ASSIST-ME: A TRANSPORTATION DATA ANALYSIS TOOL AS A POST-PROCESSOR FOR THE OUTPUT OF TRANSPORTATION PLANNING MODELS

Kaan Ozbay
Professor
Department of Civil and Environmental Engineering
Rutgers University
623, Bowser Road,
Piscataway, NJ 08854
Phone: (732) 445-2792, Fax: (732) 445-0577, Email: kaan@rci.rutgers.edu

Sandeep Mudigonda (Corresponding Author)
Graduate Student
Department of Civil and Environmental Engineering
Rutgers University
623, Bowser Road,
Piscataway, NJ 08854
Phone: (732) 445-3162, Fax: (732) 445-0577, Email: sandeepm@rci.rutgers.edu

Bekir Bartin, Ph.D.
Research Associate
Department of Civil and Environmental Engineering
Rutgers University
623, Bowser Road,
Piscataway, NJ 08854
Phone: (732) 445-3675, Fax: (732) 445-0577, Email: bbartin@rci.rutgers.edu

Tolga Sertel
Rutgers Intelligent Transportation Systems (RITS) Laboratory (Formerly)
Rutgers University
623, Bowser Road,
Piscataway, NJ 08854
Email: tolgasertel@gmail.com

Pushkin Kachroo, Ph.D.
Professor and Co-Director
Transportation Research Center
University of Nevada Las Vegas
4505 S. Maryland Pkwy
Las Vegas, NV 89154-4026

Submitted to the 89th Transportation Research Board Annual Meeting on August 1, 2009
Word Count: 4,932 (words) + 7 figures + 4 tables = 7,782 words
ABSTRACT

Analysis of transportation data is a crucial step in the evaluation of various transportation planning projects. The forecasted data from transportation planning models comes in as a very useful data source. Visualization of this rich model data in a spatial perspective is an effective and intuitive way of analysis. A software application, Advanced Software for State-wide Integrated Sustainable Transportation System Monitoring and Evaluation (ASSIST-ME) was developed for this purpose using ESRI’s ArcGIS® Engine customized in the Microsoft .NET® Framework. ASSIST-ME can not only be used to visualize various transportation performance measures but also to conduct sophisticated full and marginal transportation cost calculations and to generate reports based on the analysis conducted by the transportation planner. This flexible application that can take output from various planning models such as CUBE and TransCAD provides an effective platform for the system-wide transportation analysis. Current version of ASSIST-ME is shown to work with two major transportation planning models namely, New York Metropolitan Transportation Council’s (NYMTC) Best Practice Model (BPM) and North Jersey Transportation Planning Agency’s North Jersey Regional Transportation Model – Enhanced (NJRTM-E). This tool caters to the needs of a wide variety of end users in various transportation planning agencies by making it easy to analyze very large output of major planning models. ASSIST-ME also demonstrates a number of innovations in terms of presenting data and post-processing results to make it easier to visually identify before and after changes caused by the implementation of changes to the transportation network. By means of a synergetic approach, ASSIST-ME was developed and customized to the needs of the NYMTC staff.

INTRODUCTION AND MOTIVATION

Transportation system is a complex system that is sensitive to many components which are a part of the overall system. These components range from the toll price and speed limit on a freeway to capacity of a highway to the price of fuel. There can be many policies that can influence the transportation system in various ways. These policy implications lead to changes such as change in travel speed, travel time and volumes, as well as changes to the number and distribution of trips, variation of travel paths between different origins and destinations.

It is important that the policy makers and transportation agencies to be able to analyze the variations in transportation system. These variations in the transportation system need to be monitored in order to evaluate the effectiveness of the policy implementation. Monitoring the variations in the transportation system can be performed using the feedback received. The feedback from the system comes in the form of traffic data. An intuitive manner of analyzing this data for the transportation agencies is through visualization. If the area over which the analysis covers a large area then the visualization of data performed in spatial setting will be very helpful to understand the dynamics of different components.
In this study a software application is developed using geographic information systems (GIS) as the spatial visualization tool to analyze transportation data obtained from the output of transportation planning models. It is shown to seamlessly work with the two major transportation planning models used by NYMTC and NJTPA. NYMTC’s Best practice model is developed in TransCAD (1) while NJTPA’s NJRTM-E is developed in CUBE (2). ASSIST-ME can take the output of both models and process it and then analyze it seamlessly. The most important aspect of ASSIST-ME is that it incorporates a wealth of visualization, analysis, and reporting functionalities in a user-friendly and innovative setting.

ASSIST-ME

The visualization and analysis tool ASSIST-ME was developed as a part of this study using BPM as a primary data source. ASSIST-ME was developed by customizing ArcGIS 9.2 Developer Engine in the Microsoft .NET Framework®. (3) The salient features of ASSIST-ME are:

- capability of representing the change in various transportation metrics in a spatial perspective
- visualization of data on various levels of aggregation
- a user-friendly software tool that minimizes the need to write complex queries and scripts to process and analyze huge transportation data sets
- flexibility to accept data output from any transportation planning software tool
- an effective reporting tool for various analyses performed
- provides an effective platform for system-wide assessment of the impact of various transportation policies by estimating various transportation costs
- provide a transportation visualization and analysis tool that can be used by a large number of end users with different backgrounds

Workflow of ASSIST-ME

ASSIST-ME consists of three broad sets of functionalities, namely:

1. Visualization of traffic data obtained as a result of various scenarios created in the planning model
2. Analysis of origin-destination demand
3. Analysis and visualization of paths and trip travel times/costs

For each of these functionalities, it is necessary to obtain user input regarding the data to compare and visualize. The user input involves selection of the method of analysis, the method of feature selection for analysis, and feature selection. The workflow is shown in Figure 1.
After the user input is entered in an interactive manner through the Graphical User Interface of ASSIST-ME, based on the method of analysis chosen the corresponding database(s) are accessed. The information regarding the features selected for comparison/visualization is extracted using appropriate queries and programs. This information is presented in the form of color schemes and tables which can be saved for future reference and reporting. The process is shown in Figure 1.

APPLICATION OF ASSIST-ME TO NYMTC’S BEST PRACTICE MODEL (BPM)

Description of the BPM Model

As discussed in the previous section, the input for ASSIST-ME is the data from the Best Practice Model. The dataset obtained from the output of the BPM is in the form
of a transportation network with predicted link flow, speeds, travel times, etc. This output, or loaded network, is in the form of a GIS file, i.e. all the traffic data represented in a geo-coded format. The loaded network is in the format of a TransCAD network file. The second input for ASSIST-ME from the BPM is the origin-destination demand data, generated from a forecast run in the BPM. (1)

The structure of the BPM for a typical forecast run is shown in Figure 2.

Figure 2: Best Practice Model Structure (1)

In the framework of the BPM, the road transportation network under the New York Metropolitan region is divided into links. Each link is geo-coded to represent the network in a geographically accurate manner. Each of these links has various attributes that provide the information regarding the nature of the transportation network. The traffic-related attributes that are necessary for ASSIST-ME are:

1. Travel time
2. Speed
3. Classified volume (SOV, HOV, Trucks, Buses, etc.)

The origin destination data which is an input as well as an output of a forecast run in BPM – is also a necessary input.

Both the loaded network and the OD data can be updated for various scenarios by directly using the output of the BPM in the form of a loaded network and the corresponding OD data for that particular scenario. This step can be performed any number of times in order to have various scenarios to be tested at hand.

The results of the assignment process of the model are loaded highway networks for four time periods of the day (1):

1. AM Peak (6-10 AM)
2. Midday (10AM - 3PM)
3. PM Peak (3-7 PM)
4. Night (7PM – 6AM)

**Description of Input Data**

Once highway assignment is completed in BPM, database files specific to the four time-periods (AM, MD, PM, and NT) are produced. These four files are the data files that are connected to the geographic files in TransCAD to produce loaded networks for analysis. Each one of these files contains predicted values for traffic on all 50,000+ links of the network.

It is imperative that when comparing and visualizing traffic-related data that some necessary attributes are included. The loaded network consists of the following traffic-related data that is used in ASSIST-ME:

1. Link traffic volumes for vehicle class, namely single occupancy vehicle (SOV), high occupancy vehicle (HOV2 & Taxi), high occupancy vehicle with three or more occupants (HOV3+), trucks, commercial vans, buses, and external trips.
2. Link travel times
3. Link free flow and congested speeds
4. Link volume-to-capacity ratio
5. Capacity of the link
6. Number of lanes on each link
7. Functional class of the roadway of which the link is a part of (freeway, interstate, arterial, local)
8. Nature of the area in which the link is located (urban, rural, etc.)
9. County in which the link is located

The origin-destination matrix contains the total number of trips to be assigned by the model, between each origin zone and destination zone. In the BPM model, the origin-destination (OD) matrices are produced by the Time-of-Day processor, which takes journeys, splits them into trips, and assigns them to time periods of the day based on observed distributions. The BPM uses four time period assignments, AM Peak, Midday, PM Peak, and Night, thus four OD matrix files are produced for the assignment. (1)

Each OD matrix file is subdivided into 6 matrices, one for each class of vehicle modeled (1):

- Single Occupancy Vehicles
- High Occupancy Vehicles (2) & Taxis
- High Occupancy Vehicles (3+)
- External Vehicles entering the network
- Trucks
- Other Commercial Vehicles

Each given OD matrix contains 16 million cells, since the model is designed with approximately 4,000 zones that can both generate and receive traffic. Once the OD matrices are created, highway assignment can be run. (1)
FUNCTIONALITIES OF ASSIST-ME

A detailed description of the ASSIST-ME tool is presented in this section. The major functionalities available for ASSIST-ME are:

1. Visualization of data such as speed, vehicle miles traveled, and volume-over-capacity (V/C) ratio
2. Analysis of OD Demand between various zones in the network
3. Analysis of travel times and paths on a loaded network
4. Creation of Report and selective exporting of analyses

Data Visualization

The data visualization functionality is useful in the calculation of various macroscopic statistics and visualization of links in the network. Macroscopic statistics such as vehicle hours of delay, average delay, average volume-to-capacity ratio, etc. are useful in judging the performance of the links. The visualization option performs the representation of the links in question based on a color scheme, which is a function of speed or volume-to-capacity ratio.

The data visualization capability of ASSIST-ME is also useful in comparing various forecasts performed by the BPM as result of different policy measures and projects. This comparison can be performed at the network level with the calculation of network statistics specified earlier. Additionally the visualization gives a visual comparison of two networks based on speed or volume-to-capacity ratio.

The data visualization step involves showing the average speed and level of congestion in the network. The metrics used for this visualization are congested speed and volume-to-capacity ratio, respectively. Visualization – based on speed or volume-to-capacity ratio – can be performed for features using the following selection options:

1. Network-wide selection
3. Features within a county
4. Features within a route
5. Features within a roadway functional class (Interstate/Freeway, Arterial, and Local Streets)

The database in use for the data visualization is shown in Table 1.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Function of the Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH</td>
<td>Link Length</td>
<td>Vehicle Miles Traveled</td>
</tr>
<tr>
<td>FROMNODE</td>
<td>Node ID of starting node</td>
<td></td>
</tr>
<tr>
<td>TONODE</td>
<td>Node ID of ending node</td>
<td></td>
</tr>
<tr>
<td>TIMEAB</td>
<td>Freeflow travel time in one direction</td>
<td>Delay</td>
</tr>
<tr>
<td>TIMEBA</td>
<td>Freeflow travel time in opposite direction</td>
<td>Delay</td>
</tr>
<tr>
<td>TOT_FLOW</td>
<td>Total volume in both directions</td>
<td>Vehicle Miles Traveled, Delay</td>
</tr>
<tr>
<td>AB_TIME</td>
<td>Congested travel time in one direction</td>
<td>Delay</td>
</tr>
</tbody>
</table>
The output at the end of the “Data Visualization” process using any of the above stated options is shown in Table 2. The output and visualization can be exported to Microsoft Excel.

### Table 2: Output of the Data Visualization Process

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA_TIME</td>
<td>Congested travel time in opposite direction</td>
<td>Delay</td>
</tr>
<tr>
<td>AB_VOC</td>
<td>Volume-Capacity ratio in one direction</td>
<td>Visualization &amp; Volume/Capacity</td>
</tr>
<tr>
<td>BA_VOC</td>
<td>Volume-Capacity ratio in opposite direction</td>
<td>Visualization &amp; Volume/Capacity</td>
</tr>
<tr>
<td>AB_SPEED</td>
<td>Congested Speed in one direction</td>
<td>Visualization &amp; Avg. Speed</td>
</tr>
<tr>
<td>BA_SPEED</td>
<td>Congested Speed in opposite direction</td>
<td>Visualization &amp; Avg. Speed</td>
</tr>
<tr>
<td>AB_SOV</td>
<td>Volume of SOV in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BA_SOV</td>
<td>Volume of SOV in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>AB_HOV_TX</td>
<td>Volume of HOV + Taxi in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BA_HOV_TX</td>
<td>Volume of HOV + Taxi in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>AB_HOV3</td>
<td>Volume of HOV3+ in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BA_HOV3</td>
<td>Volume of HOV3+ in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>AB_EXT</td>
<td>Volume of externals in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BA_EXT</td>
<td>Volume of externals in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>AB_TRUCK</td>
<td>Volume of Trucks in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BA_TRUCK</td>
<td>Volume of Trucks in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>AB_COMM</td>
<td>Volume of Other Commercial vehicles in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BA_COMM</td>
<td>Volume of Other Commercial vehicles in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>ABBUS</td>
<td>Volume of buses in one direction</td>
<td>Person Miles Traveled</td>
</tr>
<tr>
<td>BABUS</td>
<td>Volume of buses in opposite direction</td>
<td>Person Miles Traveled</td>
</tr>
</tbody>
</table>

### Origin Destination-based Trip Analysis

The number of trips between various origin and destination zones is one of the necessary inputs to the traffic assignment step in the transportation planning process. The level of demand between various zones will be different based on the
implementation of specific policies or simply due to yearly variations. These changes have to be juxtaposed on a network-level in order to find the changes in the network distribution of demand for various scenarios.

For the analysis of origin-destination trips between various zones, the OD trip matrix for the complete NYMTC region is used as an input. This matrix is also the input to the BPM. Using the key field ID of the zones the number of OD trips is obtained from the trip matrix. It is to be noted that this matrix is of the order of 4000 x 4000. So an external program prepared in C programming language is used to faster execution. The options provided for OD analysis are:

1. Time
   a. Year for which the OD analysis has to be performed
   b. Time of the day (AM, PM, Midday, Night)

2. Mode of travel
   a. SOV, HOV2 & Taxi, HOV3+, Externals, Trucks, Other Commercials

3. Feature Selection
   a. Manually selected ODs
   b. ODs located within a county
   c. Inter-county trips

Each of the above must be selected by the user from the appropriate user interface.

The OD demand can be found out for the selected year, time and mode of travel can be displayed for manually selected OD pair(s). In a county-level analysis, the number of trips between origins and destination located within a county are shown. On a network-level analysis, the number of trips between origins and destinations located in different counties are displayed.

The database in use for the OD trip analysis is shown in Table 3.

Table 3: OD Database

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>ID of the Origin Zone</td>
</tr>
<tr>
<td>Destination</td>
<td>ID of the Destination Zone</td>
</tr>
<tr>
<td>Demand for SOV</td>
<td>Demand for Single-Occupancy Vehicle between O-D pair</td>
</tr>
<tr>
<td>Demand for HOV2 &amp; Taxi</td>
<td>Demand for High Occupancy Vehicle (with occupancy = 2) and Taxi between O-D pair</td>
</tr>
<tr>
<td>Demand for HOV3+</td>
<td>Demand for High Occupancy Vehicle (with occupancy more than 2) between O-D pair</td>
</tr>
<tr>
<td>Demand for Externals</td>
<td>Demand for Vehicles from or to an external zone</td>
</tr>
<tr>
<td>Demand for Trucks</td>
<td>Demand for Trucks between O-D pair</td>
</tr>
<tr>
<td>Demand for Other Commercials</td>
<td>Demand for Commercial Vans between O-D pair</td>
</tr>
</tbody>
</table>

The output of this process is displayed in a table and demand values for any two
successively selected OD pairs can be compared in a smaller table. The output of this
process can be exported into MS Excel for further calculations.

**Analysis of Travel Times, Costs and Travel paths**

Changes in trip distribution (either due to natural growth or due to implementation
of various policies) result in variations in the travel times and/or travel paths.
Forecasting these variations is the function of models such as the Best Practice
Model. Monitoring these variations is essential in the context of transportation
planning. ASSIST-ME can monitor these changes in travel times and paths in that
it is can be used as a quick analysis tool. This module in ASSIST-ME does not
perform the traffic assignment process but estimates the shortest path(s) and the
_corresponding travel time between the selected zones. It is to be noted that these
paths are fairly accurate and close to the actual
paths between the zones. (4)
Therefore the output of BPM acts as an input for further analysis of the forecasting
performed in the transportation planning process.

**k-Shortest Path Algorithm**
The methodology used to find the shortest paths in this study is based on the
algorithm proposed by Ozbay et al. (2005). (4) The algorithm used to find k-shortest
paths from an origin to a particular destination in a directed acyclic transportation
network (i.e., links on the network are all directed, and no link cannot be used more
than once in the shortest path) is mainly based on iterative application of modified
version of Dijkstra's algorithm. The basic idea in Dijkstra's algorithm is to find the
shortest path from one origin to all destinations. However, in our case, the main
focus is to find O-D specific shortest paths. Thus, to reduce the complexity of the
algorithm, Dijkstra’s approach is modified such that it terminates as soon as a path
from the selected origin to the specified destination is found. As soon as the shortest
path between the particular O-D pair is found, the network is modified by randomly
deleting two links from the shortest path while keeping the network connected. The
modified Dijkstra’s algorithm is then reapplied to the modified network to find the
next candidate path. The iteration continues until a user-defined number of paths
have been found, or no more paths that satisfy the required constraints can be
found.

The main advantage of the proposed method is that it finds the constrained shortest
paths directly, instead of selecting the paths from a large set of overall paths. In
addition, it allows for defining a path choice set on the basis of objective constraints
such as limitation of travel time, minimum required disjoint links, and limitation on
total number of links. The main idea of the multiple-path approach is to find the set
of a predefined number of feasible paths that are attractive to the travelers between
the selected O-D pair. (4)

From the perspective of the whole transportation system, the transportation process
results in wide-ranging effects on the complete system. These effects can be
represented as “costs” incurred by various entities of the system. ASSIST-ME can
also be used to estimate some of these transportation costs, namely:

1. Vehicle Operating Cost
2. Congestion Cost
3. Accident Cost
4. Roadway Maintenance Cost
5. Air Pollution Cost
6. Noise Cost

Travel times, costs and travel paths are analyzed using the output of the BPM. Since the output contains travel times on each link, the possible paths between the chosen set of ODs can be calculated from the shortest path algorithm. This feature in ASSIST-ME can be used to find three possible paths, the corresponding travel time, and travel costs for the selected set of ODs. Various OD selection options provided under this functionality are:

1. Manually selected ODs
2. ODs located within a county
3. Inter-county trips
4. Network-wide OD selection

The database in use for the travel cost analysis is similar to that shown in Table 1.

The calculation of travel times, costs, and travel paths can be performed for manually selected OD zones. This is facilitated by the built-in “Select Features” tool. The OD zones selection can be performed for zones located within a county by selecting the county from a drop-down list. The same process can be performed for trips between origin and destination zones located within different counties or on a network-wide level.

In each of the last three cases, since the number of possible origin and destination pairs is very huge, it is possible – through a time-consuming process – to perform the calculation for all the pairs. Hence, the user is prompted to enter a sample size for the number of OD pairs for which the analysis is intended to be performed. The OD pairs are randomly chosen from the complete set of possible OD pairs.

In addition to the three functionalities described above, the output of visualization and analysis can be saved and stored in the form of Microsoft Excel worksheets. The set of operations performed each time can be stored in a session and the user can selectively save the output from those operations that are deemed as required.

The functionalities of ASSIST-ME are illustrated using few applications in the following sub-section.

Data Visualization

As a primary application of ASSIST-ME, data visualization can be performed in various scenarios in different combination of options. A select few are shown in this sub-section.

Visualization of congested speed for the borough of Queens in New York for the forecasted data of an average AM peak period in year 2002 is shown in Figure 3(a). The summary output for the data visualization process (as described in Table 2) which can also be seen in Figure 3(b) are as follows: VMT = 3,996,826.1 vehicle
Ozbay, Mudigonda, Bartin, Sertel, Kachroo

miles, Average Congested Speed = 18.8 mph, Average V/C ratio = 0.562, Total PMT
= 5,685,365.8 person miles, Total vehicle hours of travel time = 260,001.6 vehicles
hours, Average delay = 0.945 min.

Visualization of congested speed for the portion of route I-78 passing through the
borough of Richmond (State Island) for the forecasted data of an average AM peak
period in year 2002 is shown in Figure 3(b). The summary of output for the data
visualization process, also seen in Figure 3(b), is: VMT = 190,576.3 vehicle miles,
Average Congested Speed = 38.0 mph, Average V/C ratio = 0.71, Total PMT =
219,566.5 person miles, Total vehicle hours of travel time = 9,096.5 vehicle hours,
Average delay = 0.656 min.

(a)
Visualization of V/C ratio for the functional class of Interstate/Freeway in the boroughs of Manhattan, Queens, Brooklyn, and State Island for the forecasted data of an average AM peak period in year 2002 is shown in Figure 4(a). The summary of output is as follows: VMT = 3,907,209.3 vehicle miles, Average Congested Speed = 33.7 mph, Average V/C ratio = 0.687, Total PMT = 4,861,428.8 person miles, Total vehicle hours of travel time = 6,388,417.8 vehicle hours, Average delay = 31.76 min.
A comparison of V/C ratios for functional class Interstate/Freeway in Westchester County for the forecasted data of an average AM peak period in year 2002 and the year 2030 is shown in Figure 4(b). The summary of outputs is shown in Table 4. A sample of the reporting capability of ASSIST-ME is shown in Figure 4(c).

### Table 4 Comparison of Summary Output

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2030</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMT (vehicle miles)</td>
<td>3,038,580.50</td>
<td>3,758,071.10</td>
<td>23.67851</td>
</tr>
<tr>
<td>Average Congested Speed (mph)</td>
<td>44.9</td>
<td>37.5</td>
<td>-16.4811</td>
</tr>
<tr>
<td>Average V/C Ratio</td>
<td>0.55</td>
<td>0.668</td>
<td>21.45455</td>
</tr>
<tr>
<td>Total PMT (person miles)</td>
<td>3,396,656.40</td>
<td>4,147,458.00</td>
<td>22.10414</td>
</tr>
<tr>
<td>Total Vehicle Hours of Travel Time (vehicle hours)</td>
<td>74,794.40</td>
<td>126,069.50</td>
<td>68.55473</td>
</tr>
<tr>
<td>Average Delay (min.)</td>
<td>0.692</td>
<td>0.964</td>
<td>39.30636</td>
</tr>
</tbody>
</table>
OD Demand Analysis

The variation in OD demand for the forecasted data for the AM Peak period for years 2002 and 2010 is shown in Figure 5. The number of vehicles in each mode between each origin and destination are shown. The circles numbers show the comparison of single occupancy vehicles (SOV), high occupancy vehicles (2) and taxis, high occupancy vehicles (3+) and trucks.

![Comparison of O-D Demands for the years 2002 and 2010](image)

Figure 5 Comparison of O-D Demands for the years 2002 and 2010

Travel Cost Analysis

The change in travel costs and travel paths over different years can also be compared using ASSIST-ME. Using the forecasted output for the AM peak period from the years 2002 and 2030, the travel cost analysis was performed for the same O-D pair for both the years. The travel paths for both the years are shown in Figure 6. The average costs in different cost categories for both the years for three paths between the O-D pair are also shown. It can be seen that the travel time increased by about 10% and as a result the congestion cost increased by about 36%.
Figure 6 Comparison of Travel Cost and Paths for AM peaks of 2002 and 2030

Figure 7(a) and Figure 7(b) show the application of ASSIST-ME using the NJRTM-E output data. Figure 7(a) shows the visualization of the level of congestion on route NJ-35 from NJRTM-E before and after improvements performed on NJ-35. Figure 7(b) shows the travel cost output and travel paths for the same set of networks between a pair of origins in Middlesex county and destination Berger county in New Jersey.
Figure 7 (a) Comparison of V/C for the NJRTM-E network before and after improvements to NJ-35 (b) Comparison of Travel Paths and Costs
Feedback and Response for ASSIST-ME

Prior to the development of ASSIST-ME there were a series of meetings with the NYMTC staff to decide on data sources to develop ASSIST-ME, the software tool that can be used to develop ASSIST-ME, etc. Also, during the course of development of ASSIST-ME there were a good amount of interaction with the staff to assess the working of various functionalities and the workflow of ASSIST-ME. ASSIST-ME was also tested for its usefulness and accuracy by the staff at NYMTC.

By means of such a synergetic approach, ASSIST-ME was developed and customized to the needs of the NYMTC staff. As a result, ASSIST-ME has been received very positive response from not only the NYMTC staff but also from various users and stakeholders of NYMTC’s BPM. So, in future, ASSIST-ME will be deployed as a support tool to the BPM users in the region.

CONCLUSIONS

A novel software application for the purpose post-processing and analysis of transportation data has been developed in this study. This software tool, ASSIST-ME, is developed as a post-processor of the output of very large regional transportation planning models. Its applicability to the output of different planning models is shown by using it with the output of the Best Practice Model developed by NMYTC as well as the output of NJRTM-E model developed by NJTPA. The salient features of ASSIST-ME are:

- a user-friendly software tool that minimizes the need to write complex queries and scripts to process and analyze huge transportation data sets
- visualization of data on various levels of aggregation
- flexibility to accept data output from any transportation planning software tool
- an effective reporting tool for various analyses performed
- provides an effective platform for system-wide assessment of the impact of various transportation policies by estimating various transportation costs

Visualization of macroscopic outputs that can be used to monitor the performance of the transportation system is an important functionality. Congested speed and volume-to-capacity ratio are used as visualization parameters. Also a summary of other parameters such as average travel time, average vehicle delay, total vehicle miles traveled, total vehicle travel time, and total person miles traveled. This visualization can be performed using various selection options such as counties, freeways, highways, arterials, functional classes, etc.

Aside from visualization, ASSIST-ME also has the capability to compare and visualize the origin-destination demand data. The highway demand data between different traffic analysis zones for various modes can be analyzed in a number of ways using ASSIST-ME.

The third set of functionalities provided by ASSIST-ME is a set of sophisticated functions that are employed to estimate path and network based transportation costs including, travel, environmental, accident, operation and maintenance,
construction and land acquisition costs. Various costs involved in undertaking a trip within the New York Metropolitan and NJTPA transportation system can be calculated and compared for different years and time periods. The travel paths can also be compared with a spatial perspective by displaying them in GIS.

ASSIST-ME has been shown to be a very useful software tool that enables transportation planners to conduct comparative analyses of their transportation decisions without having to build complicated queries and programs.

As a future addition to the existing framework of ASSIST-ME analysis of transit networks which includes visualization and various costs calculations will be implemented.

ACKNOWLEDGEMENTS
The authors would like to acknowledge the NYMTC for funding in the development of this tool, ASSIST-ME. The grant was administered by Rutgers Center for Advanced Infrastructure and Transportation (CAIT). Their support is both acknowledged and appreciated.

REFERENCES


