TRAVEL/4

Montgomery County, Maryland has had a long history of proactive planning policies. Since the 1980's the Montgomery County Department of Planning (the Department), as part of the Maryland National Capital Park and Planning Commission (M-NCPPC), has actively been developing and using travel demand forecast modeling tools. As Montgomery County has grown increasing urbanized and multi-modal, it has become challenging for M-NCPPC to fully evaluate the transportation impacts of Transit Oriented and Mixed-Use developments using traditional regional 4-step models. This was the impetus for an assessment of modeling tools including the traditional MWCOG and Travel/4 regional planning models, but also the Simplified Tour Based Model, agent-based models, and mesoscopic models. The goal of this effort is to assist M-NCPPC select the best set of modeling tools and methods to evaluate peak hour/period traffic conditions of Complete Street networks, Transit Oriented, and Mixed-Use developments, and to supplement and/or replace the Critical Lane Volume (CLV) approach and traditional forecasting methods that are currently being used by M-NCPPC. The latest step in the on-going model development process has been the development of the Travel/4 model for the Department. The Travel/4 model is an update to the Travel/3 model, and is based on the Transportation Planning Board's (TPB) Version 2.3.52 travel demand forecast model.

The objective of the Travel/4 model development was to migrate and update the Department's current travel demand forecasting tool. The current tool, Travel/3, is based on the earlier TPB Version 2.1D #50 regional travel demand forecast model. The Version 2.1D #50 model was validated in 2004, but was based on the 1994 household travel survey. The newer Version 2.3 model set was calibrated and validated to the regional 2007/2008 household travel survey. It also included a more sophisticated mode choice model, two non-home based trip purposes, an improved non-motorized model, as well as a more complex commercial vehicle and updated truck models. The Version 2.3 model is an improvement over the Version 2.1D # 50. The Travel/4 development took advantage of these improvements, and moved the regional model into a county-focused planning tool. The Travel/4 model was validated at a county level, whereas the Version 2.3 model has been calibrated and validated at the regional level. The Travel/4 model is a traditional static planning 4-step model with Trip Generation, Trip Distribution, Mode Choice, and Highway Assignment. It includes both toll and truck modeling capability, and uses cross classification of households by income and vehicle availability for Trip Generation purposes.

Simplified Tour Based Modeling

The Simplified Tour Model (STM) has been developed to address the concerns of implementing most activity-based models (ABM). Like ABM, this method is based on individual tours, but it focuses on only the most important elements. STM does not try to estimate the activities of each person or the scheduling of all activities in the household and is thus a more manageable process that is less complex, easier to develop, and faster to run. The Simplified Tour Base Model has been developed for the Brunswick GA, Atlanta GA, and Charlotte NC MPO planning areas with the validation years varying depending on the application. The ARC model validation year is 2010. The Brunswick GA model validation year is 2006, and the Charlotte MPO model validation year is 2005.

STM starts with *Household Synthesis*, which synthesizes individual household characteristics such as size and cars owned. The trip generation step becomes *Tour Frequency* (how many household tours?) Trip distribution becomes *Tour Destination Choice* and *Intermediate Stops*. Destination Choice determines the main destination of each tour and Intermediate Stops determines the number and location of stops. *Mode Choice* is similar to current logit mode choice/auto occupancy models. *Time of Day* assigns a time period to each tour, the Tours are then converted to individual trips, and traffic assignment is conducted as usual. Because this sequence of steps is familiar to transportation planners, it makes STMs easier to understand - a key strength of using STM.

MWCOG Model

Metropolitan Washington Council of Government's (MWCOG's) regional travel demand forecasting model, known as the Version 2.3 Travel Model, is designed to represent the transportation supply and demand in the Washington, D.C. metropolitan area. The area represented by this model includes the District of Columbia, neighboring parts of Maryland, Virginia, and one county in West Virginia. The 6,800-square mile modeled area is divided into 3,722 transportation analysis zones (TAZs). The model was calibrated to year-2007 conditions, between 2008 and 2011, using the COG/TPB 2007/08 Household Travel Survey and several on-board transit surveys. Revisions to the travel model are referred to as "builds," and is often indicated as the third index in the model version number.

TPB Version 2.3 Travel Model, Build 57, which is latest in a series of regional travel demand models developed by the COG/TPB staff for regional transportation planning work. The Version 2.3.57 Travel Model became the adopted, production-use model on October 14, 2014, when the TPB took the following two actions: Approval of the Air Quality Conformity Determination of the 2014 Constrained, Long-Range Transportation Plan (CLRP) and the FY 2015-2020 Transportation Improvement Plan (TIP). 2. TPB Resolution R6-2014: Approval of the 2014 CLRP. The Version 2.3.57 Travel Model became the adopted, production-use model with those two actions because it was the model used the air quality conformity (AQC) analysis. In other words, the TPB does not explicitly adopt a particular model version, but the adoption is made implicitly by the fact that it was used for an AQC analysis that was approved by the TPB.

The TPB Version 2.3 Travel Model was calibrated to year-2007 conditions from 2008 to 2011. In 2013, the Version 2.3 Travel Model was validated to year-2010 conditions, with an emphasis on validating the model's highway assignment results. Updates to the model resulting from this validation work were part of Build 52. Although the model was validated to year-2010 conditions, it was not recalibrated. The Version 2.3 Travel Model is a traditional static planning 4-step model with Trip Generation, Trip Distribution, Mode Choice, and Highway Assignment. It includes both toll and truck modeling capability, and uses cross classification of households by income and vehicle availability for Trip Generation purposes.

UMD MESOSCOPIC MODELS

In order to comprehensively analyze the traffic and demand impact of various operations and planning strategies, mesoscopic models are used. These models bridge the gap between microscopic traffic simulation and macroscopic travel demand models from both the methodological and application points of view. To bridge the gap between current modeling tools, a mesoscopic-modeling framework was developed that integrates agent-based travel behavior models with large-scale microscopic traffic simulation models. The UMD Mesoscopic model uses simulation-based dynamic traffic assignment, and combines dynamic network assignment models, used primarily in conjunction with demand forecasting procedures for planning applications with traffic simulation models used primarily for traffic operational studies. Mesoscopic models are best suited for sub regions such as the ICC and I-270 corridors. The ICC study area that was analyzed with the UMD Mesoscopic model extended from I-495 to MD 32 and from BWI Parkway to I-270 which is a much larger study area than what could be practically studied using traffic microsimulation. Moreover, the practical needs at Maryland State Highway Administration (MSHA) of analyzing highway and multimodal corridor projects with significant regional impact (ICC, I-270, I-495, etc.) also highlight the value and necessity of mesoscopic models. A good example is the before-and-after study of the Inter-County Connector project.

Applications of the integrated mesoscopic model go well beyond the before-and-after study of new network infrastructure. Given its sensitivity to changes in both network conditions and travel demand shifts, it can be applied to study a wide spectrum of transportation-related problems, including traffic operation improvement, dynamic pricing strategies, new travel demand management policies, and incident management policies. The model is used for highway/truck assignment only, and the base year for the model validation was 2010.

DTA Lite

DTALite, an open-source mesoscopic Dynamic Traffic Assignment (DTA) simulation package, in conjunction with the NetworkeXplorer for Traffic Analysis (NeXTA) graphic user interface, has been developed to provide transportation planners, engineers, and researchers with a theoretically rigorous and computationally efficient traffic network modeling tool. DTALite is actually an advancement of the UMD Mesoscopic model and was developed and used to study the same ICC study area for the year 2014; however the study area was simulated for 24 hours in this application. The calibrated models from the UMD Mesoscopic models were used as the inputs into the DTALite model, and the additional time periods were calibrated to existing count data using OD re-estimation. This fully functional, open-source DTA model can be downloaded from http://code.google.com/p/nexta/. Based on a mesoscopic simulation-assignment framework, DTALite uses a computationally simple but theoretically rigorous traffic queuing model in its lightweight mesoscopic simulation engine. To reduce data preparation efforts, it only requires a minimal set of static traffic assignment data and some time-dependent OD demand pattern estimates.

In general, the software suite of DTALite + NeXTA aims to: (1) Provide an open-source code base to enable transportation researchers and software developers to expand its range of capabilities to various traffic management application (2) Present results to other users by visualizing time-varying traffic flow dynamics and traveler route choice behavior in an integrated 2D/3D environment (3) Provide a free, educational tool for students to understand the complex decision-making process in transportation planning and optimization processes. Additionally, DTALite also adopts a new software architecture and algorithm design to facilitate the most efficient use of emergent parallel (multi-core) processing techniques and exploit the unprecedented parallel computing power newly available on both laptops and desktops. The model is used for highway/truck assignment only. The highway networks and trip tables from regional planning models are used in the development of DTALite models. The regional model trip tables are then time-sliced into 20 minute intervals and re-estimated to better match observed traffic count data. DTALite uses a simulation-based dynamic assignment to load the links in the network.

Agent Based Model

Agent based models were developed to supplement the mesoscopic modeling process, and is not a standalone traffic modeling tool. The Agent Based Model documented was developed and applied on the ICC Before and After study simultaneously with the UMD Mesoscopic model and therefore shares the same coverage area. The base year for the model validation was 2010. In the past two decades, transportation professionals and researchers have been incorporating individual person characteristics as a collection of autonomous decision-making entities called agents. These agents are used to model the planning side the traveler’s daily activities. Such daily activities include: route choice, mode choice, trip chaining, trip substitution, early or late departures, evacuation planning and emergency management, and traveler willingness to use toll roads/HOT lanes.

On the operations side, several researchers are introducing individual traveler characteristics called agents in modeling the acceleration and braking behaviors of drivers, their car following and lane changing maneuvers, and aggressive driving that is leading to car manufacturers adoption of eco-driving to name a few approaches.

Agent-based modeling allows researchers and users to keep the personal traveler identity or a collection of them as agents intact, using a modeling process to allow the users to trace and make use of the agents' characteristics in their planning and operations of transportation facilities. In contrast to aggregate-based modeling, agent based modeling looks at a system at the level of its constituent units. Although the aggregate level could perhaps be described with just a few equations of motion, the lower-level description involves describing the individual behavior of potentially many constituent units. Agent-based modeling provides a natural description of the system, flexibility in representing the system, and captures emergent phenomena as a result from the interactions of individual entities.

There are several well-known agent-based transportation modeling platforms, including, but not limited to, Transportation Analysis and Simulation System (TRANSIMS),[(83)] Multi-Agent Transport Simulation Toolkit (MATSim),[(84)] Sacramento Activity-Based Travel Demand Simulation Model (SACSIM),[(85)] Simulator of Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT),[(86)] Open Activity-Mobility Simulator (OpenAMOS),[(87)] and Integrated Land Use, Transportation, Environment (ILUTE).[(88)] (Some systems promote themselves as ABMS and some do not; the authors classify them, herein, in the same category because they exhibit similar structure in the same modeling paradigm.)

Most of these agent-based models are individual-based models. They have roots in the activity-based travel demand models and are commonly characterized by a similar feature. Naturally, they all exhibit similar architecture, more or less, which combines two transportation components-travel activities and network loading-into an integrated microsimulation platform. An agent in those models stands for a human/person/traveler in general.

It should be noted that these individual-based transportation systems also share some similarities with the simulation-based dynamic traffic assignment (DTA) approaches (e.g., Dynamic

Network Assignment-Simulation Model for Advanced Roadway Telematics (Planning version; DYNASMART-P),Dynamic Urban Systems for Transportation (DynusT), and Dynameq).

The existing agent-based transportation system in today's literature in general has the distinguishing feature of integration combining three components: travelers' activity decisions (multidimensional), travelers' route decisions, and microsimulation. Although the same decisions have been well-studied in two modeling paradigms, that is, activity-based travel demand models and DTA, the two differ in the types of feedback they utilize. In the case of an activity-based travel demand model, feedback is between travelers' activity decisions and traffic simulation. For simulation-based DTA, feedback is between travelers' route choice decision and traffic simulation. In this regard, an agent-based transportation system tries to have feedback among the three components together.

In summary, most existing agent-based transportation systems follow a structural design:

- An agent represents an individual person or traveler and is associated with the individual demographic and travel characteristics.
- The system generates demand, or an activity travel plan, for each individual agent based on the demographic characteristics.
- Activity plans are revised, enhanced, and finalized such that all plans meet spatial (facility) and temporal (schedule) constraints.
- The activity plans are fed into a microsimulation to produce the transportation results network-wide.
- Network performance is a source of feedback to both activity plan and route choice decisions. Agents revise the activity travel plan and route choice decision, such that both decisions are optimized simultaneously