New York Metropolitan Transportation Council (NYMTC) Travel Model Peer Review Report

April 2011

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1.0 Introduction

1.1 Disclaimer

The views expressed in this document do not represent the opinions of FHWA and do not constitute an endorsement, recommendation or specification by FHWA. The document is based solely on the discussions that took place during the peer review sessions and supporting technical documentation provided by NYMTC.

1.2 Acknowledgements

The FHWA wishes to acknowledge and thank the peer review panel members for volunteering their time to participate in the peer review of the New York Metropolitan Transportation Council (NYMTC) travel demand model and for sharing their valuable experience.

The Peer Review Panel Members were:

- Guy Rousseau (ARC)
- David Ory (San Francisco MTC)
- Dr. Chandra Bhat (UT Austin)
- Dr. Peter Vovsha (PB)
- Tom Rossi (Cambridge Systematics)
- Bill Woodford (AECOM)
- Nikhil Puri (AECOM)
- Ken Cervenka (FTA)

Brief biographies for each of the peer review panel members are presented in Appendix C.

1.3 Report Organization

This report is organized into the following sections:

- Overview of the purpose of this report, including an introduction to the peer review process and the objectives of the NYMTC peer review;
- Planning responsibilities of NYMTC;
- Introduction to the demographics, land use and transportation characteristics of the NYMTC region;
- A brief history of travel modeling at NYMTC;
- Discussion of how the NYMTC travel model is used, concerns about the model identified by NYMTC, a review of model inputs and each component of the model, and finally discussion of validation of the NYMTC model. This section includes the majority of the discussion that took place during the peer review;
- Additional discussion of future enhancements to the NYMTC model; and
- Peer review panel recommendations, including prioritized next steps.

In addition to the main body of the report, there are four appendices. Appendix A is a list of peer review participants, Appendix B is the peer review meeting agenda, Appendix C contains brief biographies for each of the peer review panel members, and Appendix D is a summary of the current NYMTC travel model and data sources.

1.4 Report Purpose

This report summarizes the results of a peer review of the NYMTC travel model with a focus on recommendations for new model development. The peer review was supported by the Travel Model Improvement Program (TMIP), which is sponsored by FHWA. The peer review of a travel model can serve multiple purposes, including identification of model deficiencies, recommendations for model enhancements, and guidance on model applications. Given the increasing complexities of travel demand forecasting practice and the growing demands by decision-makers for information about policy alternatives, it is essential that travel forecasting practitioners have the opportunity to share experiences and insights. The TMIP-supported peer review provides a forum for this knowledge exchange.

During the 1990s, NYMTC embarked on one of the most ambitious model development efforts undertaken in the industry, given the size of the region, complexity of travel patterns, and shift to a new modeling paradigm (activity-based models - ABMs). The Best Practices Model (NYBPM) was unveiled in 2001 and through the next decade, improvements were made to various aspects of the model to address usability needs and the ongoing evolution in modeling methods and requirements. After a decade of extensive use of the NYBPM, NYMTC has embarked on a proactive and comprehensive data collection and model improvement program.

As a first step in the development of NYBPM 2.0, NYMTC began an exploration program to inform a model development plan, and this review is a critical part of that exploration program. NYMTC applied for the peer review to assess the processes that have been implemented in the agency's model stream and make recommendations for the next major model improvement. It is important to NYMTC and its members that the agency moves forward with the model in an appropriate direction and makes the best use of the limited funds available for improving and operating the model for future planning and air quality efforts.

More specifically, the objectives of the exploration effort include:

- Synthesize experience and comments with the current NYBPM.
- Learn from others' experience in advanced model features and application.
- Reach consensus and establish understanding of desired features for NYBPM 2.0.
- Prioritize needed improvements based on capabilities and resources.
- Explore options/available tools to achieve desired modeling capabilities.

NYMTC's overall goal for model improvement and motivation for seeking a TMIP peer review is to continuously maintain and apply a model that is representative of the state of the practice in travel demand forecasting and equips the agency, its policy board, and local jurisdictions with the support that is needed for informed decision making in this complex region. To that end, the peer reviewers spent two days responding to specific questions from NYMTC and its planning partners.

2.0 NYMTC Overview

2.1 Agency Responsibilities

NYMTC was formed in 1982 with the dissolution of the Tri-State Regional Planning Commission. NYMTC is the federally designated Metropolitan Planning Organization (MPO) for the New York metropolitan region, covering the Bronx, Brooklyn, Manhattan, Queens and Staten Island in New York City; Nassau and Suffolk Counties on Long Island; and Putnam, Rockland and Westchester Counties in the lower Hudson Valley. To respond to local needs, NYMTC is comprised of three Transportation Coordinating Committees (TCC's): New York City TCC, Mid-Hudson South TCC and Nassau/Suffolk TCC. These committees recommend sub-regional transportation priorities and projects and provide opportunities for the private sector, general public, local government and interested stakeholders to become involved in the planning process on a local level.

While the jurisdictional boundaries for NYMTC encompass 10 counties in New York State, New York City is the hub of one of the world's largest urban areas that extends much beyond the NYMTC MPO boundaries further upstate in New York, and well into New Jersey and Connecticut. As a result, the NYBPM covers 28 counties in 3 states.

This dichotomy between jurisdictional boundaries and the true geography of the New York metropolitan region presents a significant challenge from a technical modeling perspective affecting the agency's ability to acquire consistent/current/quality data, maintain the model and produce consistent and timely forecasts.

2.2 Regional Characteristics

According to 2009 Census estimates, the NYBPM modeling area covered approximately 22,803,000 residents and 9,357,000 jobs. NYMTC adopted a set of model year 2035 socioeconomic forecasts in February 2008. The population of the 28-county modeling region is expected to grow to 25,596,000 and the employment to 15,464,000.

3.0 Development of the NYBPM

3.1 1994-1997

In the mid-1990s, NYMTC and its member agencies undertook the Transportation Models and Data Initiative (TMDI).

As part of this TMDI process, NYMTC and its member agencies implemented a preliminary model system in a very short timeframe in order to meet the basic requirements of ISTEA. As a result, the Interim Analysis Method (IAM) was first developed, and was used for two rounds of Air Quality SIP/TIP Conformity Analysis.

IAM was a relatively primitive planning tool. It met the needs at the time, and integrated the highway databases and analysis tools developed by NYMTC for the downstate New York region with the transit forecasting procedures developed by the Metropolitan Transportation Authority (MTA) in its Long Range Forecasting (LRF) project. Additionally, transportation networks and forecasts from northern New Jersey and Connecticut were incorporated to provide for the full representation of travel in the metropolitan region.

In a parallel effort, a detailed modeling requirements and data assessment effort was undertaken to establish the needs and specific modeling approach for the best practice models to be developed in the second phase of the project. This effort was the pre-cursor to NYBPM.

3.2 NYBPM 1.0

As the final phase of the NYMTC TMDI project, the NYBPM was developed and first previewed in front of a national audience on January 2001 during the TRB Conferences in Washington, and immediately was in wide implementation throughout the region on various projects of different sizes including:

- Air Quality Conformity Analysis
- Southern Brooklyn Transportation Investment Study
- The Gowanus Expressway and Kosciuszko Bridge Study
- Tappan Zee Bridge and the I-287 Corridor Study
- Bruckner Sheridan Expressway Study
- Bronx Arterial Needs Study
- Goethals Bridge Modernization DEIS

The NYBPM is an activity-based model, which estimates the detailed travel patterns of a diverse population using numerous travel modes. It does this by introducing some innovative approaches to the traditional travel demand models including the concept of a journey or tour as the unit of travel, a micro-simulation approach to demand modeling, and the inclusion of non-motorized modes as an alternative to motorized travel.

3.3 Current NYBPM Model

The development of the NYBPM, and the input data, largely occurred in the 1990's. Data and networks were developed to represent a 1996 base year condition. At the time of completion and implementation in 2002, the data needed to be updated using the new socio-economic data based on the 2000 Census. In addition, adjustments needed to be made to the employment and labor force data to reflect the impact of the September 11th disaster.

Since the NYBPM was first developed and released in early 2002, NYMTC has updated its model every three to five years to better reflect the regional transportation system and have more accurate travel demand forecasts of future years.

The first update occurred in 2004-2005 and the NYBPM base year was changed from 1996 to 2002. In addition to updating all of the input data and recalibrating the model to the new base year, several NYBPM procedures were improved. Improvements included a major improvement in the external auto travel model, the inclusion of bus vehicle pre-loads in the highway assignment process, revisions to the multi-class assignment method, and the elimination of the adaptive highway assignment methods (i.e. adjustment of trip table to traffic counts). Improvements were also made to the post-processing procedures used with the NYBPM for air quality analysis and the model was implemented within the PPSuite platform.

The second major update occurred in 2008-2009 when the base year was changed from 2002 to 2005. In addition to updating all of the input data and recalibrating the model to the new base year, several NYBPM procedures were improved. Improvements included further refinements in the external auto travel model, correcting the taxi tour/trip generation, updates to bus vehicle pre-loads process for highway assignment, accounting for one-way tolls in tour level choices, and revisions to multi-class highway assignment. NYBPM was also improved by linking to a regional TIP project database, a new GUI was designed, and the production of a series of model-related output reports and maps was automated. Additionally, the feedback and convergence processes were improved and formalized. The model was improved and optimized to utilize distributed processing, which resulted in a substantial improvement to run-time (from 173 hours to 12 hours).

The NYBPM is used extensively by many agencies and consultants and there is an active model users group. The model is used for multi-modal long-range planning and programming, air quality analysis, and project level forecasting at a corridor scale.

3.4 NYMTC's Goals for Peer Review

NYMTC requested a TMIP peer review to continue to build its institutional capacity to develop and deliver travel-related information to support transportation and planning decisions. NYMTC has a keen interest in developing and improving travel modeling techniques that respond to the needs of the planning and environmental decision-making process; and developing mechanisms to ensure the quality of travel modeling results used to support decision-making, and to meet local, state, and Federal requirements.

The charge to the peer review panel was to identify modeling capabilities and functionalities required to meet the region's transportation analysis needs. NYMTC engaged the panel to help gain an understanding of what is needed to maintain its modeling systems and NYBPM's status as a state-of-practice model over the next 10-12 years.

4.0 Topics of Interest to NYMTC

Prior to the peer review, NYMTC staff identified a list of issues to guide the discussion during the peer review. These issues are mentioned briefly below, and discussed in further detail in the following section.

4.1 Usability/Maintenance

Time Required to Complete an Analysis

The NYBPM is a complex model in every respect. As a result, the time to complete a modeling analysis and share results is often measured in weeks to over a month. The sheer amount of required input data spread across 28 counties and 3 states is a real obstacle to prompt response times for certain analyses. Complex models are also more difficult to use regardless of the geographic scale.

Additionally, while improved computer processing has improved run times dramatically, the complexity of the hardware and software has resulted in installation challenges for NYMTC's planning partners and consultants, creating an initial hurdle to effective and broad application of the model.

Flexible TAZ/Network Detail

The NYMTC staff is interested in exploring options to create a model that is "flexible" or scalable in terms of geographic and network detail. For example, perhaps TAZs could be aggregated on the fly within the model application (based on user-input) in areas well outside the corridor of interest. As another example, perhaps for certain applications the transit network does not need to be as detailed in terms of the number of modes, which would reduce the network coding burden and model run-time.

4.2 Unrepresented Travel Markets

Non-residents/Visitors

NYBPM does not currently represent visitors explicitly. However, the region, and New York City in particular, attracts a substantial amount of visitor travel for business and leisure purposes and their travel patterns and mode usage are clearly different relative to residents of the region.

4.3 Enhancements to Existing Modeling Components

Network Consistency

The roadway and transit networks in the NYBPM are stored in different GIS layers and are not related other than by physical proximity. That is, the operating speeds for buses, for example, are not a function of modeled roadway speeds for autos. Similarly, the impact of buses on traffic operations is not incorporated dynamically (only through static preloaded bus equivalents).

Distinguishing Attractiveness of Land-Uses

The NYBPM uses five employment categories for modeling activity participation and destination choice – office, retail, industrial, institutional and other. These categories are too broad to explain the wide variety of attractions in the region with the necessary level of accuracy, For comparison ABMs recently developed for San-Diego, Phoenix, and Chicago operate with 20-25 employment categories (2-digit NAICS codes).

The core models of the NYBPM focus on the typical weekday travel of residents observed in the sample survey. The models do not necessarily address precisely the magnitude or nature of certain types of land uses in the region, such as airports, hospitals, and universities, for which, ideally, site specific data can be developed that will more accurately profile travel to and from these facilities.

The NYBPM core models do account for a significant amount of travel by residents of the region to and from airports, medical complexes and universities/colleges – most notably work travel. In addition, visiting medical facilities is a common activity reported in the survey data and included in the core model forecast. In addition, attending a University or college is one of the six activity types that are explicitly modeled in the NYBPM.

With respect to sporting facilities, major recreational attractions and tourist sites, the NYBPM models do not address travel to and from these sites in an adequate manner. Only a small portion of this travel is captured by retail and/or office employment variables. Air passenger travel, whether for residents or visitors, is not captured.

Effect of Parking Supply & Parking Pricing

The availability, price and location of parking can be significant issues affecting mode choice. The NYBPM incorporates parking considerations in several ways, most of which are standard approaches. NYMTC is interested in approaches to more realistically represent parking, particularly in Manhattan where parking constraints are unique.

The presence of on-street parking is a roadway network attribute affecting roadway operations. Parking cost for auto trips is modeled in the NYBPM, but parking supply is not directly factored into the NYBPM choice models for auto trips. Instead, an assumed terminal time is utilized consistent with area type. For transit trips, parking supply at stations is factored into transit path-finding but not as an explicit constraint.

Effect of Urban Form on Mode Choice

Similar to the parking discussion above, urban form generally can have an observable impact on mode choice. Urban form encompasses many factors, such as the presence and connectivity of mode-specific infrastructure, the diversity and density of nearby land-uses, and factors such as parking supply and convenience, and pedestrian and bike friendliness, among other things.

Throughout the NYBPM model region, there are locations with extensive non-motorized travel both as an access/egress mode and as the sole means of travel. Additionally, urban form can greatly affect roadway operations and can affect transit ridership depending on the relationship between these networks and the surrounding land-use. The NYBPM uses area type variables to assign road network operational parameters and estimate parking costs and terminal times. Additionally, size/density variables influence destination choice and trip length. However, NYMTC is interested in methods to potentially improve these aspects of the NYBPM. This is essential in view of highly diverse travel and urban conditions in the NY metropolitan region.

Time-of-day Choice

The current version of the NYBPM has a simplified timing model based on a set of predetermined look-up tables (often referred as time-of-day factors) with percentage of journeys by 30-min time intervals. The look-up tables are stratified by journey purpose, leg, mode, and some aggregate spatial categories with a substantial level of detail. However, these factors are static and not sensitive to congestion and/or pricing. This simplified technique has produced reasonable results in terms of the aggregate zone-to-zone mode matrices by four specified periods of a day. However, for further development of the time-of-day models for the NYBPM, it would be desirable to incorporate more flexible timing considerations. This would allow for better replication of individual travel patterns (in terms of journey sequencing and scheduling) as well as make the modeling system more sensitive to policy measures aimed at congestion relief.

Road Pricing

The NYBPM incorporates directional toll pricing applied at the link-level, with different tolls for trucks, and these tolls are incorporated into path-finding. Auto operating cost is a fixed input that is applied on a per-mile basis. NYMTC is looking to enhance these capabilities by potentially being able to consider complex pricing structures and reflect policies such as managed lanes with dynamic pricing. Further, NYMTC is interested in mechanisms to make network coding more efficient related to network pricing generally, including roadway pricing, transit fares and operating costs, among other factors. More broadly, NYMTC is interested in defensible validation strategies related to pricing.

Freight/Commercial Vehicles

The commercial travel models of the NYBPM address two components of commercial travel – trucks moving goods and other commercial vehicle traffic. Trucks are defined as vehicles with at least 2-axles and 6-tires, while other commercial traffic consists of commercial delivery vehicles, sometimes also referred to as “vans” in NYBPM documentation. While addressing commercial traffic as part of the overall NYBPM regional models was considered essential, the emphasis for the initial NYBPM was clearly on developing an advance set of private passenger travel models. The resources for development of the commercial travel element were significantly more limited. Consequently, rather than grounding these models in the overall framework of freight or goods movement analysis, the methodology targeted an empirically oriented modeling of truck and other commercial traffic that would make maximum use of vehicle class traffic count and origin-destination (O-D) data in the region. The freight and commercial vehicle models utilize simplified trip-based models followed by matrix estimation to match observed truck counts. Future truck and commercial vehicle demand is factored from the base year using fratar methods.

4.4 Additional Advanced Modeling Components

Dynamic Traffic Assignment

NYMTC currently utilizes a static aggregate equilibrium assignment model. NYMTC is interested in whether a Dynamic Traffic Assignment model could be implemented in the region at the mesoscopic level, and wants to better understand the pros and cons. With a static model, it is challenging to reflect real operating conditions in the urban core of the NYBPM model region given the high degree of congestion and variability in operating characteristics by time-of-day. In particular, significant queuing on the most critical facilities (bridges and tunnels around Manhattan) has to be addressed.

Land-use Models

NYMTC does not currently rely on a land-use model to forecast sub-area land-use allocation. While the idea of a land-use model is appealing, jurisdictional issues present an obstacle along with the sheer size of the geography. Like many MPOs, NYMTC has a desire to do scenario-based planning in a theoretically consistent manner.

5.0 NYBPM 2.0

5.1 Data Collection Plan

Just as in the case of the development of NYBPM 1.0, NYMTC is currently in the midst of an extensive data collection effort that will provide the basis for advancing the model. Data from the 2010 census will form the basis for an updated 2010 housing/population database, and TAZ-level employment data are being updated.

The agency is conducting a 24-hour travel diary survey of over 18,000 households in the region, along with extensive GPS speed data (2,000 directional miles of roadway), origin-destination data at 12 cordon stations, and extensive traffic count/classification data (2300 screenlines).

NYMTC has plans for a regional establishment survey, a river crossing survey, and an on-board transit survey in the next two years.

5.2 NYMTC's Initial Priorities for NYBPM 2.0

NYMTC staff outlined their preliminary strategic vision for modeling capabilities in 2017. The vision is for a model that supports all levels of analysis, as follows:

- "Conformity Model" – A state-of-practice model for addressing conformity requirements, as they are likely to be in 2017 and beyond.
- "MIS/Corridor Studies Model" – A model that is optimized to provide mode splits and O-D tables needed for corridor and project studies.
- "Policy Analysis Model" – A model designed to inform policymakers about the impacts of pricing and other policy decisions.
- "Operational Analysis Model" – A model that assists in the simulation of operation factors (intersection delay, queuing, turning movements, etc) and provides inputs to the traffic simulation model.

To that end, the NYMTC staff proposed a prioritized list of topics for the panel to consider, recognizing there was limited time for the peer review and of course limited resources for model development. That list is presented below. The panel in the end reframed these priorities, but NYMTC's initial list helped steer the overall discussion.

Overlaying most of the topic areas were issues around usability, including the modularity and applicability of the model system and opportunities for dynamic flexibility in terms of geography/segmentation/modes.

- Highest Priority
  - Intra-household interactions in daily activity patterns
  - Sensitivity to a wide range of pricing policies
  - Realistic mode choice by geography
  - Destination Choice & incorporation of upcoming Establishment Survey
  - Dynamic time-of-day scheduling sensitive to congestion and pricing
- Medium Priority
  - Dynamic traffic assignment
  - Interfacing with Traffic Simulation/Subarea Analysis
  - Transit modeling and calibration
  - Non-resident travel
  - Parking supply and pricing
- Lowest Priority
  - Zoning and networks
  - Representing non-motorized travel
  - External travel model
  - Model applications platform and IT issues
  - Freight/commercial vehicle movement

NYMTC requested an objective assessment of their modeling needs with respect to state of the practice and the modeling goals of the agency. NYMTC looked to the peers for advice on a systematic approach to model enhancements, and technical guidance on modeling processes to address the various policy and investment questions.

NYMTC, along with its partner agencies, will critically assess the feedback from the peers when prioritizing its model development plan for NYBPM 2.0. While the advice of the peers is invaluable, there are many factors to work through when considering a model improvement strategy, and therefore the recommendations of the peers should be regarded as recommendations for NYMTC and its partners to consider.

6.0 Panel Discussion and Recommendations

The NYBPM is a complex model, and the New York metropolitan region is one of the most complicated regions in the world. Given this complexity, the peer review panel had to prioritize the list of topic areas and while some topics received extensive consideration, others received relatively little. Further, advanced models are full of nuanced detail and the substance of the peer discussion remained at a relatively high level in order to begin to address most of the topics identified in advance by NYMTC staff. The panel intentionally avoided being overly prescriptive, in deference to agency staff.

While the panel made numerous recommendations for model improvements that NYMTC should consider, it was important for the panel to point out that these recommendations did not necessarily imply greater complexity in each case. The panel felt that NYMTC should first aspire to handle its basic modeling responsibilities well and the agency should have reasonable expectations around the accuracy of the model at different resolutions. The panel was pleased with NYMTC's ongoing data collection plan and felt strongly that careful observation and data analysis should guide the model design as much as possible, in contrast to an overly specific design not informed by data.

The following text summarizes the panel's discussion on the topics of interest to NYMTC and the audience. The summary of this discussion follows the panel's final presentation back to NYMTC, with additional initial feedback on administrative topics and analysis needs.

6.1 Recommendations: Staff Roles and Model Application

One important issue raised early in the meeting revolved around the time it takes to produce a useful result from NYBPM once a request is made of the modeling staff. NYMTC's Executive Director raised this issue, as he is concerned that modeling analyses take too long.

The panel discussed this issue at some length, and the clear consensus was that NYMTC's experience (approximately 1 month to complete an analysis) was not atypical or unreasonable given the size and complexity of the region and the model. One month to do a thoughtful and accurate model run is consistent with experience at peer agencies.

The peers recommended that NYMTC consider appointing one person to interface with those who need analysis to provide:

- Decisions as to what to model and how to set a model run and all necessary inputs;
- Clarification/translation on analysis needs (try to avoid unnecessary iterations in running the model, if possible);
- Schedule for deliverable; prioritization of staff time.

The peer panel recommended that NYMTC staff work carefully to identify the real bottlenecks where time can be saved when using the NYBPM. Issues such as network coding, review/summary of forecasts, iterating on an analysis, translating planning questions into the modeling terms, conflicting priorities on staff time, among other things, can all be remedied but with different potential solutions.

Advanced models require sufficient in-house technical proficiency, regardless of who is using the model. The panel recommended that NYMTC consider appointing one person to interface with those who need analysis, as a means to efficiently and clearly work around issues associated with forecasting. The panel recommended that NYMTC consider ways to participate actively in the upcoming model development to enable better understanding and use of model. This involvement can take many forms but ideally NYMTC staff would work alongside the consultant team responsible for the bulk of the work (as feasible), because ultimately the agency will be best served to the degree that NYMTC staff develop a thorough understanding of the development of NYBPM. Finally, the panel recommended that NYMTC continue its model user group and work towards effective knowledge sharing and enhancement.

6.2 Recommendations: Analysis Needs

General Comments

Good forecasting requires the proper perspective, in addition to the necessary technical knowledge. The panel advised NYMTC staff on the importance of having the proper perspective on accuracy of the model at different resolutions. Instead of trying to solve every modeling challenge with NYBPM 2.0, the panel cautioned NYMTC to cover the necessary bases well.

The panel recommended that NYMTC let careful observation/data analysis guide the design of NYBPM 2.0. The panel sees regional models as (ideally) an effective starting point for an analysis, but there may be a need for focused refinement in any given study. The panel felt that certain types of operational flexibility desired (variable choice sets, sub-area extractions) is not practical at this time.

Prioritized Analysis Needs

The panel agreed with NYMTC that the design for NYBPM 2.0 should be based in part on key analysis needs envisioned over the next several years. The panel took a somewhat different tack than NYMTC in describing the vision for NYBPM from an application standpoint. Instead of trying to design a model that would be usable for all macro and micro analyses, the panel felt that NYMTC's core analysis needs are:

- Regional analysis needs
    - Spatial travel patterns (reasonable representation of aggregate travel flows – good destination choice is critical, especially for work flows)
    - Accounting for regional temporal patterns and differential peak factors
    - Air quality
- Key policies
    - Roadway capacity expansion
    - Transit (at the appropriate level of detail)
    - Managed lanes
    - Pricing & TDM programs
- Complex and important behavior/segments
    - Basic household travel
    - Non-resident travel (especially in Manhattan)
    - Effects of urban development form & non-motorized infrastructure on travel behavior
    - Freight, commercial and service vehicles

The first order of business for NYMTC is to ensure that the NYBPM is useful for regional planning and NYMTC's MPO responsibilities. The above list represents the panel's view of the most important policies and market segments for the MPO to address reliably in the model. The panel felt strongly that NYMTC should focus on achieving a model that handled the things in the above list well at a regional scale, and only then, consider use of the model for more refined analysis needs. The priority for NYBPM 2.0 must be to ensure that regional travel patterns are modeled reliably for all major traveler segments, in response to the most critical set of transportation policies and investments.

6.3 Necessary Components for NYBPM 2.0

Following two days of discussion and consideration related to data availability, analysis needs and model capabilities, the peer review panel identified a list of priorities for NYMTC to focus on for NYBPM 2.0. The priorities identified by the panel are provided in the context of the need for a model that is more useful for both regional and corridor level forecasting. Implicit in all of this is the need to do a careful calibration and validation of both the demand and supply side components, and to ensure that the model is defensible and useful to the MPO and its planning partners.

Hierarchical geographic resolution

To represent land-use and localized accessibility, the panel recommended a hierarchical geographic structure that ranges from the parcel to the TAZ. Different steps in the model would be performed on the appropriate geography based on how much detail is needed and processing times. Parcels would be ideal for representing household and activity locations, but the panel recognizes that this might not be possible in the short-term given the scale of the region and jurisdictional challenges.

- 4-6000 TAZs (traffic assignment)
- 20-30,000 Master Geography Reference Areas (MGRAs) that are smaller spatial units based on Census Blocks (transit access, non-motorized)
- Several million parcels if possible (population, land-use, and location choices)

Better, more detailed, more disaggregate land-use data

Related to the geography, the panel recommends that NYMTC invest significant effort in building a detailed small area land-use and socioeconomic database. While the panel feels that a complete land-use model for the NY metropolitan region is not yet realistic, this land-use and socioeconomic database is an important step towards land-use modeling and more geographically explicit travel modeling.

- Possibly a step towards a land-use model;
- More detailed land-use data are a critical input to better activity-based modeling; without it, certain ABM components that relate to location choices must be simplified.

Networks

The roadway and transit networks for the NYBPM are not on the same base map currently and the panel recommends that NYMTC change this so that interactions between autos and transit can be more easily captured. Further, the panel recommends a region-wide non-motorized network to better represent non-motorized accessibility.

- Put road and transit networks on the same base map and link them
- Non-motorized network region-wide

Advanced daily pattern models

The panel feels strongly that with more detailed socioeconomic data, a more robust population synthesis is possible, and from that, NYMTC can better represent key travel markets and realistic intra-household interactions. Additionally, particularly in Manhattan, the visitor market is critical to represent since it constitutes a significant share of travel.

- intra-HH interactions
- enhanced population synthesis
- Non-residents

Temporal resolution

Time-of-day modeling was identified as a critical issue by NYMTC, and the panel agrees. The panel feels strongly that NYMTC should build a fine-grained demand model, but with some hesitation recommends a fine-grained regional network supply model. The panel is endorsing the idea that NYMTC investigate the feasibility of "planning-level" dynamic traffic assignment (DTA) models with a 1-hour resolution as a first step towards a fully-fledged meso-level DTA.

- Fine grained on demand side (30 min or less)
- Consider planning-level DTA with 1-hour resolution (only if feasible and based on review of available software)

Improved destination choice models

With respect to demand modeling, the panel placed the utmost importance on properly modeling and validating destination choice. NYMTC's ability to validate the mode choice and assignment models hinges on getting overall travel patterns right by time-of-day. This requires collecting sufficient data (HH diary, cordon, river crossing, establishment surveys) and mining that data to understand observed trip-making and what makes specific destinations unique along with other aspects of the model (attractiveness, time-of-day, typical visitors, mode choice and accessibility, etc.).

- Enriched set of explanatory variables describing activity locations
- Improved multi-modal accessibility measures, specifically accounting for non-linear time, cost, and distance effects
- Enhanced, detailed calibration and validation, informing the model design

Reconsider mode choice sets

The panel feels that the available modes should be reassessed, particularly with respect to transit. Specifically, the panel listed as priorities an investigation to first understand kiss-and-ride (drop off) access to transit, and to evaluate what mode characteristics affect demand (as opposed to mode technologies). These investigations might lead to redefined transit choice sets. Additionally, capacity constraints are a big issue in the region, both on transit vehicles and at stations (parking). These capacity constraints affect time-of-day choice, route choice and mode choice.

- Consider need for kiss-and-ride modeled explicitly and distinguished from park-and-ride
- Do research on the appropriate choice structure for transit sub-modes based on service attributes and markets served
- Utilize capacity constraints in transit path-finding and mode choice
- Better represent taxi in terms of level-of-service variables (at least in Manhattan where taxi is an important mode)

6.4 Longer-Term Priorities

The panel urges NYMTC to focus on the above priorities, but believes that other potentially good ideas may not be feasible for NYBPM 2.0. These longer-term priorities are:

- Land-use model
- Dynamic traffic assignment

- Non-recurring congestion in traffic assignment
- External travel
- Parking location choice
- Freight

In a few instances, the panel is recommending important steps in these longer-term directions. While the land-use model is not a priority in the panel's opinion, significantly improved parcel-level land-use and socioeconomic data is a very high priority. Similarly, the panel is recommending exploring the feasibility of planning-level DTA models.

In the other cases, the panel either feels that NYMTC is not ready to undertake these efforts due to data limitations (non-recurring congestion, freight, parking location choice, DTA), significant methodological challenges (non-recurring congestion, freight, DTA), or relatively little need for improvement due to a small share in traffic (external travel).

Freight modeling was listed earlier as a prioritized analysis need by the panel, but while that may be true, the reality is that freight modeling requires a substantial investment in data and model development, so it falls to a longer-term priority.

7.0 Peer Review Panel Response to Technical Questions

7.1 Daily/Activity Travel Patterns

What is the complexity involved in terms of data needs and model structure?

Incorporating intra-household interactions affects the model's ability to analyze behavior and policy in some cases where intra-household interactions are particularly important (pricing, shared ride, vehicle availability). Incorporating this capability is not a data issue (an activity-based travel diary is sufficient), but the model structure becomes more complicated.

How are intra-household interactions dealt with?

Intra-household interactions are now typical practice in ABMs although the actual implementation varies from model to model. There are several techniques and the peers recommend that NYMTC review models that are already implemented, such as methods the recently developed for advanced ABMs in San Diego, Phoenix, Chicago, and Los Angeles.

How reliable are the model outputs?

Daily travel generation can be validated against the (expanded) household survey, Census/American Community Survey data on journeys to work, traffic counts, and transit ridership data from MTA and NJT.

When developing a model, consider new trends related to activity patterns (e.g. telecommuting, flex-time).

7.1.1 Population Synthesis

NYMTC should borrow/adapt methods for population synthesis that have person-level and household-level control variables from the advanced ABMs developed in practice. See for example recent work on the PopGen program developed by Ram Pendyala at Arizona State (and implemented in Los Angeles, among other regions).

How much detail is necessary?

There are control and non-control variables in a population synthesis. The control variables are critical inputs, and the reliability of the synthesis depends on the quality and resolution of the control data. The non-control variables provide additional detail about individuals or households that is useful in segmenting models.

The panel advises NYMTC to do a good job describing the population (and activity centers) in the base year. The New York region is fairly stable overall, so the panel felt that NYMTC should not simply base data detail decisions on the need to forecast land-use growth. The design of the population synthesis relates to analysis needs, and it is important to know what travel market (or place) generates substantial travel and to be able to distinguish these markets/places in the NYBPM (which requires detailed segmentation).

7.2 Destination Choice Model / Establishment Survey

What information from an establishment survey would benefit the development of the model?

An establishment survey should be designed so that NYMTC can construct better zone size measures (attractions) for use in destination choice. Well-done establishment surveys would allow NYMTC to perform some basic level of validation, and would collect some useful data on visitors and trucks. The panel feels that NYMTC should design a survey to identify characteristics that make certain places much more attractive, and to better understand and model associated generation, trip length distribution, activity duration and time-of-day considerations. NYMTC should keep in mind that agglomeration and uniqueness affect what types of people visit certain locations (see for example Fotheringham's work on Spatial Interaction models).

How to define and sample the establishments given the size, diversity and complexity of the region?

The panel recommends focusing on as few major types of establishments as possible (not more than 30 or so). Specifying this list must be done based on careful consideration of the travel characteristics associated with each type of establishment (activity generation, trip lengths to visit the establishment, portion of visitor travel, freight demand, and time-of-day patterns). The goal is to identify types of establishments that represent to a sufficient degree the breadth of activity centers in the region so that the findings from this survey can be generalized. Care should be taken to work this out iteratively with the consultant team responsible for that survey. Effective pre-testing will be important, since these surveys are new and the technology of data collection has not been yet established.

Is it important to consider which aspects of establishments can actually be forecast?

There needs to be recognition of the need for balance on both sides of this particular issue. Here again, the panel feels that the New York region is fairly mature, NYMTC should not simply base data detail decisions on the need to forecast land-use growth. In general, there should be a forecastable size variable developed for each establishment type.

Should the establishment survey be recast as a visitor survey?

Another approach would be to focus on hotels and get a daily pattern for visitors. This approach only covers people who stay in hotels, and the visitor diary data are very difficult to collect. The establishment focus is biased towards the particular types of establishments, but it is probably best to not think of the establishment survey as a visitor survey since a key recommendation is to focus on destination choice validation, which is distinct from representing visitor travel better. The establishment survey and the visitor survey are complementary and not duplicative.

7.3 Pricing

There are many types of pricing, such as:

- Facility pricing (various toll collection schemes)
- Cordon or area pricing
- Parking cost
- Cost of gasoline
- Transit fare policy/payment type.

There are many additional complexities, as well:

- Time-of-day aspects
- User heterogeneity; segmentation cliffs
- Value of time aspects
- Value of reliability aspects
- TDM policies affect price and demand response
- Vehicle type and occupancy affect sensitivity to gas price.

The panel urges NYMTC not to confuse what a regional model can do with investment grade forecasting. Investment grade studies are highly focused efforts on a single corridor that represent a special issue that includes many additional aspects and specific modeling, data collection and post-modeling procedures. This is not to suggest that regional models are not useful in investment grade studies, but they are only one piece of a significant and focused data collection, forecasting, validation and post-processing effort.

How to incorporate complex pricing structures to reflect different payment methods, and to represent managed lanes?

Most of the things NYMTC would need to do in terms of representing pricing structures in the model have been done in other models. Parking and facility pricing, for example, have been handled a variety of different ways in models representing a spectrum of collection policies, with the possible exception of modeling non-trip cordon pricing policies. The panel recommends NYMTC consider a route type choice model to segment toll users from non-toll users and HOT/HOV lane users from general purpose lane users. This route choice model can be done as part of the assignment model, or within the mode choice model.

What mechanism can be implemented that allows users to easily update/modify tolls, fares, and other prices for policy and scenario analysis?

It is important to keep in mind the trade-off between what you CAN do and what is reasonable to do (need to carefully consider the need to explicitly represent all the variation in fare/toll schemes). It is possible to build a model to estimate which residents have toll passes, for example, but then it would be necessary to handle that detail in the assignment step. Rigorous validation of pricing models should be performed using the available data and traffic counts on the existing toll facilities.

7.4 Mode Choice Model

What is the optimal choice set for the model given the users' needs? What strategies can be implemented to improve the transit model?

7.4.1 Transit

- Should consider kiss-and-ride as an access mode to transit
- Transit modes are often distinguished by vehicle type/technology (i.e. light rail, bus, commuter rail, ferry), but do not presume this is the right technique. It is possible that different types of vehicles can carry the same market (e.g. long distance commuters, or local travelers).
    - In reality, the same technology can serve very different markets (e.g. NJ Transit light rail)
    - Frequently, paths involve multiple technologies, which confounds mode definitions
    - Need to think about the attributes that distinguish different services such as reliability, comfort, and convenience.

7.4.2 Auto

- Consider including toll/managed lane choices, and/or multi-class assignment as alternative approaches for toll modeling.

Is it feasible to have multiple calibrated choice sets in this model?

The panel feels that this is not a realistic option.

7.5 Transit Modeling and Calibration

What procedure can be used to reflect bus operating delays on the highway network?

Link the transit network to the roadway network. Develop functions for bus level-of-service attributes related to the highway network congestion.

Are there examples in other places where New Starts forecasts come from ABM's, or examples like in the New York City region where there are four different models that could be used?

San Francisco is an analogous example; ABM's have been used for transit New Starts forecasting in San Francisco. ABM has also been used in Columbus for transit New Start forecasting and analysis. The case needs to be made that the tool used for New Starts analyses is useful for the need at hand (whatever tool that is). FTA does not approve models; they approve forecasts. However, they scrutinize model structure and parameters to ensure that they are reasonable and logical.

What procedures can be implemented to conform to FTA requirements?

An MPO model should be a solid foundation for New Starts forecasting. This requires accurate network coding, socioeconomic data, and aggregate travel patterns. Often times the biggest concern with transit forecasts is related to the underlying person trip/activity demand. Models are often not well calibrated for specific corridors, and users of the model should expect that many corridors have unique issues. A proactive approach to New Starts forecasting would involve collecting corridor specific data and making corridor specific improvements in the context of studies. In this respect, NYMTC should incorporate improvements incrementally. The panel feels strongly that NYMTC should not have an expectation the MPO can foresee all needs and get everything right within a single framework.

7.6 Non-Motorized Modes

What recommendations are there to develop a non-motorized network that would support modeling of non-motorized trips?

This depends on whether NYMTC wants a model that is sensitive to non-motorized networks. If so, it is going to be expensive, time-consuming and complicated, but potentially quite useful. This will include special networks for pedestrians and bicycles.

How to improve the non-motorized mode and destination choice model?

The existing NYBPM has a basic capability and a special sub-model for non-motorized travel; however, this sub-model is greatly simplified. This is an important issue for non-motorized and transit mode choice, as well as destination choice.

What strategies can NYMTC implement to incorporate urban design factors such as walkability, bike friendliness, density, etc?

The panel recommends that NYMTC incorporate more explanatory variables (walkability, bike friendliness, density, etc) into the demand models; approaches depend on GIS data availability and quality.

7.7 Non-Resident Travel

What are the recommendations for a visitor model and what are the data needs?

A non-resident model could be approached incrementally, but you need some basic data. Basic data needs include relevant land-use data (hotel rooms, tourist attractions) and ideally a hotel survey distinguishing business/leisure travel. A non-resident model can be activity-based and with a synthesized (daily) population at the individual level, or aggregate.

How to forecast non-resident visitors? What are the key variables for visitor profiles?

The panel feels it is first necessary to get a handle on current visitation, and consider macro trends. Sometimes visitor/convention bureaus do surveys/forecasts, so NYMTC should research any readily available data on overall travel, trip purpose (business/leisure) and mode usage, for example. Macro trends can be linked to the national and regional economic and employment forecasts.

What are the recommendations for the development of an airport access model?

This is important to include since the airports are major generators and there have been and will continue to be major studies of ground access infrastructure associated with the airports. Remember that airport choice is also important since there are 3 major competing airports in the NY region. Thus, the choice structure should include two levels: airport choice and ground access mode choice (conditional upon the chosen airport). Data exists for this from a variety of recent studies by the Port Authority, and the Port Authority is considering investing in an airport choice and access mode choice model for its planning purposes that would interface with the NYBPM.

7.8 Time-of-Day / Activity Scheduling

What are the pros and cons of a discrete choice model and a continuous choice model for our purposes?

The panel feels that it is essential to work towards a fine temporal resolution (at least approaching continuous), particularly on the demand side. A fine-grained temporal resolution is important to properly consider time-of-day pricing and dynamic pricing, along with representing the fact that both the road and transit systems are at capacity in the peak periods. Therefore, the goal is to ensure model sensitivity (whether via discrete or continuous methods) to congestion and pricing. Currently continuous time-of-day modeling is difficult to achieve, particularly on the supply-side, although the corresponding theory and numeric methods are improving rapidly.

It is common for ABM's to have finer temporal resolution in the activity schedules than in traffic assignment. The more you sub-divide the static assignment process by time-of-day, the trickier traffic assignment becomes due to large percentages of trips spanning time periods. The panel recommends that NYMTC consider a planning-level DTA option at perhaps a 1-hour resolution as an intermediate solution, but feels that a full DTA implementation is impractical given other needs.

As for the demand side, the panel recommends methods to model consistent daily schedules for individuals in a few recently developed advanced ABMs (e.g. San Diego, Phoenix, Chicago, and Los Angeles).

7.9 Freight/Commercial Vehicle Model

What recommendations are there to improve the commercial vehicle model?

Modeling techniques and data availability vary by truck type (freight, local distribution, commercial vehicles, service). Long-haul freight is best modeled with an economic, commodity flow framework. The Calgary tour-based microsimulation local freight model offers a potential framework for local distribution.

What data can be obtained?

- Transearch (Global Insight)
- Cell phone and GPS data vendors are worth approaching (Inrix, TomTom, AirSage, etc.)

What freight data can be obtained in the establishment survey?

Basic trip rates for the surveyed establishments, by type of truck. An establishment survey will only provide some basic validation data. Keep in mind that freight/commercial vehicles may access surveyed sites in a different location from employees/visitors.

7.10 Dynamic Traffic Assignment

Is Dynamic Traffic Assignment a feasible option given the size of the model? How about simulation of transit vehicles in Dynamic Traffic Assignment?

The panel recommends consideration of a planning-level DTA, if available and feasible. Caliper recently released a planning-level DTA, which is a 30-60 minute static assignment that is linked across time increments so that trips "bridge" time periods. This is distinct from a regional meso or micro-simulation model (e.g. TransModeler). That type of DTA is currently infeasible at the regional scale. Transit vehicles (buses) can be included in traffic simulations but only some of the DTA packages provide this option.

7.11 Interface with Traffic Simulation and Sub-Area Studies

What is a feasible strategy for the regional model to interface with mesoscopic and simulation models?

The NYMTC model already has a sub-area extraction capability. Some other comparable models, such as the Atlanta Regional Commission model, do not have a sub-area extraction capability. Model run-time is not prohibitive, so the panel advises NYMTC not to over-think the need to develop an intricate sub-area extraction capability and recognize it may be easier to just run the whole model. The panel recommends that NYMTC consider opportunities to bring corridor details into the regional model if appropriate from a regional context.

How to develop a guideline to facilitate the application of the regional model for different types of studies?

The panel advises against overly prescriptive guidelines for forecasting work, since there is truly not a "one size fits all" approach to forecasting work. Instead, consider ways to maintain documentation in "real-time" (e.g. wiki). Ideally, any application work in a sub-area or corridor would be informed by useful data that NYMTC could leverage for its own use. Ideally any forecasts would tell a clear story and be grounded in data regardless of the technique used to arrive at that forecast.

What about transit considerations in a sub-area context? The current model does not allow transit analysis after sub-area extraction.

The way NYBPM's sub-area extraction process works, you have to run the entire model first (so all modes are taken into consideration on a regional basis). Demand can be extracted covering all modes, but the assignment process is particularly complicated on the transit side (requiring ultimate origin and destination data for accurate path-finding, both of which will not often exist within the sub-area). Other MPOs do not have sub-area transit extraction capabilities, but in the San Francisco Bay Area MTC region, there are 2 counties that have their own models with transit capabilities.

7.12 Zoning and Network System

What strategy can be implemented to achieve flexible TAZ structure?

Hierarchical geographic structures should be explored as a solution to flexible TAZs and improved geographical resolution. Simulated demand can be parcel-based, but supply is often TAZ-based (these geographies should nest). Transit and walk accessibility can be modeled at a finer resolution that nests within aggregate TAZs (e.g. Sacramento, San Diego, Chicago is in process).

What are the complexities involved?

With hierarchical structures, land-use data needs to be allocated to the lowest spatial resolution units (MGRAs or parcels). Special procedures have to be developed and applied to model transit access/egress and non-motorized modes.

Manhattan, for example, has much more detail than other parts of the model, but still the calibration is "not very good". What can be done?

It is relatively easy to look at the model output in intelligent ways. The challenge in making a better model is how effective your data are for the questions at hand, and identifying why the model output is unreasonable. Let the data and intelligent comparisons guide necessary model improvements. Start at the macro level and get regional flows right, then work down into more detailed contexts. Complexity of a model should not be confused with accuracy. Do not use crude techniques such as k-factors simply to match observed data.

7.13 Model application platform and IT issues

What are the advantages and disadvantages of cloud computing (feasibility, the platform and other relevant issues)?

All large agencies with ABMs have invested in a server environment as opposed to the cloud; this server environment can cost up to $100K. Cloud computing technology is changing rapidly, so explore the feasibility of the cloud, and talk to vendors about how this product works (as members of the panel have in the past). Keep in mind that modeling servers can be used for many purposes (not just running models).

There are numerous model users at NYMTC and in the consulting/stakeholder community, and these entities have already spent “lots” of money on hardware/software.

It is acknowledged that it is difficult to install new versions of the NYBPM (hardware/software compatibility issues).

While the hardware costs seem big, the panel has found they are small considering the operating costs, which are the basis for cloud computing costs. Keep in mind a model has to be run many times for a given application need. The cloud may be the best way to make the model available more broadly, however. The panel felt that from the point of view of an MPO, the first priority is to take care of the MPO, and the MPO is best served by a server and not the cloud. One possibility to explore in lieu of a cloud might be a cost-sharing arrangement where NYMTC staff would apply models for other agencies. Additionally, setting up the NYBPM in a cloud environment is bound to a special agreement with Caliper to provide a cloud TransCAD license.

What can be done to reduce the perception that the model is a black box?

NYMTC’s source code is available; it makes sense to first read the model documentation thoroughly. The models are incredibly complicated, which admittedly affects transparency.

7.14 Sustainability

How to address sustainability within the context of the regional model?

The panel feels that NYMTC must define sustainability first, but then travel models estimate an extensive amount of data that can be recast as aspects of sustainability (emissions, multi-modal mobility and accessibility, VMT, etc.)

7.15 Gas Price

How to incorporate fuel price?

The NYBPM already considers auto operating cost (fixed coefficient per mile by vehicle type). Real-world dynamics are more complicated however. For example, do transit fares rise due to cost of operating buses? How does vehicle type choice change? There are different choices that can be made in the short-, mid- and long-term in response to gas prices. The panel recommends that as gas prices change significantly, NYMTC should monitor observed elasticities. There may be some opportunity to analyze current travel survey data, given recent large fluctuations in gas prices. Comparisons between the Household Travel Surveys in 1996 and 2010 could be also useful.

7.16 Land-use Model

How important is a land-use model for NYMTC?

So many aspects of BPM 2.0 require detailed land-use data, and a land-use model is one way to get at that, but it is probably not feasible in the timeframe (2017). Generally speaking, NYBPM requires an intelligent way to inform Population Synthesis and populate small zones (MGRAs).

Induced demand is another aspect to consider with respect to land-use modeling. There is near unanimous agreement that an integrated model is the right theoretical approach for a variety of reasons (two-way interactions), but not an immediate need – the rates of land-use, population, and employment change in the New York metropolitan area are relatively modest in the aggregate.

NYMTC stakeholders have serious concerns about the need to forecast land-use detail. The panel feels that this effort should be more systematic, but not necessarily more complicated than what NYMTC currently does without a model. The database you need for a land-use model, or detailed demand modeling, is very valuable independent of land-use forecasting.

7.17 Is the NYMTC Model Getting Too Complex

Some recommendations from the panel might lead to simplifications (e.g. transit network representation, and overlaid networks). The panel feels strongly that theoretical elegance (e.g. more temporal resolution in assignment) results in a model that is easier to explain in some instances. There is an ongoing need to make the model easier to install and quicker to run (acknowledging that a lot has changed in 10 years in this regard with respect to general software and hardware).

Finally, complexity is neither inherently good nor inherently bad. Generally speaking, NYMTC should strive for “meaningful” complexity, rather than “arbitrary” or “excessive” complexity.

Appendix A List of Peer Review Panel Participants

Peer Review Panel Members:

Guy Rousseau	Atlanta Regional Commission
David Ory	San Francisco MTC
Dr. Chandra Bhat	UT Austin
Dr. Peter Vovsha	Parsons Brinkerhoff
Tom Rossi	Cambridge Systematics
Bill Woodford	AECOM
Nikhil Puri	AECOM
Ken Cervenka	FTA

Local Agency and Partner Agency Staff:

Ali Mohseni	NYMTC
Sangeeta Bhowmick	NYMTC
Dr. Xia Jin	NYMTC

Consultant Staff:

Bob Donnelly	PB

Supporting Staff to Peer Review Panel Members:

Sarah Sun	FHWA
John Lobb (Peer Documenter)	Resource Systems Group, Inc.

Appendix B Peer Review Panel Meeting Agenda

NYMTC Model Peer Review

April 14 and 15, 2011

April 14, 2011

9:00 - 9:15 a.m.	I. Welcome, Introductions, and Peer Process Overview
9:15 - 10:00 a.m.	II. Background and Future Plans
10:00 - 10:45 a.m.	III. Lessons Learned from Developer Perspective
10:45 - 11:00 a.m.	Break
11:00 - 11:30 a.m.	IV. Data Collection Efforts
11:30 - 12:00 p.m.	V. 1st Set of Technical Topics: Activity and Travel Patterns, Sensitivity to Pricing, Mode Choice, Destination Choice, Time-of-Day/Scheduling
12:00 - 1:00 p.m.	Working Lunch
1:00 - 2:30 p.m.	VI. Panel Discussion (closed)
2:30 - 3:30 p.m.	VII. Participants Discussion and Q&A
3:30 - 3:45 p.m.	VIII. 2nd Set of Technical Topics: DTA, Interface with Simulation/Sub-Area Models, Transit Modeling, Non-Resident Travel, Parking Supply/Pricing
3:45 - 5:00 p.m.	IX. Panel Discussion (closed)

April 15, 2011

8:30 - 9:30 a.m.	X. Panel Discussion (closed)
9:30 - 10:30 a.m.	XI. Participants Discussion and Q&A
10:30 - 10:45 a.m.	Break
10:45 - 11:00 a.m.	XII. 3rd Set of Technical Topics: TAZ/Networks, Non-Motorized Travel, External Travel, Application Platform/IT Issues, Commercial Vehicles
11:00 - 12:00 a.m.	XIII. Panel Discussion (closed)
12:00 - 1:00 p.m.	XIV. Working Lunch
1:00 - 2:00 p.m.	XV. Participants Discussion and Q&A
2:00 - 4:00 p.m.	XVI. Panel Recommendations and Discussion
4:00 - 4:15 p.m.	XVII. Closing Remarks

Appendix C Peer Review Panel Biographies

Guy Rousseau (ARC)

Guy Rousseau is the Surveys & Transportation Model Development Manager for the Atlanta Regional Commission (ARC), the MPO for Atlanta, Georgia, which he joined in 1998. He is responsible for model development activities for the 4-step trip-based model, the activity-based model and the population synthesizer, for modeling the impact of Regional Transportation Plans and Transportation Improvement Programs, coordinating the travel model with the land use model, providing model results for air quality emissions for conformity and attainment of clean air goals, and obtaining data for the modeling process through household travel surveys, transit on-board surveys and other surveys. He is extensively involved with the Transportation Research Board and TMIP, and is a member of the NYMTC Technical Advisory Committee (TAC) for their recent household travel survey.

David Ory (San Francisco MTC)

David Ory is Principal Planner/Analyst with the Metropolitan Transportation Commission in San Francisco. He leads the analytical group that performs travel modeling, travel behavior data collection, and geographic information systems. Prior to joining MTC in 2009, David was a

New Starts Team Leader with the Federal Transit Administration. In this role, he helped project sponsors navigate through FTA's New Starts programs, worked on New Starts guidance, and reviewed technical project deliverables, including ridership forecasts. From 2000 to 2008, Mr. Ory was a Planner with Parsons Brinkerhoff who worked in the travel forecasting service center, focusing exclusively on model development and application work.

Dr. Chandra Bhat (UT Austin)

Chandra Bhat is an international expert in the area of travel demand modeling and travel behavior analysis. His substantive research interests include land-use and travel demand modeling, activity-based travel modeling, policy evaluation of the effect of transportation control and congestion pricing measures on traffic congestion and mobile-source emissions, marketing research of competitive positioning strategies for transportation services, use of non-motorized modes of travel, and physical health and transportation. He serves or has served on the peer review panels for examining the models of the Metropolitan Washington Council of Governments (MWCOG) in the Washington D.C. area, the Metropolitan Transportation Commission (MTC) in the San Francisco Bay Area, the Southern California Association of Governments (SCAG) in the Los Angeles area, the San Diego Association of Governments (SANDAG), the North Jersey Regional Transportation Model Enhancement Project (NJRTME), and the East-West Gateway Council of Governments in the St. Louis area.

Dr. Peter Vovsha (PB)

Peter Vovsha has 28 years of experience in the development and application of transportation models. He has developed numerous models and computerized procedures for advanced discrete-choice models of travel behavior and integrated multi-modal network simulations. As a principal modeler, he has developed transport models for several large-scale regional model development projects in major cities such as Moscow, Tel-Aviv, Jerusalem, New York, Columbus, Montreal, and Ottawa. Peter is one of the leading experts in the development and application of the advanced tour-based and activity-based model systems in practice. He is pioneering in design of the new generation of advanced activity-based models that has been widely adopted in U.S. and worldwide (8 out of 12 activity-based models developed or being developed in practice in the U.S. were designed by him).

Tom Rossi (Cambridge Systematics)

Mr. Rossi is the Principal Investigator for the Strategic Highway Research Program (SHRP) Project C10 – Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained, Time-Sensitive Network. He is leading the development of a new activity-based model for the Houston region and previously led the development of such a model for the Denver region. He also has participated in the development of activity- and tour-based model systems in Portland, San Francisco, New Hampshire, and Tel Aviv. Mr. Rossi has previously led the development of complete travel model systems in several urban areas, including Philadelphia, Detroit, Atlanta, Minneapolis, and Memphis. Throughout the country, Mr. Rossi has led model validation efforts as well as the development of time-of-day modeling, external trip modeling, and auto ownership modeling procedures as well as mode choice models and network development. He has been an expert advisor to Federal agencies and MPOs in the development of travel models and survey data collection efforts.

Bill Woodford (AECOM)

Bill Woodford has 30 years of consulting experience in the areas of travel demand forecasting, ridership forecasting, and transportation planning. He has specific experience in developing transit ridership forecasting models with a particular emphasis on applying these tools to project ridership for fixed guideway investments, commonly known as “New Starts.”

Mr. Woodford is currently serving the FTA and Transit Cooperative Research Program to improve the state of transit ridership forecasting. He has directed the development of the transit ridership forecasting models currently used by NJ TRANSIT, the MTA in New York, the Washington Metropolitan Area Transit Authority, the Charlotte Area Transit System, the Chicago Transit Authority, Metra, and the Regional Transportation District in Denver.

Nikhil Puri (AECOM)

Mr. Puri leads a team of transportation planners working on regional travel demand and traffic microsimulation models. He plays a significant role in analyzing, interpreting and communicating complex model results to audiences that range from technical experts and decision makers to the public. His experience includes transportation planning and travel demand forecasting - transit and highway, integration of travel demand and microsimulation models, integration of commuter models with air passenger models, and the application of traffic simulation models. He is currently engaged in two of the larger regional multimodal transportation planning projects using the NYBPM. The projects required calibration and validation of key aspects of the model, and his team has been credited with significant contributions to the improvement of the model over the years.

Ken Cervenka (FTA)

Ken Cervenka works at the Federal Transit Administration, Office of Planning and Environment. His responsibilities focus on before-and-after studies, technical assistance on transit rider surveys and development of transit ridership forecasts, and review of forecasts submitted for New Starts and Small Starts evaluation. Prior to joining FTA he worked as the travel forecasting manager for the North Central Texas Council of Governments for 14 years. He has also worked as a transportation engineering consultant and university researcher.

Appendix D Overview of NYBPM

The following text summarizes the current version of the NYBPM at the time of the review, along with data sources used in the development of the model.

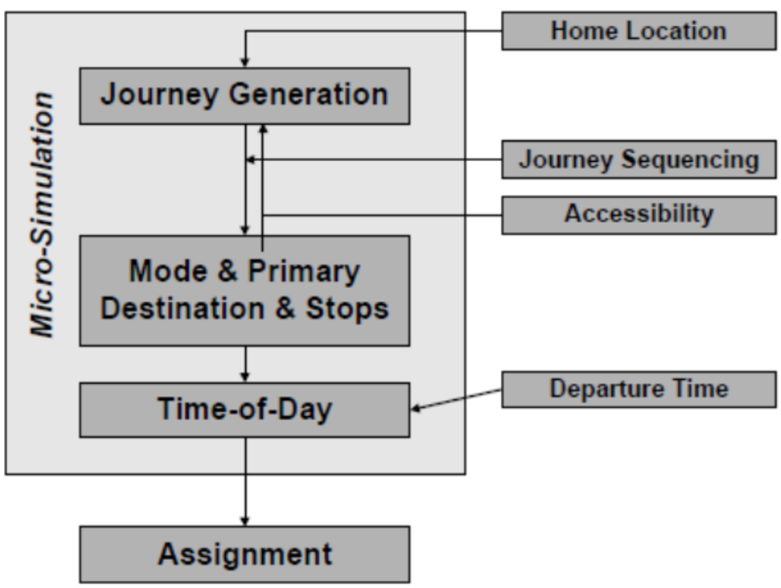
NYMTC Model Components

The following sections summarize models components as described in the final report of the NYBPM (2005). The model is made up of four primary modules that are shown in Figure 1:

- Journey Frequency (or Production), with Population Synthesis and Auto-Ownership (HAJ)
- Mode and Destination and Stop choice (MDSC),
- Time of Day choice (TOD),
- Highway and Transit assignment.

The first three modules are implemented as fully-disaggregate micro-simulation procedures working with individual records for the synthesized population (i.e., households, persons, journeys). The last module is currently implemented on a standard aggregate (i.e., zone-to-zone) basis, using assignment algorithms built into TransCAD.

Figure 1: General modeling structure of NYBPM (Source: Final Report on NYBPM, 2005)



Household, Auto-Ownership and Journey-Frequency (HAJ) Model

The Household, Auto-Ownership and Journey-Frequency (HAJ) Model in the BPM replaces the traditional trip generation model. It first involves generating a list of households with necessary socio-economic attributes (income, size, number of children, number of workers) using zonal level aggregate totals and seed distributions observed in the Census Public Use Micro-Sample (PUMS). In the second step, auto ownership for each household is determined using a discrete choice model based on socio-demographics of the household and the residential urban environment. A multinomial logit model with four alternatives (0, 1, 2, 3+ cars) was estimated using the household survey data.

The last component in the HAJ model is the Journey-Frequency model. The NYBPM generates "journeys" instead of trips that are produced in a traditional model. A journey, defined as travel between principal locations, identifies anchor points in an individual's travel pattern, such as home, work or school. Thus, a journey could have intermediate stops apart from the primary destination. A pair of symmetric journeys (outbound and return) forms a tour. There are 13 journey-frequency multinomial logit models (MNL) estimated based on person type (worker, non-worker and child) and journey purpose (work, school, university, at work, maintenance and discretionary). Each MNL has three alternatives - no journeys, one paired journey, two or more paired journeys. A logical sequence for running all the models has been developed. Explanatory variables include both journey frequencies generated in prior models for the same person and those of other members in the household to incorporate space-time constraints and intra-household interactions.

Mode Destination Stop Choice (MDSC) Model

This model replaces the traditional trip distribution and mode choice model. Based on the person and household characteristics, and land-use densities around the journey origin, this model predicts which modes of travel each person chooses, where the person goes and if the person stops along the way on the journey. If a person does make a stop on his/her way to work or school or university, this model will predict the location of the stop.

The MDSC model starts with pre-mode choice where each journey is assigned to either motorized or non-motorized mode of travel, modeled by a binary logit choice structure. The model has been calibrated for six journey purposes. If a non-motorized mode is chosen, an MNL model for non-motorized destination choice is run. The choices are all the individual attractions in a 3-mile radius of the journey origin. There is only one non-motorized mode modeled – walk.

For motorized pre-mode choices, destination and mode choice models for the whole journey (without intermediate stops) are run first. The destination-choice model (motorized) has been calibrated by eight purposes (six original purposes with additional subdivision of journeys to work by three income categories). There is a zonal attraction-size variable that is reduced after each individual destination choice simulation. The mode-choice model has been calibrated by six purposes as a nested logit construct with differential nesting depending on the purpose. In most cases drive-alone and taxi modes proved to be in separate nests while transit and shared-ride mode were nested in different combinations. There are ten motorized modes considered.

Intermediate stops on journeys are modeled as two linked choice models of stop-frequency and stop-location. Stop-frequency model was developed and calibrated for six purposes as a multinomial logit model with the following alternatives:

- No stops on either outbound or return leg,
- One stop on the outbound leg, no stops on the return leg,
- No stops on the outbound leg, one stop on the return leg,
- One stop on each leg.

Stop-location choice model is a multinomial logit construct. A bone-shape envelope that is a combination of the ellipsoidal and double-circle shapes was used to define the choice set with a goal to cover at least 95% of the observed cases from the HIS estimation data. The composite logsum from the stop-location model is used in the upper-level stop-frequency model to allow stop-making patterns as a function the density of opportunities present along the route.

Time-of-Day and Pre-Assignment Processor

The current version of the NYBPM has a simplified timing model based on a set of predetermined look-up tables (often referred as peak/off-peak factors) with percentage of journeys by time periods. The look-up tables are stratified by journey purpose, leg, mode, and some aggregate spatial categories. Time of day choices were aggregated by four broad time of day periods for which assignment procedures are implemented:

- AM peak period spanning 4 hours (6.00 AM – 9.30 AM)
- Midday off-peak period spanning 6 hours (10.00 AM – 3.30 PM)
- PM peak period spanning 4 hours (4.00 PM – 7:30 PM)
- Night period spanning 10 hours (8:00 PM – 5:30 AM)

It was assumed that the entire outbound or inbound leg belongs to the same broad time-of-day period since this was violated across the observed journeys in the household survey for less than 2% of the cases. Hence, all the trips in a particular leg are assigned the same arrival time period.

In the pre-assignment processor, the journeys generated along with the time-of-day tables are further processed to produce a set of time period specific zone-to-zone aggregate demand flow matrices. The purpose of this modeling stage is to prepare the time-of-day period specific trip tables for highway and transit assignments implemented in TransCAD. This model system component is applied after the core set of choice models described above that includes choice of destination, mode, stop frequency, and stop location for each journey. At this stage, journeys are broken into trips and trip tables are prepared for highway and transit assignments by time-of-day periods.

In addition, various additional traffic components not covered by the core travel model system and modeled by ancillary models (external trips, trucks, commercial vehicles) are added at this stage in order to create a full set of highway vehicle class tables. Additional traffic components (trucks, commercial vehicles, and external auto trips) are initially modeled in the form of aggregate daily trip tables. These trip tables are produced by ancillary models and have the following segments:

- Freight vehicle trip tables:
  - Heavy trucks
  - Commercial vehicles/vans
- External auto trip tables:
  - Home-trips to and from region
  - Home-based-other (HBO) trips to and from region
  - Non-home-based (NHB) trips to and from region
  - Traversal trips from the external zones to external zones

Highway Assignment

The last step in the application of the series of NYBPM choice models, results in a full set of about 25 million paired-journey records (in the 1996 base year), in production/attraction format, each record containing estimated household and personal attributes, chosen destination zone and mode of travel. These data are converted to aggregate “trip tables,” or flow matrices in origin-destination format, with a time of travel estimated in the Pre-Processor for Assignment. TransCAD is then used for assignment of these trip tables, using a multi-class technique

(TransCAD 4.0) for highway including SOV, HOV, Truck, and Other Commercial. The currently applied assignment procedure for highway modes is based on vehicle stratification by the following 6 classes:

- Passenger car – drive alone
- Passenger car – shared ride 2
- Passenger car – shared ride 3+
- Taxi
- Trucks
- Commercials

The reason for the vehicle class stratification is that different vehicle classes have different volume-delay functions as well as different network prohibitions that are taken into account in the multi-class highway assignment procedure developed in TransCAD.

Transit Assignment

Transit trips were estimated for Drive-to-Commuter Rail, Walk-to-Commuter Rail, Drive-to-Other Transit (Bus and Subway), and Walk-to- Other Transit (Bus and Subway) for assignment. Assignment is performed using the origin-destination trip tables by time period and the TRANSCAD pathfinder assignment method. This assignment procedure separately assigns each transit sub-mode in the following order for all time periods:

- Walk-to-Subway Trips
- Drive-to-Subway Trips
- Walk-to-Commuter Rail Trips
- Drive-to-Commuter Rail Trips

After the completion of all four assignments, an automated procedure computes the total ridership on each route and between each stop. The ridership on each route is compared to the equivalent time period capacity and an adjusted in-vehicle time is computed. All sub-modes are reassigned using the pathfinder method again and the results are blended with those of the previous iteration using weights to produce new travel times. The assignments are repeated for a total of five iterations.

Commercial Travel

The commercial travel models of the NYBPM take into account two components of commercial travel – trucks (vehicles with at least 2 axles and 6 tires)and other commercial vehicles (delivery vehicles, sometimes also referred to as “vans. Due to resource constraints, an empirically oriented approach for modeling truck and other commercial traffic that would make maximum use vehicle class traffic count and origin-destination data in the region was used. The base year truck trip tables using the NYBPM Truck Flow Estimating Model (TFEM) developed as part of NYMTC TMDI project. The methodology to estimate the base year commercial van trip tables is identical to the trucks, except a smaller dataset was employed due to the limited availability of data sources.

External Travel (Autos)

The sub-model of the NYBPM for non-commercial travel is a set of procedures that forecast the number of private passenger vehicle trips, by purpose, between each pair of external stations, and between internal zones and external stations. There are two different model sets used for estimating auto vehicle external travel. The first model estimates external-internal trips (X-I). These trips are both external-internal and internal-external in direction. The second component estimates through or external-external trips (X-X). The external models generate estimates for 4 different trip purposes. They are home-based work (X-I), home-based other (X-I),

Non-home based (X-I) and through (X-X)

For external-internal trips (X-I), a forecast function estimates the volume of external-local weekday auto traffic, for a forecast year at each station first. Next, a function distributes trips between external stations and internal zones using procedures that were estimated based on data collected from the External Cordon Survey. The through trip component of the model is essentially a distribution model that allocates and balances the estimated through travel at each station with a corresponding points of entry into the model region.

Validation

The calibration target data for the NYBPM was largely taken from aggregate summaries and tabulations of the RT-HIS, weighted and expanded to represent aggregate totals for regional households. Other aggregate data sources included the 1990 Census files (STF3A and CTPP), and other socioeconomic, employment and land use data assembled. Modeled journey productions were matched by county and purpose to those observed in the expanded survey. Most counties obtained reasonable modeled work journey productions, with about a 10% deviation from observed data. The mode choice validation was done across several dimensions – region wide mode shares by purpose, absolute journeys by mode and mode shares for county origin and destination of journey. For validation of destination choice model, absolute number of journey attractions at destination county level and average journey length and journey length distribution by travel purpose were used. It was noted that further improvement of the NYMTC destination choice model performance may require breaking the broad maintenance category into several, more detailed and homogenous, travel purposes.

Finally, the highway screenline and transit count data were used to evaluate and validate the NYBPM in the final assignment stage of the model. Highway model volumes were compared to two basic sources of count data developed as part of the TMDI project – the Screenline database developed, and the MATRIX database of counts developed by NYSDOT State Route System in the New York counties of the model area. The assignment procedures for transit, however, unlike the highway assignment are for the AM 4 hour peak period only. assigned model AM peak period volumes are compared to the 1995 and 1997 transit counts available at the time from the Metropolitan Transportation Authority (MTA), along with the model volumes from the 2001 Version of the MTA's Long Range Forecasting model generally used for by the agency for transit studies and analysis. Full calibration of the NYBPM for AM peak period transit assignment would involve review and possible adjustment to the time-of-day factors that allocate daily transit trips to the morning peak period assigned, as well as detailed checking of the route system coding and assignment parameters. This level of calibration was not done for transit loadings as part of the Base Year 1996 model implementation.

NYBPM Data Sources

The data for the current version of the NYBPM was first obtained in the initial phase of Transportation Models and Data Initiative (TDMI) in the mid and late 90's. The model base year (1996) has been updated twice since then to 2002 and 2005.This section contains a brief overview of the various data components used for developing and implementing the current model.

Household Survey

Household travel surveys are the primary source of data for developing models of travel demand. They contain information about various travel characteristics and socio-demographics, which are used as explanatory factors in models. The most recent household survey was collected for NYMTC in the year 1997-98, in partnership with the North Jersey Transportation Planning Authority (NJTPA) called the Regional Travel – Household Interview Survey (RT-HIS). The RT-HIS gathered responses from 27,369 people in 11,263 households in 28 counties of New York, New Jersey, and Connecticut. It was a diary type travel survey, in which detailed travel information for each member of participating households was collected during an entire travel day. The data was used for the estimation of disaggregate or individual-based estimation of travel behavior choice models that comprise the NYBPM travel forecasting system.

Demographic and Census Data

Socioeconomic, demographics and land use (SED) data are maintained and used at the NYBPM zonal level. The data consists of 15 zonal attributes of population, employment, and enrollment elements. Base year 1996 data were first generated by Urbanomics at Census Tract and Minor Civil Divisions levels and then Parsons Brinkerhoff allocated these to TAZs. As part of the TMDI project, the "2020 SED forecast series" developed a full set of zonal NYBPM SED variables for 2000, 2005, 2010, 2015 and 2020 horizon years.

Transit Counts

1995 and 1997 transit counts by service type and branch were available from the Metropolitan Transportation Authority (MTA), along with the model volumes from the 2001 Version of the MTA's Long Range Forecasting model generally used for by the agency for transit studies and analysis.

Traffic Volume Data

The NYBPM screenline volume database was developed as the principal source of observed traffic volume data for use in Base Year 1996 calibration and validation. It is comprised of 2,226 highway network link records, with estimated volume data by direction, by hour, for each link in the database. There is a 3-tiered system of screenlines where Tier 1 are county boundaries, Tier 2 define north-south / east-west lines that form intra-county quadrants, and Tier 3 lines form sub-quadrants within the Tier 2 quadrants. The data is collected a various sources such as traffic count data compiled from secondary sources, new Automatic Traffic Recorder (ATR) counts, and estimated traffic volumes for links with no count data.

Travel Time and Speed Data

The estimates of average travel speeds and times are maintained by Physical Link Types (PLT) and by Area Type. NYMTC conducted an extensive travel time survey, covering sixteen (16) weekday hours of operations, from 5 AM to 9 PM for estimating average speeds. The data collection effort focused on roadways functionally classified as principal arterial and above, to be consistent with NYBPM model in providing good estimates for links categorized as major arterials and above. A total of approximately 4,500 roadway segments, or the equivalent of approximately 2,400 travel time segments, were surveyed.

Truck Data

Truck trip tables created from vehicle classification counts data and the following OD surveys:

- 1991 PANY&NJ Truck Origin-Destination/Commodity Survey
- 1992 PANY&NJ Regional Truck Regional Cordon Survey—Phase 1

- 1993-1994 PANY&NJ Truck Regional Cordon Survey—Phase 2
- 1997 MTA Bridges and Tunnels OD Survey
- 1989 East River Truck Crossing Study

External Surveys

In 1998, NYMTC conducted an External Cordon Origin-Destination (O-D) survey to obtain information on external travel patterns for an average weekday. Only auto drivers from twelve locations within New York State were surveyed. The collected responses were used in the development of the Best Practice Model's external travel demand forecasting sub-model.

GIS Data

The highway and transit components of the NYBPM were developed and are maintained and applied with TransCAD, which features a Geographical Information System (GIS) framework that provides a realistic representation of the highway and transit route systems. The highway network consists of approximately 53,000 links and includes most minor arterial roadways and above roadway facilities. The link attributes include number of lanes, functional class, speed, parking restriction, and truck-usage. As inputs to the NYBPM core models, the networks are used to estimate travel times and distances between all parts of the regions (by TAZs), and then for assignment of models forecast travel demand flows (trip tables) to produce link level volumes flows by vehicle class (SOV, HOV, Taxi, Trucks, and Commercial Vans), as well as speeds reflecting volumes and capacities.

The transit network of NYBPM is based on information provided by the Metropolitan Transit Authority, New Jersey Transit and other transit operators in the region. The network has 100 NY city subway routes, 900 commuter rail routes, 2300 bus routes and 50 ferry routes as well as the sidewalk network in Manhattan. In addition, the transit network components also include station-to-station transfer databases, walk/drive links for rail and other transit connectivity, route coding and fare coding.

Other Data

A set of highway Origin-Destination surveys were compiled to obtain travel flow estimates at an aggregate level (district-to-district) and to validate the highway assignment for selected regional facilities:

- Cross Bronx Origin and Destination Study (1996)
- Major Deegan Origin and Destination Study (1994)
- MTA Bridges and Tunnels (1997)
- PANYNJ Vehicular Customer Travel Surveys (1996)

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