, planning assumptions and modeling methodologies are reviewed by the FHWA/FTA/EPA Certification Team. Inventory and planning assumptions are typically documented in the MPO long range transportation plans (LRTP), which are found to meet requirements well. MPOs pay attention to the quality of these LRTP documents perhaps because of their high visibility and wide circulation. With respect to model methodology reports, it is my observation that these models are well documented when the models are initially

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attainment and maintenance areas. These minimum specifications apply to metropolitan planning areas with an urbanized area population over 200,000 that are also Serious, Severe, or Extreme ozone or serious carbon monoxide non-attainment areas. Current federal guidance requires that the latest planning assumptions be used for conformity analyses. Latest planning assumptions have been defined by the USDOT and USEPA to mean population, employment, and vehicle registration assumptions that have been updated within the last five years.

Primarily as a result of national peer reviews, the ARC strategic travel demand enhancement program included the following priorities, many of which correspond to modeling requirements in the transportation conformity regulations:

- Implementation of full model "feedback" of congested travel times. Producing congested travel time for each iteration of the highway assignment and providing the new congested travel times into the trip distribution and mode split models provides a more realistic representation of congestion on travel and mode choice.
- Creation of separate HOV trip tables and assignment procedures. Prior to 1995, HOV trips were synthesized from existing auto trip tables. Adding this feature into the travel demand model provides a significant improvement in forecasting HOV use.
- Development of an improved commercial vehicle model. The commercial vehicle model includes a full stratification of vehicle type and greater detail in commercial vehicle travel.
- Creation of a new external travel model. Required to address the expansion of the demand model domain to 13 counties – the entire non-attainment area. The external model update is based on a 1994-1995 external vehicle survey.
- Creation of time-of-day highway assignments. Time-of-day highway assignments produce more accurate estimates of vehicle speed and travel, as they are affected by congestion during the peak and off-peak travel periods throughout the day. This procedure supports the changes in regional emissions modeling that account for the emissions produced during specific travel periods.
- Implementation of empirical speeds in all relevant elements of the travel demand model. Empirical speeds are coded into highway networks to better represent vehicle speeds particularly during off-peak periods. Typically travel models use the posted speed limit to represent maximum vehicle speed. It is widely accepted that, particularly during off-peak periods, vehicles generally travel at speeds well above posted speed limits. Capturing this by using an empirical (or observed) speed produces more representative travel and emission estimates.
- Implementation of a land use allocation model and preparing consistent travel impedances for use in the land use model. Implementation of the DRAM/ EMPAL land use model and establishing travel impedance directly from the travel demand forecasting model provides a direct connection to evaluating the land use impacts of transportation infrastructure investment.
- Expansion of the ARC model area to 13 counties.
- Updating the CTPP data to include 13 counties is required to fully calibrate and validate the model to the 13-county area.
- Full model calibration using MARTA ridership data, SMARTRAQ Household Travel Survey and CTPP data.
- Full model validation for 1990 and 1995 using all relevant travel and vehicle count data.
- Creation of a speed sensitive emissions estimation procedure. Consistent with the production of travel and emissions estimates that are sensitive to variation of travel throughout the day.

The ARC model enhancement program was completed and fully implemented as part of the 2025 RTP and 2001-2003 TIP development. The work program deviated from the original enhanced model program by implementing additional "nests" into the mode choice model to better represent park-and-ride and kiss-and ride modes of station access, and the implementation of the car ownership model in the trip generation model. "Feedback" of congested travel times is addressed by linking trip distribution, mode choice and assignment models. Link travel times from each iteration are passed from the assignment procedure to the trip distribution, providing full "feedback" of travel times.

Basically it is important to remember that travel demand models and mobile source

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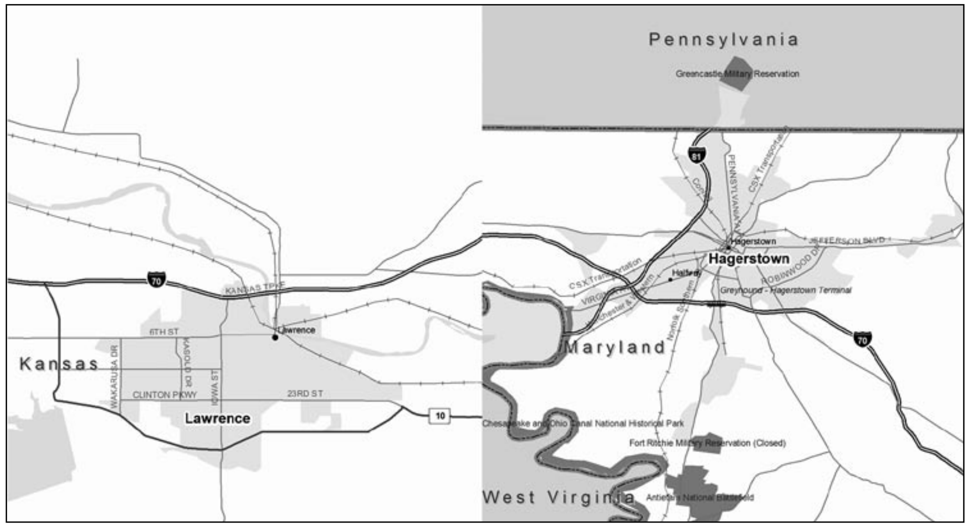
emission models have been developed with different purposes in mind, and MPOs often struggle with that dichotomy, while attempting to satisfy both. As we all know, travel demand models are used to assess the potential demand for a roadway segment (or link) or transit line so that construction and maintenance of the transportation system is optimized according to needs. It follows that the principal output of the travel model is vehicle volume for each link in the network, because volume is the variable that indicates the predicted demand for a particular facility. Mobile source emissions models, on the other hand, are intended to quantify the pollutants emitted by the vehicles using the transportation system. Speed and VMT (rather than traffic volumes) are the primary variables needed to estimate mobile source emissions. For this reason, the USEPA recommends the output from the travel demand model be adjusted (or post-processed) for accurate estimations of mobile source emissions. Post-processing of travel model output generally occurs through an adjustment to congested flow speeds and through reconciliation of model VMT with VMT data collected by the HPMS system.

Guy Rousseau is the Modeling Manager for ARC, the MPO for Atlanta, Georgia, which he joined in 1998. He is responsible for modeling the impact of regional transportation plan updates and transportation improvement programs, coordinating the travel model with the land use and the air quality model, geographic information system applications, and obtaining data for the modeling process through household surveys and other studies. Before coming to ARC, he was the Principal Traffic Engineer for the City of Atlanta Department of Public Works, with responsibilities for travel modeling and traffic simulation. Mr. Rousseau has also been a transportation modeler for the MPOs in Dayton, Ohio, and Tulsa, Oklahoma, and for Jefferson Parish, Louisiana. He is a member of the TRB Committees on Transportation Planning Applications (ADB50) and Travel Survey Methods (ABJ40), as well as the one on the Determination of the State of the Practice in Travel Forecasting (B0090), and he is also a member of the FTA New Starts Summit Model Advisory Working Group. He has participated in the FHWA Travel Model Improvement Program peer review panel of metropolitan travel forecasting for Memphis, the North Carolina Department of Transportation, and SANDAG (San Diego model), as well as the Seattle MPO (PSRC), and the upcoming one for Knoxville, Tennessee. He has undertaken doctoral studies at the University of New Orleans, and holds an M.S Degree from Laval University (Quebec City) and a B.S Degree from the University of Montreal. ■

Data Transferability Peer Exchange

By Elaine Murakami, FHWA



On December 16, 2004, a TMIP peer exchange on data transferability was held at the National Academy of Sciences' Keck Center in Washington, D.C. Several Transportation Research Board data and modeling committees joined TMIP in sponsoring the event. The nineteen participants included representatives from State DOTs, MPOs, consultants, universities, and FHWA. Tom Rossi from Cambridge Systematics served as the facilitator, and kept everyone focused on the tasks.

"Transferability" can be interpreted very broadly, from the overall structure of a model, to specific model parameters to outcomes. While most of the discussion focused on spatial transferability, that is, to transfer data or models from one location to another, the participants reiterated that it is very common for models to use temporal transferability, that is, data from one year applied to another (future) year, even if this kind of transfer has rarely been validated!

The peer exchange began by reviewing past efforts in the "outcomes" category of transferable elements, particularly the use of national household travel survey data (1990 and 1995 NPTS) for trip generation rates, auto occupancies, trip length distributions, or distributions by time-of-day. The approach suggested by NCHRP Report 365 "Travel Estimation Techniques for Urban Planning" is limited to comparisons by major metropolitan area size. Similarly, TRIMM (Travel Related Inputs Model for Mobile6.x), which is a way to apply NPTS data as inputs into MOBILE6, is limited to comparisons by Census Region, MSA Size and (sometimes) State. A proof-of-concept project conducted by Oak Ridge National Laboratory (ORNL) tested clusters of census tracts combined with 1995 NPTS data to more closely approximate locally collected travel data.

After these brief presentations a lively discussion ensued about what transferability meant. Because private consultants often work for many different clients, they are very likely to have transferred elements from one model to another because a) they have found something that seems to have previously worked, and b) to save time and effort. Models are often "over specified" using geographic or other constants to obtain an acceptable fit to observed travel behavior. So, what are these "contextual variables" that might better describe factors which influence behavior? A long list of potential variables was developed and recommended for testing, including:

- Detailed land use data
- Potential activities along paths to and from primary destinations
- Transportation system reliability (both transit and highway)
- Road condition
- Comfort and convenience factors
- Climate
- Distance to employment or shopping opportunities
- Ease of finding parking
- Bottle-neck facilities (bridges, tunnels)
- Safety perceptions, including social frictions
- Cultural variations and familiarity with English
- Process decisions influencing destination choices, time of day, etc.

Trip and tour generation models were considered to be the easiest to transfer, followed by time-of-day choice models. Mode choice model parameters and the relationships between them (such as the relative values of in-vehicle time to out-of-vehicle time) were also considered as transferable. There was considerable interest in testing whether or

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Uncertainty and the Use of Travel Models

By Berry Ives
Transportation Planner/Modeler, Mid-Region Council of Governments, Albuquerque, NM

This short article should be viewed as one planner's take on the subject and not as a literature review. A recent thread on the TMIP email list was stimulated by questions regarding the "Hot Topic" article in the Spring 2005 *TMIP Connection*, entitled "Travel Demand Model Forecast Accuracy," by Jiji V. Kottommannil.

Propagation of Uncertainty

The recurring TMIP discussions on model accuracy and uncertainty have reinforced, for me, the idea that there is indeed a great deal of model uncertainty. Not surprisingly, model uncertainty increases through the steps of the modeling process. This is intuitive, since new dimensions of variation are brought into the process with each stage of our models. If traffic assignment is measured by link volumes, then the final assignment step attenuates the uncertainty due to the fact that volumes on links are a highly aggregative cross section cut from many trips. This was demonstrated by Zhao and Kockelman in testing the propagation of uncertainty from randomly varied input data, as cited in Kottommannil's article.

The recent thread began by questioning the attenuation of uncertainty at the assignment stage. Traffic assignment contains much more than link volumes, since it is the culmination of the multistage modeling process. Thus, traffic assignment embodies trip generation results and reflects origin-destination trips and mode choice shares, resulting in volumes on paths, not merely isolated link volumes, although users may not preserve all this information. Ideally, it would permit model applications such as select link analysis and turning movement analysis at intersections. My own paper comparing our model's peak hour turns with observed turns at 30 intersections indicated a very weak relationship between the two. It would also indicate a poor representation of travel paths in our model, and ours is a fairly typical model. (I confess, no attempt was made to account for traffic count personnel observation error or the variation in traffic from day-to-day or seasonally.)

Uncertain Inputs

The Zhao and Kockelman uncertainty tests were primarily focused on the propagation of uncertainty rather than the actual levels or variance of uncertainty of the various inputs. As such, it may be seen as a measure of machine performance in a controlled setting rather than an attempt to measure real world variance of inputs. In the real world, the variance of the input data is not uniform across inputs, and may not be well known, especially for such inputs as future land use.

Now, consider that the measure of transit walk access is usually based on the percentages of a TAZ's area within specified distance buffers along transit routes, with no regard for the local street network where sidewalks exist nor for the location of bus stops. Yet walk access methodology is just as important for transit forecasts as estimation of bias coefficients. My point is simply that we need to improve the quality of our input data rather than focusing predominantly on model structure.

Zoey Ives says "As for me, I predict that my parabolic path will intersect the pseudo-random flight pattern of that hummingbird, whose seed number I know!"

When one feeds this process with input data that would represent the future, the uncertainty only expands. What will fuel prices be in 2030? How extensive will ITS implementations be? How will household size change? And income? The evolution of e-commerce and its effect on shopping related travel and home delivery by trucks? Fuel economy of vehicles? Telecommuting and flex time? Growth rates and development patterns? Social philosophies? Will there be continued growth in the popularity of neo-traditional urban living versus suburbs? Mostly, we forge ahead with the status quo, but some on the list have suggested that we use our models to test strategies for their endurance with respect to such real world uncertainties.

Aggregate Nature of Travel Demand Models

One cannot help thinking about all the areas within models that are supposed to allow reasonable representation of trips and travel within urban areas. There are good reasons why the traditional models were built the way they were with their productions and attractions using highly aggregated trip purposes in trip generation; the gravity model in trip distribution; bias and nesting coefficients in mode choice; and the BPR function constraining path selection in auto assignment. The primary reason was probably that such models could actually be estimated based on information that could be collected half a century ago. But with such highly aggregate and loosely approximate relationships being used for the building blocks of our models, it is no wonder that there would be a high degree of uncertainty.

There have certainly been some improvements over these traditional methods, but I'm not sure they affect my general feeling about travel model uncertainty. There is currently a project underway among some TMIP list participants, led by Ken Cervenka, to investigate the efficacy of model improvements.

Model Structure

My feeling is that model structures in general could be much improved, and that much of that deficiency could be addressed through the use of standardized urban models developed and applied in the context of greater land use specificity. By not having a "national urban default model" (or set of such models), then each urban area must build its own model based on a very expensive home interview survey, other surveys, and expensive consultants, etc. The level of aggregation is dictated by the tension between survey costs and what are deemed to be the required model features. For example, the model may have NHB (non-home based) trips as a "trip purpose" that includes

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35% of all urban travel. To the model, they are all the same. But the aggregation of trips into broad purposes has been determined by the limitation of sample size in the home interview survey, and the need to have some required level of specificity in mode choice.

A database like that of the National Household Travel Survey might be used to provide the basis for a default urban model that could embrace both sophisticated mode choice and trip purposes that are far more specific with respect to land use. That model would then be fitted to an individual urban area by adjusting key coefficients based on affordable household sample sizes and other local data such as traffic counts and census data. But this is another discussion that has gone on in the TMIP email list, and I hope it continues to evolve. While land use, trip generation, and trip distribution may be the largest sources of uncertainty, it seems that mode choice consumes an inordinate share of model run time.

Another model deficiency that is fairly universal and contributes to uncertainty is that the size of zones is much too large to do a reasonable job of modeling non-motorized trips, especially walk trips. Many areas probably have more walk trips than transit trips, yet all the focus is on transit. With the growing popularity of mixed use developments, walk trips are of growing importance. Better modeling of walk trips would also support better modeling of walk access to transit.

An additional challenge would be to find a way to implement such improvements without resulting in exorbitant model run times.

Final Comments

All in all, when I think about model structure and input uncertainties, it makes me think that what we really need to do is to continue testing and improving our models, but improve them in ways that focus more on their applications in analysis of transportation system performance rather than localized projects. Analysis of system performance may be the forte of travel models. No doubt, we will always be asked to provide project level data, but along with that we can provide information on model uncertainty and systemwide implications of the project alternatives.

Some modelers are already addressing some larger system problems, even when we are not requested to do so. Modelers may often be the primary ones who think of some broader aspects of a problem, or at least have the knowledge to know they can test solutions that, for some, are outside the box: "How many lanes need to be added to a freeway section?" is one question, but is it the right question? The modeler may see, if they bother to look, that the entire downstream freeway system will be threatened with grid lock if those lanes are added in that "critical" section. He may know that he can test ramp metering and may (with difficulty!) succeed in adding that to the alternatives analysis.

Prediction of the systemwide number of crashes by severity category would be a valuable output of models. While this might be done today with post-processing routines, based on simple relationships of crash rates to volume, modeling that better predicts exposure by counting potential vehicle conflicts and speeds would be superior. That might be based on a cellular automata assignment method. Why not make safety a major element in our travel modeling? I think this is a dimension of system applications that could have great benefits by bringing the value of life into the equation. ■

not travel time reliability would improve current models.

The participants also discussed at length the different research needs for large metropolitan areas and smaller to medium areas.Planners from small and medium jurisdictions expressed the desire for up-to-date aggregate statistics and models such as trip length frequencies and trip generation models. Planners from large metropolitan areas expressed the desire for augmenting their travel surveys with survey data from other areas.

Several DRAFT Scopes of Work for further research in transferability were developed during the Peer Exchange. These proposed projects will be forwarded to a variety of potential funding agencies, including NCHRP, the University Transportation Centers, and AASHTO SCOP.

A follow-on Workshop on Data Transferability of Household Travel/Activity Survey will be held on Sunday, January 22, 2006, sponsored by four different TRB committees. For more information, please contact Ed Christopher at edc@berwyned.com

FHWA is continuing research on using the National Household Travel Survey (NHTS) 2001 for Data Transferability. The original pilot was conducted using the 1995 NPTS data, http://npts.ornl.gov/npts/1995/Doc/transfer.html and the current project is using the 2001/2002 dataset. For the current effort, the planned output files will be by census tract. Additional work will explore the development of an automated process to migrate down to from census tracts to local TAZs.

The Summary Report for the Peer Exchange on Data Transferability can be found at: http://tmip.fhwa.dot.gov/services/peer_exchange/reports.stm ■

developed. The subsequent model updates including changes in model parameters or model structure (e.g. introduction of new modes) and the model validations for a new base year are not often sufficiently documented. It is my suggestion that MPOs need to allocate resources in the coming years to improving this frequently overlooked area.

• Staff Capability. One of the key indicators of health of the travel demand model is the technical capabilities of the modelers. Staff capabilities at MPOs vary widely, with large MPOs retaining some of the best modelers in the country. Modelers at the small or medium sized MPOs generally face more challenges. They wear multiple 'hats,' including the job duties of modelers, planners and engineers. Some of them have no formal modeling training and have had limited resources for ongoing training or conferences. Sometimes the modeling work at these MPOs does not sufficiently challenge the modelers (no mode choice models, for example), resulting in higher turn-over rates. Typical suggestions from the Certification Team for these MPOs include participation in regional or statewide modeler users group meetings and liftserv discussions, seeking NHI and NTI training courses, effective use of consultants to develop in-house capabilities, increasing state roles in providing training and networking opportunities, and use of outside experts via the TMIP peer reviews to guide their model development and enhancement activities. It is my view that the FHWA sponsored Data Transferability Study and the upcoming NCHRP 365 Report Update of the 1998 Travel Estimation Techniques for Urban Planning will be particularly useful to these smaller and medium sized MPOs.

• Risk Factors. Another focus area for modeling certification reviews is risk factor assessments. Conformity determinations or environmental impact studies based on weak forecasting methods are particularly susceptible to legal challenges. Early and frequent involvement of all impacted parties and interests groups is strongly encouraged for any EIS or alternative analysis studies. Any bias toward certain modes inherent in existing model structures should be modified, minimized and documented. Transferred modeling parameters and techniques used due to lack of local data should be defensible, reasonable and thoroughly documented. For highly controversial highway projects, it is recommended that modeling methodologies be reviewed by local expert panels or reputable modelers in the country. ■

UPCOMING EVENTS

Conferences

Advanced Transport Modeling and Tools
September 5–9, 2005–Thessaloniki, Greece
Contact: http://www.hit.certh.gr/site/indexen.php

AMPO annual conference in Denver
October 11–14, 2005
http://www.ampo.org/

Association of Collegiate Schools of Planning 46th Annual Conference
October 27–30, 2005 – Kansas City, MO
www.acsp.org/events/conferences.html

Courses

Travel Model Calibration, Validation and Reasonableness Checking Seminar
September 27, 2005 – Fort Worth, TX
November 8, 2005 – New York, NY
Contact: Penelope Weinberger at (202) 366-4054

Activity and Tour Based Forecasting Seminar
September 28, 2005 – Fort Worth, TX
November 9, 2005 – New York, NY
Contact: Penelope Weinberger at (202) 366-4054

Forecasting Land Use Activities Seminar
September 29, 2005 – Fort Worth, TX
November 10, 2005 – New York, NY
Contact: Penelope Weinberger at (202) 366-4054

Introduction to Urban Travel Demand Forecasting
October 3–7, 2005 – Arlington, VA
October 17–21, 2005 – Frankfort, KY
Contact: Penelope Weinberger at (202) 366-4054

Estimating Regional Mobile Source Emissions
November 15–18, 2005 – Arlington, VA
Contact: Penelope Weinberger at (202) 366-4054

Model Citizens Sought

TMIPConnection is seeking subjects for the Model Citizen column. If you are a modeler employed in the public sector working on an interesting problem and you would like to talk about it in the TMIPConnection, please send an email describing the work to penelope.weinberger@fhwa.dot.gov

Additional offerings may become available; consult the TMIP website http://tmip.fhwa.dot.gov/ for the latest training information.

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Center for Professional Development
3135 TAMU
College Station TX 77843-3135

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