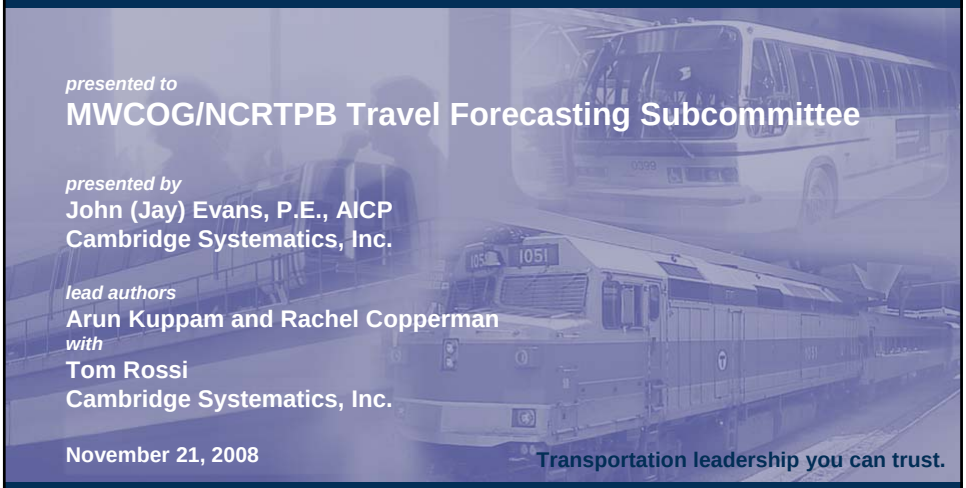
Near-Term Model Enhancements



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MWCOG/NCRTPB Travel Forecasting Subcommittee

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Transportation leadership you can trust.

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Task Purpose

Explore possible directions for near-term model enhancements while keeping an eye towards the next steps in long term model development

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Four-Step Process Limitations

- Performs reasonably well in representing and forecasting aggregate system- and corridor-level travel demand, but
- Cannot fully address complex policy alternatives and traffic operation scenarios applying to strategies such as
  - Road and congestion pricing
  - Time-specific policies
  - Improvements in traffic operations and ITS deployment
  - Freight and goods movement
  - Nonmotorized travel
  - Peak spreading and highly congested networks

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Movement toward Advanced Models

- Aggregate tour-based models
  - Applied at the aggregate household level but consider tour (with multiple stops with in each tour) as the unit of travel rather than trips
  - Limited in their ability to address today's policy concerns
- Activity-based models
  - Model individual participation in activities, and incorporates the sequences of activity throughout the course of the day
  - Able to address complex policy issues

MPO's that recently moved toward more advanced modeling systems have chosen to implement activity-based models

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Benefits of Activity-Based Models

- Provide a more accurate representation of travel behavior
- Applied disaggregately to individuals, whose personal activities and travel are simulated – greatly reducing aggregation error
- Easier to understand for decision makers and public, who may be unfamiliar with the four-step modeling process
- Provide the ability to perform certain types of analyses, such as road pricing, environmental justice, and peak spreading, or to perform them more accurately

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Disadvantages of Activity-Based Models

- Activity based models are more complex
- Activity based models are more expensive to implement, validate, update, and maintain
- Activity based models require more consultant assistance to develop
- Activity based model run times can be significantly longer and managing simulation error can result in the need for multiple model runs for each scenario
- Hardware requirements could be greater and may require custom software

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Near- versus Long-Term Enhancements

- For an MPO such as MWCOG, the benefits of activity-based models likely outweigh the disadvantages
- Activity-based models can be (and to some extent are) included in long-term model development plans
  - Model is expensive and takes a significant time to develop, so budgeting and planning should begin immediately
- Updating and improving the current four step model is a valid option for near-term model enhancements

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Near-Term Model Enhancements

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Near-Term Enhancements to Current Model

- Trip-based destination choice model
- Trip-based time of day choice model
- Improved assignment models
- Special generator models
  - Airports
  - Special events
  - Visitor models

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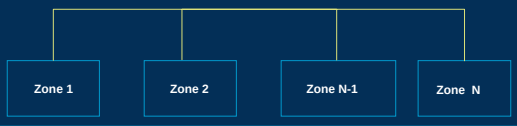
Destination Choice Model

- Multinomial logit model by trip purpose that would replace the current gravity model
- Explanatory variables include distance, mode choice logsums, region and area type, party size, demographics, employment and household characteristics
- Each zone is a potential destination choice
- Predicts probabilities of choosing a destination zone



There is little doubt that destination choice models are superior, but the value of migration may be limited if an activity-based model is planned within a few years

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Time of Day Choice Model

- Captures travel behavior that reflects tendency to shift to nearby time periods (peak spreading)
- Logit-based choice model, applied after mode choice to auto trips
- Discrete time slices are used (e.g., 30-minute or 60-minute) as potential choices
- Explanatory variables include demographics, trip characteristics (carpool, bridge crossing), delay
- Essential to develop an approach that is sensitive to pricing scenarios

Although such a model component would add to the capabilities of the present model, the cost to develop it may represent resources better spent on migrating to an activity-based model. Fewer success stories.

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Improved Assignment Models

- Multiclass assignments with trip purpose and income group stratification
  - Home-based Work Trips by Income Quartile
    - SOV Quartile 1
    - SOV Quartile 2
    - SOV Quartile 3
    - SOV Quartile 4
  - Auto Trips by Mode
    - SOV
    - HOV 2
    - HOV 3+
  - Truck Trips by Class
- Volume-delay functions by facility type
- Different values of time by vehicle class, purpose and income (particularly useful for pricing studies)
- Final assignments for 30-minute or 60-minute time slices in peak periods (most desirable slice size would depend on data analysis and operational requirements)

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Special Generator Models

- Introducing new or enhancing existing special generator models can help better address demand patterns and sensitivities of travel markets that are not otherwise well handled in the existing framework
- New data collection likely required to support development of special generator models
  - Airports -- Requires aviation demand data (historical, current and forecast), O-D data from airport surveys, counts at airport access roads
  - Special Events -- Requires surveys at sporting arenas, entertainment venues, convention center(s)
  - Visitors -- Requires hotel-based survey to collect O-D data

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Airport Model

- Projects future number and distribution of air passenger, employee, meeter/greeter, service and air freight trip ends within the MWCOG region
- Determines the allocation of these trips by mode, time-of-day, and airport choice
- Provides capability to study changes in airport usage patterns, including significant changes in airline operations in the region

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Special Events Model

- Estimates O-D and mode of travel for trips to and from special events in the DC area
- Origin/destination choice will be determined, using a gravity or logit model, for each type of event
- Mode choice will be logit-based estimated from survey data
- Outputs will include transit person trip tables and drive alone and shared ride vehicle trip tables

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Visitor Model

- Estimates visitor demand by trip purpose and mode of travel
- Trip generation will be function of zonal characteristics, party size, demographics
- Trip distribution could be gravity-based or destination choice model expressed as a function of travel times (or logsums), zonal data, distance to CBD
- Mode choice will determine chosen mode of local visitor trip

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Long-Term Model Enhancements

Review of Activity-Based Models

- Focused on regional travel models – nine urban activity-based models in North America
  - Completed:
    - San Francisco County Transportation Authority Model (2001)
    - New York Model (2002)
    - Columbus Model (2005)
    - Sacramento Model (2007)
    - Lake Tahoe Model (2007)
  - Under development:
    - Atlanta Model
    - Portland Model
    - Denver Model
    - MTC Model

General Model Structure

- All models were estimated using data from a household travel/activity survey
- In most models the activities and travel for each member of the population in the modeled region are individually simulated
  - Population synthesizer develops a synthetic population and the corresponding households for the entire modeled region
  - Each person's activities are predicted, along with their locations and times, and the modes of transportation
- Columbus, Lake Tahoe, Atlanta, and MTC models explicitly consider interactions among household members in the daily activity pattern process

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Model Development Process

- Model development time ranged from 1.5 to 8 years, with typical times in the two- to three-year range
- Consultants were used to estimate models in almost all cases
- The public agencies who eventually maintain the models always participate in data development and sometimes in model validation as well

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Planning and Policy Analysis

- Analyses that would benefit from the use of activity-based models include the following:
  - Toll Feasibility Studies
  - High Occupancy Vehicle Lane Studies
  - New Starts/Small Starts Analyses, System-Level Transit Ridership by Mode, and Transit Operations
  - Congestion Management Systems
  - Determine Impact of Proposed Developments and Impact Fee Calculations
  - Campus Master Plans

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Planning and Policy Analysis (cont.)

- Analyses that would benefit from the use of activity-based models include the following (cont.):
  - Bicycle and Pedestrian Trips
  - Emergency Evacuation Modeling Support
  - Highway Operations
  - Time-of-day Assignment
  - Air Quality Conformity Determinations
  - Integrated Land-Use Model
  - Incorporate Ability to Test Impact of Gasoline Prices

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Activity-Based Model Recommendations

- The timeline for activity-based model development depends on financial, staffing, and political environment
- The first step is development of a work program for building an activity-based model framework
- Decisions regarding implementation will depend on planning analysis needs of the Washington D.C. area region, and on resource constraints for model development and application

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Model Inputs

- Can use existing zone structure, socioeconomic data, and highway and transit networks
- Two potential update to inputs include:
  - Implementing a zone system that has a high degree of spatial resolution
    - Especially if modeling nonmotorized travel is a priority
  - Including highway and transit networks that have a higher degree of temporal resolution
    - Especially to increase the model sensitivity to time-of-day policy scenarios
- Use recently completed home interview survey

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Population Synthesizer

- Model should include a synthetic population generator and the corresponding households for the entire region
- There are many existing population synthesizers that can be adopted for use
  - For example, the population synthesizer developed for the Atlanta region has been adapted by others
- At a minimum, income, persons per household, and workers per household should be controlled for, other options are:
  - Age of Head of Household, Nonworking Adults, Children, Family Type, Dwelling type, and Ethnicity

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Long-Term Choice Models

- Activity-based models normally include long-term choice models
- At a minimum, an auto ownership model and regular usual workplace location model are recommended
- Other optional long-term choice models include usual university location, usual school location, and work at home choice
- Since the MWCOG 2007/2008 household travel survey includes information on vehicle type and characteristics, including a vehicle type model is an option

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Daily Activity Pattern Models

- The daily activity pattern modeling process is the area that varies the most among reviewed activity-based models
- Three decisions that MWCOG needs to make regarding the daily activity pattern modeling process, include:
  1. Whether to include household interactions
  2. Sequence of tour-level models
  3. Time-of-day choice placement and choice of time periods

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Household Interactions

- Including household interactions increases the behavior realism of the modeling system
- A modeling system that includes household interactions requires additional resource to implement
- Some modelers have noted that "the jury is still out" regarding whether the explicit inclusion of such interactions produces enough additional accuracy to offset the cost of inclusion (Bradley *et al*., 2006)

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Sequence of Tour-Level Models

- **Option 1:**
  - In the Columbus, Lake Tahoe, Atlanta, and MTC models, the "mandatory" activities (work and school) are modeled first, including tour-level destination, mode, and time-of-day choice. Next, joint tours (among two or more household members) are modeled, followed by maintenance (e.g., shopping) and discretionary tours. Finally, the intermediate activities (stops) are modeled.
- **Option 2:**
  - For all other systems, all tour choices (destination, mode, and time of day) are modeled for each tour type (mandatory, joint, maintenance, discretionary) before modeling the next tour type. Notably, the tours of higher priority types are scheduled, with the time periods used unavailable for subsequently modeled tours.

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Time-of-Day Choice Placement and Choice of Time Periods

- The tour-level time-of-day choice decision occurs in different places in the various models
  - Before destination and mode choice in the SFCTA models,
  - Between destination and mode choice in the Columbus, Sacramento, and Atlanta models
  - After destination and mode choice in the New York and Denver models
- One-hour periods are often used for time-of-day choice
  - Even shorter time periods allow for more options and flexibility when analyzing sensitivity to policy scenarios
  - However, such shorter time periods also require longer model run times and introduce further data requirements

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Trip Assignment

- To date, all of the modeling systems examined use traditional static equilibrium highway and transit assignment procedures
- Including a traffic microsimulator within the system would require more resources to implement
- We would generally recommend that conventional methods be initially used, but the design should allow for pairing with a traffic microsimulation system in the future
  - If accurately estimating motor vehicle emissions is of higher priority, we would suggest incorporating traffic microsimulation within the initial activity based model

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Model Execution

- Plan for about one day as a reasonable model run time
  - Accomplishing this may involve using multiple processors
- Can continue to run the model in-house

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Phased versus Non-Phased Implementation

- The option to either develop the system all at once or implement a phased approach is often discussed
- A phased approach would take longer and cost more
  - May be a good option if sufficient funding is only available over time, or if short term products help get political support
- We recommend not using a phased approach
  - There is no documentation on whether interim products are useful, and
  - The additional cost and time of implementing a phased approach make it undesirable compared to developing the system all at once

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Consultant and Agency Involvement

- Consultants were used to develop and estimate models in almost all reviewed cases
- Public agencies should participate in data development and in model validation as much as possible
  - Can also assist in model implementation and estimation
- It is recommended that the public agency be highly involved in the process
  - Greater involvement leads to a much better understanding of the entire model than having the consultant do everything

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Model Development Time and Cost

- Implementing a non-phased approach will take from two to four years
  - Depends on the modeling system complexity, agency involvement, and level of annual funding
  - A phased approach will take longer
- Model development costs will be in the U.S. $600,000 to $800,000 range for a non-phased approach

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Near-Term Next Steps

1. Decide on near-term enhancements to four-step model
2. Assess and create timeline and budget for moving toward activity-based model
3. Based on timeline, budget, and policy needs, decide on broad model components and model development process
4. Focus on updating inputs to system (i.e. zonal changes and/or network TOD) that can be done in-house in the near-term

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