Travel Demand Modeling

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Statewide and Urban Travel Analysis Section
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Presentation Goal

- Improve the utilization of travel demand models for Project level analysis
- Describe how travel demand models work
- Interpreting model outputs
- Different types of analysis available
Presentation Overview

- Background
  - Why we make models
  - Primary uses
- Networks
  - Structure
  - Attribution
- Traffic Analysis Zones
  - Structure
  - Data
Presentation Overview

- Trip generation
  - Number of person trips by Traffic Analysis Zone (TAZ)
- Trip distribution
  - TAZ to TAZ
- Mode Split
  - Convert person trips to different modes of travel
- Assignment
  - Assign the route for the vehicle trips
Presentation Overview

- Calibration and Validation
  - Standards for performance
- Different capabilities of different urban models
  - All model utilize different techniques depending on the model area
- Statewide model
- General model assumptions
  - The basis for equations
Presentation Overview

- Model applications
  - Uses of the model
- Discussion on using travel demand models for project level analysis
  - Information request process
  - Levels and types of analysis
  - Working together to enhance the final product
Why Urban Models are Developed

- Metropolitan Planning Organizations (MPOs) are required to have an objective method to evaluate the federal aid road system as part of their Long Range Plan (LRP)

- MDOT holds the models for Small MPOs
  - 50,000 – 200,000

- Transportation Management Areas (TMAs) are required to have a model and staff that are knowledgeable in modeling
  - Over 200,000
Primary Uses of Model

- **Forecasts**
  - How changes in Socio-Economic data (SE-data) affect traffic flows
  - Predict future traffic congestion
  - Test solutions

- **System wide analysis**
  - How changes in the network affect traffic flows
Primary Uses of Model

- Development of MPOs LRP Project list
- Test alternative methods for alleviating congestion
  - Not just widening roads
  - Parallel corridor
  - Connectivity improvements
- Congestion management
  - Use a volume over capacity (V/C) ratio to identify deficiencies or congestion
  - Hierarchy of congestion
Air Quality

- Travel demand model outputs provide the inputs for air quality models
  - Vehicle Miles Traveled (VMT)
  - Vehicle Hours Traveled (VHT)
  - congested speed
What is Modeled

- Collectors and above
- All capacity projects need to be in the LRP and the Transportation Improvement Program (TIP)
  - LRP has at least a 20 year horizon
  - TIP has a four year horizon
- All future capacity projects identified in the LRP need to be modeled in forecasts
What is Modeled

- A build network represents all of the capacity projects to be completed by the year of the network
- A no-build network represents the existing road system
- A TIP or Existing plus Committed (E + C) network represents current conditions and the capacity projects in the TIP
Model Updates

- The model inputs are developed, reviewed and approved by the MPO committee as part of their LRP process.
- Urban models are updated for each LRP:
  - Air quality non-attainment or maintenance areas every 4 years
  - Air quality attainment areas every 5 years
Model Updates

- Updates can range from developing new SE-data to a complete rebuild
- Interim updates
- Tip amendments involving capacity projects require new air quality conformity analysis
What is a Travel Demand Model

- A travel demand model is a series of mathematical equations which are used to estimate traffic conditions.
Networks
Network Structure

- Base Year Road Network
  - Michigan Geographic Framework
    - Federal Aid Roads (Collector and above)
    - Add Local roads as needed
Framework “all roads” file
Framework with model network
Network Attributes

- Number of Thru Lanes
- Posted Speed
- Lane Width
- Parking Allowed
- Center Turn Lane Present
- Area Type - Urban, Rural, etc.
- Percent Commercial Traffic
- Traffic Counts
Network Attributes

- Purpose of Attributes
  - Establish capacity
  - Establish network speed
  - Create turn prohibitions & penalties
  - Validate with traffic counts
Capacity

- **Main uses:**
  - Equilibrium Assignment
  - Volume to Capacity Ratio (VC Ratio)

- **Base Capacities are Level of Service (LOS)**
  - D or E not Design Capacity

- **Daily Capacity**
Capacity

- Look-up table
  - Based on area type
  - National Functional Classification
- Models
  - Grand Rapids
  - SEMCOG
<table>
<thead>
<tr>
<th>Area Type</th>
<th>Facility Type</th>
<th>Number of Lanes</th>
<th>Capacity Per Lane</th>
</tr>
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<tbody>
<tr>
<td>CBD</td>
<td>Freeway</td>
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<tr>
<td>CBD</td>
<td>Divided Arterial</td>
<td>4</td>
<td>7700</td>
</tr>
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</table>
Capacity

- All other Models use:
  - Capacity Calculator
    - Developed by Lansing TMA
    - Updated in 2006 to 2000 HCM
  - Some Model Capacities adjusted by locals
Capacity

- Attributes used in Calculating Capacity
  - Area type
  - Link type
  - Traffic Operation Code
  - Number of thru lanes
  - Lane width- Travel Lane
  - One or Two Way Traffic
  - Percentage Commercial
  - Trunkline
  - Parking Allowed
Capacity

- Uses default green time based on Area Type and Facility Type
- Adjustments to base capacity based on each attribute
## Capacity

<table>
<thead>
<tr>
<th>NAME</th>
<th>PK_HR_F</th>
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<th>24HrCap_2w</th>
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<td>17050</td>
<td>1100</td>
<td>1100</td>
<td>1100</td>
<td>1023</td>
</tr>
</tbody>
</table>
Speed

- Used as a measure of time (how fast you can travel)
- Important for Network Paths
- Reflects roadway conditions without the effect of congestion
Speed

- Determining Speeds
  - Posted speed limit
    - Limit set by a jurisdiction
  - Look-up tables
    - Based on area type, facility type, number of lanes, posted speed
## Speed Table (Holland)

<table>
<thead>
<tr>
<th>Functional Class</th>
<th>Posted Speed</th>
<th>Thru Lanes</th>
<th>Model Speed</th>
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<tbody>
<tr>
<td>1</td>
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<td>45</td>
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</tr>
<tr>
<td>2</td>
<td>55</td>
<td>4</td>
<td>63.85</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>4</td>
<td>61.59</td>
</tr>
<tr>
<td>6</td>
<td>45</td>
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<td>35</td>
</tr>
<tr>
<td>99</td>
<td>20</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>
### Speed Table (Relative)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Link</th>
<th>Road</th>
<th>CBD</th>
<th>Urban</th>
<th>Sub</th>
<th>Fringe</th>
<th>Rural</th>
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<tr>
<td>Freeway</td>
<td>1</td>
<td>1</td>
<td>50</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Trunk line</td>
<td>3</td>
<td>2</td>
<td>29</td>
<td>34</td>
<td>41</td>
<td>49</td>
<td>53</td>
</tr>
<tr>
<td>Major Art</td>
<td>4</td>
<td>3</td>
<td>25</td>
<td>30</td>
<td>37</td>
<td>45</td>
<td>49</td>
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<tr>
<td>Collector</td>
<td>6</td>
<td>All</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>42</td>
</tr>
</tbody>
</table>

1 MPH added based on number of lanes, including center turn lane form default of 2.
Turning Movements

- No Intersection right and left turn lanes
- No Traffic lights
- Turns Prohibited
  - Added to ramps
  - Intersections
- Turn Penalties (sometimes used)
  - Global
  - Specific
Turning Movements
Traffic Analysis Zones (TAZ)
What Are Traffic Analysis Zones (TAZs)

- Small geographic subdivisions of the study area
- Built from adjacent census blocks that have similar land use
  - Allows the aggregation of census block data for households and population
Merged Census Blocks
Centroids

- A point or node in the network
- Corresponding to a TAZ
- Trips loaded from centroids
- Trips travel from centroids to centroid
- Generally placed at center of TAZ activity
Merged Census Blocks
Centroid Connectors

- Connectors represent the local roads not in the network and all driveway cuts along a road segment
  - Loading points
  - Statewide model utilizes single point loading
Developing TAZs

- TAZs are developed before the centroid connectors
  - designed so that the connectors can be properly created

- Building Connectors
  - No intersections
  - No connections where physical barrier
  - Connect where road is
Developing TAZs

- Constrained by the network
  - This facilitates the loading of trips to the network
Developing TAZs

- Constrained by natural features
  - This helps prevent impossible loadings
Developing TAZs

- Constrained by political boundaries
  - This aids in developing the socio-economic data
  - TAZ data for a jurisdiction can be added up and compared to control totals
Socio-Economic Data (SE-Data)
Households and Population

- Households and population
  - Start with census block data
  - Adjust to base year
  - Forecast to future years
    - Demographics specialist Garth Banninga creates growth rates or control totals utilizing REMI, Woods and Poole and other sources that most small MPOs utilize
    - Specific information on the area is requested from local agencies and incorporated
Employment data usually comes from Claritas and MESA. The data is cleaned in house and then reviewed by local road agencies and officials. It is in the form of a point file. Each record is tagged with a TAZ number.
The number of employees for each business are aggregated by the type of employment (retail, non-retail, service and other) to TAZ totals
Average Autos Available

- Start with Block Group data
- Average number of autos available per household method
- Categories autos method
  - Number of 0, 1, 2, 3+ car households
Income

- Start with census block data
- Can use average or categories
TAZ Level SE-Data

- Aggregated data
  - Population
  - Number of occupied households
  - Persons per household
    - Average or categorized
  - Number of employees by business type
  - Number of autos per household
    - Average or categorized
  - Some models use household income
    - Average or categorized
Socio-Economic Data (SE-Data)

- The base and future years SE-Data is reviewed and approved through the MPO committee structure
Trip Generation
Trip Generation

- Estimation of person trips produced by or attracted to a TAZ
- Calculated by Household & Employment data
Data Sources

- National Cooperative Highway Research Program (NCHRP)
  - NCHRP 365 Report - Travel Estimation Techniques for Urban Planning

- MI Travel Counts
  - Michigan statewide household travel survey
    - 2004/2005
Trip Purpose

- Purposes
  - Home-Based & Non-Home Based Work
  - Home-Based & Non-Home Based Other
  - Home-Based School & Non-Home Based School
  - Home-Based Shopping & Non-Home Based Shopping
  - Home-Based University & Non-Home Based University
Trip Production & Trip Attraction

- Trip production is where the trip is generated
- Trip attraction is where the trip is attracted
- For Home-based trips the home end is always the production end
Trip Purpose

- Work
- Home Based Work
- Home
- Non-Home Based
- Retail Mall
- Home Based Other
## Cross Classification Table

Based on Autos and HH Size for Home-Based Other Daily Trip Purpose

<table>
<thead>
<tr>
<th>Autos Per Household</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5+</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.6</td>
<td>4.8</td>
<td>7.4</td>
<td>9.2</td>
<td>11.2</td>
<td>3.9</td>
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<tr>
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<td>4.0</td>
<td>6.7</td>
<td>9.2</td>
<td>11.5</td>
<td>13.7</td>
<td>6.3</td>
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<td>4.0</td>
<td>8.1</td>
<td>10.6</td>
<td>13.3</td>
<td>16.7</td>
<td>10.6</td>
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<tr>
<td>3+</td>
<td>4.0</td>
<td>8.4</td>
<td>11.9</td>
<td>15.1</td>
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<td>13.2</td>
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<tr>
<td>Avg</td>
<td>3.7</td>
<td>7.6</td>
<td>10.6</td>
<td>13.6</td>
<td>16.6</td>
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## Productions
### Number of Households

<table>
<thead>
<tr>
<th>TAZ 21</th>
<th>56 HH</th>
<th>Persons Per Household</th>
<th>Total</th>
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<tbody>
<tr>
<td>Autos Per Household</td>
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<td>2</td>
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<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>3+</td>
<td>3</td>
<td>5</td>
<td>8</td>
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</table>
## Productions

### Households *Trip Rate

<table>
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<tr>
<th>TAZ 21</th>
<th>Persons Per Household</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 HH</td>
<td>1</td>
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<tr>
<td></td>
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<td>2*4.0</td>
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<td>2</td>
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<td></td>
<td>Total Productions =</td>
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### Productions

**Daily HBO Trips**

<table>
<thead>
<tr>
<th>TAZ 21</th>
<th>Persons Per Household</th>
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</thead>
<tbody>
<tr>
<td>56 HH</td>
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<tr>
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<tr>
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<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3+</td>
<td></td>
</tr>
</tbody>
</table>

Total Productions = 481.3
Trip Production

- Cross Classification Method
  - Total Households
  - Autos per household
  - Household size
  - Students per household
  - Income Class
Trip Attraction

- Regression equations
  - Total occupied households
  - Total employment
  - Retail employment
  - Service employment
  - Other (non retail or service) employment
  - Area type
Trip Attraction

- Example
\[ \text{HBO} = (9.0 \times \text{RE}) + (1.7 \times \text{SE}) + (0.5 \times \text{OE}) + (0.9 \times \text{HH}) \]
\[ \text{HBO} = (9.0 \times 25) + (1.7 \times 68) + (0.5 \times 10) + (0.9 \times 56) = 396 \]

396 Home-Based Other Person Trip Attractions

TAZ 12
- Households = 56
- Retail Employment = 25
- Service Employment = 68
- Other Employment = 10
Special Generator

- **Special Generators**
  - Land use with unusually high or low generation characteristics
    - Airport
    - University
    - Military base
    - Hospitals
- **Trip Generation Handbook**
- **Methods for Including**
  - Add to TAZ
  - Replace TAZ Productions & Attractions
Special Generator

- Models with Special Generators
  - Lansing
  - Tri-City (Bay-Midland-Saginaw)
  - Kalamazoo
  - Muskegon
  - Jackson
  - Flint
  - SEMCOG
  - Ann Arbor
<table>
<thead>
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<th>HBOP</th>
<th>HBOA</th>
<th>NHBP</th>
<th>NHBA</th>
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<td>1307</td>
<td>2014</td>
<td>1638</td>
<td>890</td>
<td>780</td>
</tr>
</tbody>
</table>
Balancing

- Total Productions & Attractions need to be equal
  - If a trip is made to work, there needs to be a return trip.

- Balance by Productions for Home-based Purpose
- Balance by Attractions for Non-Home Purpose
<table>
<thead>
<tr>
<th>TAZ</th>
<th>HBWP</th>
<th>HBWA</th>
<th>HBOP</th>
<th>HBOA</th>
<th>NHBP</th>
<th>NHBA</th>
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<tr>
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<td>269*%</td>
<td>198</td>
<td>312*%</td>
<td>35*% or Replace</td>
<td>96</td>
</tr>
<tr>
<td>203</td>
<td>156</td>
<td>15*%</td>
<td>216</td>
<td>11*%</td>
<td>90*% or Replace</td>
<td>8</td>
</tr>
<tr>
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<td>11</td>
<td>698*%</td>
<td>15</td>
<td>780 *%</td>
<td>12*% or Replace</td>
<td>654</td>
</tr>
<tr>
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<td>753*% or Replace</td>
<td>22</td>
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<td>1638</td>
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<td>780</td>
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## Trip Production

<table>
<thead>
<tr>
<th>TAZ</th>
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<th>HBOA</th>
<th>NHBP</th>
<th>NHBA</th>
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<tr>
<td>202</td>
<td>58</td>
<td>328 (+59)</td>
<td>198</td>
<td>383 (+71)</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>203</td>
<td>156</td>
<td>18 (+3)</td>
<td>216</td>
<td>14 (+3)</td>
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<tr>
<td>204</td>
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<td>2014 (+376)</td>
<td>780</td>
<td>780</td>
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</table>
Trip Distribution
Trip Distribution

- Trip distribution joins the productions to the attractions
- Gravity model
  - Interaction between two TAZs
  - The relative size of the TAZ
  - Travel time on the network and friction factors measure the distance between TAZs
### Distribution Matrix

<table>
<thead>
<tr>
<th></th>
<th>76</th>
<th>77</th>
<th>78</th>
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<td>0.11</td>
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</table>
Mode Choice
Mode Choice

- What is Mode Choice?
  - Assigning Person Trips to mode of travel
  - What models have Mode Choice?
    - TMA Models
    - Logit Model
Mode Choice

- Example Different Modes used:
  - Drive Alone
  - 2 Person shared ride
  - 3+ Person shared ride
  - Transit
  - Non-motorized
Nested Logit

Person Trip Mode Choice

- Auto
  - Single Occupancy
  - Carpool
- Transit
- Non-motorized
  - Bus
  - Train
Auto Occupancy

- Auto Occupancy
  - Trip Distribution = Person Trips
  - Auto Occupancy factors are applied by trip purpose
    - Different Rates for Different Models
  - Person Trips $\rightarrow$ Vehicle Trips (HBW, HBO, NHB)
- Source Data:
  - NCHRP 365
  - MI Travel Counts
  - Area Specific Studies
# Auto Occupancy Rates

<table>
<thead>
<tr>
<th></th>
<th>NCHRP 365</th>
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<tbody>
<tr>
<td>HBW</td>
<td>1.11</td>
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<tr>
<td>HBO</td>
<td>1.67</td>
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<tr>
<td>NHB</td>
<td>1.66</td>
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## Auto Occupancy

### Home-Based Other Person Trips

<table>
<thead>
<tr>
<th>TAZ</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
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<td>4</td>
<td>33.9</td>
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<td>53.7</td>
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<td>444.5</td>
<td>84.3</td>
<td>22.4</td>
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</table>
# Auto Occupancy

Home-Based Other Person Trips to Vehicle Trips-1.67

<table>
<thead>
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<th>3</th>
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<th>5</th>
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<tbody>
<tr>
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<td>21.2/1.67</td>
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<td>89.4</td>
<td>12.5</td>
<td>146.8</td>
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<tr>
<td>2</td>
<td>22.2</td>
<td>12.6</td>
<td>864.5</td>
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</tr>
<tr>
<td>3</td>
<td>14.3</td>
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<tr>
<td>4</td>
<td>33.9</td>
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<td>64.3</td>
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</table>
## Auto Occupancy

### Home-Based Other Person Trips to Vehicle Trips

<table>
<thead>
<tr>
<th>TAZ</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P 21.2</td>
<td>P 53.9</td>
<td>P 89.4</td>
<td>P 12.5</td>
<td>P 146.8</td>
</tr>
<tr>
<td></td>
<td>V 12.7</td>
<td>V 32.3</td>
<td>V 53.5</td>
<td>V 7.5</td>
<td>V 87.9</td>
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<tr>
<td>2</td>
<td>P 22.2</td>
<td>P 12.6</td>
<td>P 864.5</td>
<td>P 55.9</td>
<td>P 43.9</td>
</tr>
<tr>
<td></td>
<td>V 13.3</td>
<td>V 7.5</td>
<td>V 517.7</td>
<td>V 33.5</td>
<td>V 26.3</td>
</tr>
<tr>
<td>3</td>
<td>P 14.3</td>
<td>P 89.9</td>
<td>P 10.3</td>
<td>P 75.4</td>
<td>P 156.8</td>
</tr>
<tr>
<td></td>
<td>V 8.6</td>
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<td>4</td>
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<td>P 222.9</td>
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<td>P 19.8</td>
<td>P 118.5</td>
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<td>P 64.3</td>
<td>P 444.5</td>
<td>P 84.3</td>
<td>P 22.4</td>
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<td>V 38.5</td>
<td>V 266.2</td>
<td>V 50.5</td>
<td>V 13.4</td>
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</tbody>
</table>
PA to OD Conversion

Home-Based Other Person Trips to Vehicle Trips

- Trips are distributed as Productions and Attractions
- Need to transpose to Origins & Destinations
  - Home-Based Trips
PA to OD Conversion

- Production
- Home
- Destination
- Attraction
- Work
- Origin
Assignment
Delay function - BPR Curve

- An equation that tells the model how to adjust the speed of a link depending on the V/C ratio
  \[ C_{\text{time}} = F_{\text{time}}(1 + a(v/c)^b) \]
- Can be adjusted globally and/or on an individual link basis
BPR curve

**TRAVEL SPEEDS**

<table>
<thead>
<tr>
<th>Facility</th>
<th>α</th>
<th>β</th>
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</thead>
<tbody>
<tr>
<td>70 mph</td>
<td>0.88</td>
<td>9.8</td>
</tr>
<tr>
<td>Freeways</td>
<td>0.83</td>
<td>5.5</td>
</tr>
<tr>
<td>60 mph</td>
<td>0.56</td>
<td>3.6</td>
</tr>
<tr>
<td>50 mph</td>
<td>1.00</td>
<td>5.4</td>
</tr>
<tr>
<td>Multilane</td>
<td>0.83</td>
<td>2.7</td>
</tr>
<tr>
<td>60 mph</td>
<td>0.71</td>
<td>2.1</td>
</tr>
<tr>
<td>50 mph</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BPR FUNCTION**

![Graph showing travel speeds and BPR function values](image-url)
Traffic Assignment

- **Inputs:**
  - Final Total O&D Matrix of Vehicle Trips
- **Road Network**
  - Travel Time
  - 1-Way Capacity
  - Optional specific Alpha and Beta values
  - Turn prohibition/penalty file
Traffic Assignment

- **Methods**
  - **All or Nothing** – assigns all trips to shortest path (capacity is not a factor)
    - Statewide Model uses All or Nothing
  - **User Equilibrium**
    - Assigns all trips to shortest path until traffic volumes become congested then assigns the remainder to the new shortest path
    - Goes through a series of iterations until it reaches a level of convergence
Time of Day
Time of Day

- Assignment volumes available for 24-hour daily time period
- Some models have assignments by Peak Period
  - Peak Period assignment volumes added to get 24-hour daily
Time of Day

- Models with Peak Period assignment
  - Holland
  - Lansing
  - SEMCOG
  - Flint
  - Ann Arbor
Time of Day

- **Peak Periods**
  - AM Peak - 7am-9am, 6am-9am (Flint)
  - PM Peak - 3pm-6pm
  - Off Peak - all other hours (Lansing, Holland)
  - Mid-Day – 9am-3pm (SEMCOG, AA, Flint)
  - Evening-7pm-6am (SEMCOG, AA)
  - Evening-6pm-6am (Flint)
Calibration & Validation
Calibration

- Calibration
  - Adjustments made to achieve desired results
- Validation
  - How well the results match the criteria at each step
Calibration

- Adjustments at each step
  - Trip Generation
    - Adjust Trip rate tables
    - Use Area Types
    - Use different variables
      - Workers
      - Averages or Categories
    - Adjust Attraction Equations
Calibration

- Adjustments at each step
  - Trip Distribution
    - Adjust Friction Factors
    - Adjust method of applying friction factors
  - Assignment
    - Adjust the BPR Curve
Calibration

- Adjustments at each step
  - Vehicle Trips
    - Auto Occupancy rates
  - Network paths
    - Turn penalties
    - Speeds
Network Paths

- Reasonable Paths
  - Use Shortest Path tools
    - Shortest Path
    - K Shortest Path

- Why
  - Connectivity
  - Travel Times
  - Illogical travel patterns
Network Paths
Traffic Counts

- Traffic counts for base year
  - Modified raw counts
    - Seasonal Variation
  - Average annual daily traffic (AADT)
    - Trunkline & local roads
- Counts
  - +/− 2 years from Base Year.
Traffic Counts

Where counts come from

- MDOT
- Local Road Commissions
- Planning Agencies
MDOT Assignment Validation Standards

- Area wide VMT: +/- 5%
- Area Type +/- 10%
- CBD, Urban, Suburban, Fringe, Rural
- Screenline: +/- 5%
- Cutline: +/- 10%
## LINK TYPE Validation Standards

<table>
<thead>
<tr>
<th>LINK TYPE</th>
<th>MDOT Standards</th>
<th>FHWA Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>+/- 6%</td>
<td>+/- 7%</td>
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<tr>
<td>Ramps</td>
<td>NO STANDARD</td>
<td>NO STANDARD</td>
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<tr>
<td>Trunkline</td>
<td>+/- 6%</td>
<td>NO STANDARD</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>+/- 7%</td>
<td>+/- 10%</td>
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<tr>
<td>Minor Arterial</td>
<td>+/- 10%</td>
<td>+/- 20%</td>
</tr>
<tr>
<td>Collector</td>
<td>+/- 20%</td>
<td>+/- 25%</td>
</tr>
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</table>
**VOLUME GROUP Validation Standards**

- Individual link targets (percent deviation of assignment/count volumes on a link-by-link basis)

<table>
<thead>
<tr>
<th>Volume Group</th>
<th>MDOT Standards</th>
<th>FHWA Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 50,000</td>
<td>+/- 10%</td>
<td>+/- 21%</td>
</tr>
<tr>
<td>25,000 – 50,000</td>
<td>+/- 15%</td>
<td>+/- 22%</td>
</tr>
<tr>
<td>10,000 to 25,000</td>
<td>+/- 20%</td>
<td>+/- 25%</td>
</tr>
<tr>
<td>5,000 to 10,000</td>
<td>+/- 25%</td>
<td>+/- 29%</td>
</tr>
<tr>
<td>2,500 – 5,000</td>
<td>+/- 50%</td>
<td>+/- 36%</td>
</tr>
<tr>
<td>1,000 – 2,500</td>
<td>+/- 100%</td>
<td>+/- 47%</td>
</tr>
<tr>
<td>&lt; 1,000</td>
<td>+/- 200%</td>
<td>+/- 60%</td>
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</tbody>
</table>
Validation

- Only calculate validation criteria using links with counts
- Percent of links validated to volume group
  - Should be above 80%
Model Differences
Model Differences

- Years Available
  - Different Base Years
  - Different Horizon Years
  - Different Air Quality Years
    - Projects are group by these years
Model Years

- **1998 Base Year**
  - Kalamazoo (updating to 2008)

- **2000 Base Year**
  - Holland (updating to 2009)
  - GVMC (updating to 2009)
  - Traverse City

- **2002 Base Year**
  - Muskegon (updating to 2009)
  - Battle Creek

- **2004 Base Year**
  - Jackson
Model Years

- 2005 Base Year
  - Statewide
  - Lansing
  - Tri-City Regional Model
  - Flint
  - Ann Arbor
  - SEMCOG

- 2006 Base Year
  - Benton Harbor/St. Joseph
  - Niles
Model Years

- 2030 Horizon Year
  - Ann Arbor
  - SEMCOG
  - Kalamazoo
  - Battle Creek
- 2035 Horizon Year
  - All other models
Model Differences

- **Update Cycles**
  - LRP Cycle - 4 or 5 year cycle
    - Jackson & Tri-city on 5 Year
  - Interim Updates
  - Project plan updates

- **Project plan updates**
  - Any year that is not the base year
  - Whenever there is a capacity project amendment to the TIP or LRP
Model Differences

- **Who builds and holds model**
  - MDOT
    - Tri-City Model: Kalamazoo, Jackson
    - Holland: Niles, Benton Harbor/St. Joseph
    - Battle Creek: Statewide, Muskegon
    - Traverse City
  - TMAs have their own models, MDOT holds copy
    - Grand Rapids, Lansing, Ann Arbor
    - Flint, SEMCOG
Model Differences

- Peak Period Capabilities
- Transit Models
  - Lansing - integrated
  - Flint - integrated
  - SEMCOG - integrated
  - Grand Rapids - stand alone
- Capacity Differences
Model Differences

- Model Design
- Data Sources
- Changes made during Calibration
Statewide Model
Network Comparison

Statewide Model

Tri-County Model
Zones and Loadings Comparison

Statewide Model

Tri-Statewide Model

Tri-County Model
## Trip Purposes

<table>
<thead>
<tr>
<th>Urban Models:</th>
<th>Statewide Model:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Based Work</td>
<td>Home Based Work/Business</td>
</tr>
<tr>
<td>Home Based Other</td>
<td>Home Based Social Recreation</td>
</tr>
<tr>
<td>Non-Home Based</td>
<td>Home Based Other</td>
</tr>
<tr>
<td>Non-Home Based</td>
<td>Non-Home Based Work/Business</td>
</tr>
<tr>
<td></td>
<td>Non-Home Based Other</td>
</tr>
</tbody>
</table>
## Data Requirements

### Urban Models:
- Households (avg or by cat)
- Autos per Household
- Income per Household
- Total Employment
- Retail Employment
- Service Employment
- Other Employment

### Statewide Model:
- Households by Size (1-5+ persons)
- Households by Income (low, medium, high)
- Manufacturing Employment
- Other Basic (farming, fishing, mining)
- Retail
- Wholesale
- Service
- Other (insurance, real estate, finance)
Statewide Model:
All-Or-Nothing Traffic Assignment

All the traffic traveling between two zones uses the shortest path between the zones.
Traffic traveling between two zones uses the shortest path until congestion causes the speed to drop, at which time it diverts to another faster path.
Why not use an Equilibrium Assignment with the Statewide Model?

- The Statewide Model is mainly concerned with rural areas and freeway corridors in which congestion is not as much of a problem as in urban areas.

- The Statewide Model network is sparse and does not offer many opportunities for traffic to divert in the event of congestion.
When should the Statewide Model be used?

- When the analysis area is outside the urban model areas
- When a project may have significant impacts beyond the boundaries of an urban model
- When comparing two or more areas that would fall in different urban models
- SUTA staff can recommend which model should be used for a given analysis
What are we doing to improve the models?

- Models are currently being developed from the MI Travel Counts survey data.
- Socioeconomic data has recently been updated with the latest REMI forecasts.
- A statewide truck model for commercial traffic is under development.
Assumptions
Assumptions

- Everyone has perfect knowledge of the network
- Everyone wants to minimize travel time
- Everyone wants to go to the closest destination
Assumptions

- Not Considered
  - Traffic Signals
  - Access Management
  - Geometrics
  - Human Behavior/Preferences
Model Outputs & Applications
Model Outputs

- Travel demand models were designed for system wide analysis
- Patterns and Changes not necessarily specific numbers
Model Outputs

- Volumes
  - Total Volumes
  - Volume Changes
  - Growth Factors
- Congested Speeds
  - Urban only
- Vehicle Miles Traveled
- Vehicle Hours Traveled
Model Outputs

- Volume to Capacity Ratios
  - Post processing for Statewide
- Statewide model can post process for commercial traffic utilizing the percent commercial from Sufficiency
Types of Analysis

- Alternative Testing
  - Project Selection

- Detour Analysis
  - Assignment differences based on temporary change in network
  - Distribution remains the same

- Permanent Network Change
  - Assignment differences based on permanent change in network
  - Distribution Changes
Types of Analysis

- Project Analysis
  - Expand/Decrease Capacity
  - New Roads
  - One-Way Changes
  - Speed Changes
  - Changes in Connectivity

- Select Link Analysis
  - All the trips that pass thru that link
  - Flows to and from a specific link
Types of Analysis

- Major Land Use Changes
  - New Mall
  - Major Housing Development
- Sub-Area Analysis
  - Corridors
  - Small Communities/Areas
Questions about Travel Demand Models?
Discussion

Where do we go from here

- Presentation from Project Planning
- Cross divisional team
  - Review of NCHRP Report 255
    - Highway Traffic Data for Urbanized Area Project Planning and Design
  - Review methods of other DOTS
  - Set standards for requests and levels of analysis
Thank you for participating!