Enhanced Travel Modeling Tools at ODOT

Presented to the Ohio Transportation Engineering Conference

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Overview

ODOT Modeling & Forecasting has enhanced a number of our travel modeling tools and methods:

• Statewide Travel Model
• Focus Model
• Stand Alone Freight Model
• User Benefits Tool
• Economic Impact Model
• Network Calculators (HCM 2010)
• MPO Model Support Contract
• Standardized Medium/Small MPO Model
• Standardized Large MPO Model
Statewide Travel Model

Model covers all of Ohio and Surrounding Areas
Statewide Travel Model

- In its current form has been operational about 8 years (V1 Model was operational in 2003)
- Recent updates to 2010 conditions
- Perhaps more importantly: model has been enhanced to make it more portable so while previously it had to be run at ODOT, it is possible* for consultant’s to obtain for use on projects (contact me)

*Note this says possible, not easy, an advanced travel demand modeler, decent sized computer and physical transfer medium are necessary
Focus Model

- In its native form, spatial resolution in statewide model isn’t suitable for most project level analysis.
Focus Model

- Model has about 5000 zones, need closer to 20,000 zones to have the correct balance to achieve reasonable loadings on arterial system (similar to MPO model TAZ density) but run times would be prohibitive.

MPO vs Statewide zones
Focus Model

• Focus model is a stand alone tool that uses fixed trip tables from statewide model runs and more detailed network and zonal data files to automatically enhance model resolution in a focus area.

• ODOT maintains the model data at the more detailed level to support this tool.
Focus Model

- Usually requires some additional clean up after applying the tool

- This can* be obtained from us for use on projects as well

*Note once again you would need an advanced travel demand modeler, decent sized computer and physical transfer medium
Stand Alone Freight Model

• One of the statewide model’s strengths versus MPO models is its ability to analyze freight

• It was completely overhauled to:

1. Be based upon FHWA’s FAF
2. Have additional sensitivities
3. Be entirely in Cube (previously was purpose built Java code)
4. Stand alone version (minus passenger transport models) created for enhanced portability
Stand Alone Freight Model

- Now based on FAF (Freight Analysis Framework)
- Consistency with Federal/Other state freight efforts
- Easier to update

Model Converts from FAF to Statewide Geography First

SW Model 3600+ TAZ in Ohio, 1500 Outside Ohio
Stand Alone Freight Model

• Additional Sensitivities
  • Separated intermodal rail services into competing networks by carrier (CSX vs NS)
  • Add sensitivity to Intermodal capacity
  • Maintain foreign freight flows throughout
  • Assign intermodal drayage truck trips to net
  • Better empty truck modeling
Stand Alone Freight Model

- All in Cube and Stand Alone Version

- Only need Cube software/knowledge

- All inputs in CSV/DBF/Cube

- Stand alone model only 1 GB (zipped), 50 GB after running

- Requires static passenger trip tables from full statewide run

- 9 hour run time on large server, 21 hours on lap top

<table>
<thead>
<tr>
<th>Computer Name</th>
<th># Processors</th>
<th>RAM</th>
<th>Run Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOTMODEL01</td>
<td>24</td>
<td>48 GB</td>
<td>8 hours, 50 mins</td>
</tr>
<tr>
<td>ASHISH_DESKTOP</td>
<td>24</td>
<td>64 GB</td>
<td>9 hours, 25 mins</td>
</tr>
<tr>
<td>LOGAN_SERVER</td>
<td>24</td>
<td>48 GB</td>
<td>11 hours, 7 mins</td>
</tr>
<tr>
<td>ASHISH_LAPTOP</td>
<td>8</td>
<td>16 GB</td>
<td>21 hours, 36 mins</td>
</tr>
</tbody>
</table>
Stand Alone Freight Model

- Has been used in various studies
Stand Alone Freight Model

- We’ll take a little show and tell break here
Stand Alone Freight Model
• Still More Show and Tell

Daily Shale Gas Trucks by Origin Zone
Connecting to Proposed Rail Intermodal

Truck Flows to Port without Rail Intermodal

Become Truck Flows to Rail Intermodal
Stand Alone Freight Model
• And Finally...
User Benefits Tool

- Monetizing Costs of Travel Time, Vehicle Operating Costs, Crashes and Tolls

- Updated Tools in Attempt to Make the Cost Accounting More Consistent with Costs Used in the Travel Demand Model (only partly successful due to difference in real economic costs and “perceived” costs that drive actual human behavior)

- Same Tool Used for MPO and Statewide Models, Consistent Formats
User Benefits Tool

• Outputs can be Compared to Costs for Benefit Cost Analysis

<table>
<thead>
<tr>
<th></th>
<th>Project 6</th>
<th>cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Time</td>
<td>17,808,470</td>
<td>4473000</td>
</tr>
<tr>
<td>Crashes</td>
<td>2,796,113</td>
<td></td>
</tr>
<tr>
<td>Veh Op Cost</td>
<td>4,123,513</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24,728,101</td>
<td>6373000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Project 9</th>
<th>cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Time</td>
<td>17,400,000</td>
<td>2500000</td>
</tr>
<tr>
<td>Total</td>
<td>24,728,101</td>
<td>6373000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Benefits in 2003 Dollars</td>
<td>3.54626</td>
</tr>
</tbody>
</table>

• Can also be Fed into Economic Impact Model to Derived Indirect and Induced Impacts
Economic Impact Model

- EIMs uses Economic Models to Compute Anticipated Economic Impacts Caused by Direct Benefits (Jobs, Additional Output Etc.)
- Have Implemented an Interface Between the Statewide Model and TREDIS EIM
Economic Impact Model

• Also have a Simpler Spreadsheet Version called QEIM “Quick”

• And we Have a License to Access Tredis On-line Directly if Needed
Network Calculators

- Travel Demand Models Traditionally Need Capacity and Free Flow Speeds as Primary Network Inputs
- ODOT Has Maintained Software that Implements HCM Methods for Over 20 Years
- Recently Updated to HCM 2010
Network Calculators

Software Also Generates Detailed Intersection Defaults for Employing Dynamic Intersection Delay Models in the Travel Demand Models Rather Than Using Tradition Volume Delay Functions
Network Calculators

Additional Enhancements Implemented:

• Expanded Stop Sign Look Up Tables
• Roundabout’s Added

Typical Roundabout Approach Capacities

Typical 4 Way Stop Approach Capacities
Network Calculators

Additional Enhancements Implemented:

• Uninterrupted/interrupted flow break point and interchange density factors now calculated from network geometry instead of AREATYPE
• Freeway Weaving Capacity Reduction Factors

Illustration of Capacity Reduction in Weave Area
Network Calculators

Additional Enhancements Implemented:

• Explicit IXTYPE Codes for Dummy Node Approaches
• Speeds Changed for Midblock Conflicts to Enhance MEDTURN Impacts
• Addition of New Signal Phasing Options in IXTYPE
• Support for Time of Day Specific Over-rides for SPDMOD, LANES, PARKING, TurnPro
• Use of Explicit Truck PCE instead of Generic TERRAIN coding

Illustration of Capacity/Speed Changes By Time of Day
MPO Model Support Contract

- ODOT will Maintain an On-Call Consultant to do Model Work for MPO’s in the Future Rather Than Support with Staff

- Funded 50/50 with MPO’s Using it

- Some MPO’s Staff this Function Themselves

- Can Also Choose to Hire Their Own Consultants
Standardized Medium/Small MPO Model

- “OMS” Model was deployed 10 years ago for small/medium MPO areas
- Standardized model and inputs/outputs
- Updated recently
Standardized Medium/Small MPO Model

- 4 Step Model is 100% Cube and very portable/easy for others to get for studies and projects

- Recent updates included:
  - Addition of global feedback
  - Time of Day Over-rides
  - Enhanced School Trip Models
  - New Auto Ownership Model
Standardized Large MPO Model

• 3C Model
  – Columbus/Newark
  – Cincinnati/Dayton
  – Cleveland

  • Also includes the Akron area for better traffic assignment
    – Reduces external trips, especially along IR 271
Approach to the Project

• One ABM design:
  – Combination of best features of recently developed ABMs (State of the Practice)

• One generic software:
  – The same core Java code
  – Network procedures and data / scenario managements in Cube
  – Different cities might have different sets of parameters in control files and subsets of procedures enabled or disabled
  – Further updates, modifications, or bug fixes affect all 3 models
Output Files

- Full information on all tours and trips for all households & persons (like an entire-population Household Travel Survey)
- Can be aggregated in many ways to produce conventional statistics:
  - Trip tables by purpose, time-of-day, and mode
  - Trip length distribution, &c.
- Can be use for more elaborate analysis:
  - Equity across household income groups, compositions, ethnicity, &c., in conjunction with the household file
New Features

• Extended set of usual work arrangements
• Extended set of individual mobility attributes
• More detailed Coordinated Daily Activity Pattern (CDAP) including work from home, business trip chains, telecommuting, etc
• Explicit modeling of escorting children to school
• Improved temporal resolution (continuous) for trip-departure time choice (integration with DTA)
• Activity generation & tour formation instead of tour generation & stop insertion
• Individual participation in special events
• University sub-model
Enhanced Spatial Resolution

• MAZs nested in TAZs:
  – CT-RAMP handles all location choices at MAZ level
  – Assignment & skimming cannot handle MAZ-to-MAZ matrices, so they use TAZz
  – MAZs are based on Census Blocks
MORPC Highway Network
MORPC TAZ System
1-2107
MORPC MAZ System
20001-39418
Standard 3C Model

- Implemented in Cube with Java steps
- Requires a good amount of RAM
- ODOT/MPOs have high powered computers
SHRP2 C10

• This is a research project that is funded through TRB’s SHRP by FHWA
• This is a move to Agent-Based Modeling
• Ohio’s implementation combines the new 3C model with DynusT DTA
  – Builds upon the improvements made to the ABM (e.g. MAZs, better integration of intra-HH travel)
  – Uses highway junction attributes (traffic control, intersection geometry)
Integration with 3C ABM

- Internal loop w/individual Schedule Adjustment Module (iSAM) and calculation of HH “stress measures”
- External loop w/mining individual trajectories LOS and gradual freezing of “non-stressed HHs”
Preliminary Conclusions for Use of Individual Trajectories instead of Skims

• Possible to completely avoid aggregation:
  – Find the best proxy even if it is very different
  – Trajectory coverage follows highly uneven demand
  – Frequent trips covered well with minimal relaxations
  – Infrequent trips not covered well but less important

• Possible to use aggregations and crude skims to fill up the gaps in trajectory coverage:
  – Extensive empirical ongoing testing
Indexing Schema and Search

• Node 1 (loading point 1):
  – Trajectory ID=1, nodePlacement=5
  – Trajectory ID=2, nodePlacement=3
  – ....

• Node 2 (loading point 2):
  – Trajectory ID=2, nodePlacement=8
  – Trajectory ID=3, nodePlacement=10
  – ....
## Levels of Aggregation for ADIT Search

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>1=Detailed</th>
<th>2=Mid</th>
<th>3=Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car occupancy</td>
<td>1,2,3+</td>
<td>1,2+</td>
<td>1+</td>
</tr>
<tr>
<td>VOT</td>
<td>$1, $2, … $100+</td>
<td>$5, $10, …, $100+</td>
<td>$0+</td>
</tr>
<tr>
<td>Departure time</td>
<td>5 Min</td>
<td>15 min</td>
<td>AM, PM, OP</td>
</tr>
<tr>
<td>OMAZ</td>
<td>MAZ</td>
<td>TAZ</td>
<td>District</td>
</tr>
<tr>
<td>DMAZ</td>
<td>MAZ</td>
<td>TAZ</td>
<td>District</td>
</tr>
</tbody>
</table>

Max aggregation across all dimensions ensures a full coverage.
# Current Aggregation Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Trip origMaz == Trip destMaz</td>
</tr>
<tr>
<td>1</td>
<td>Vehicles located with same origMAZ, destMAZ, and 5 minute departure interval as trip</td>
</tr>
<tr>
<td>2</td>
<td>Vehicles located with same origMAZ, destMAZ, and 15 minute departure interval as trip</td>
</tr>
<tr>
<td>3</td>
<td>Vehicles located with same origTAZ, destTAZ, and 15 minute departure interval as trip</td>
</tr>
<tr>
<td>4</td>
<td>Vehicles located with same origTAZ, destTAZ, and 60 minute departure interval as trip (benchmark similar to conventional skimming)</td>
</tr>
<tr>
<td>9</td>
<td>No vehicles found for aggregation levels 1-4</td>
</tr>
</tbody>
</table>
## Coverage

<table>
<thead>
<tr>
<th>Departure Period</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>9</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA before 6:00 am</td>
<td>6%</td>
<td>37%</td>
<td>11%</td>
<td>21%</td>
<td>11%</td>
<td>14%</td>
<td>100%</td>
</tr>
<tr>
<td>AM 6:00 am - 8:59 am</td>
<td>2%</td>
<td>53%</td>
<td>12%</td>
<td>20%</td>
<td>6%</td>
<td>6%</td>
<td>100%</td>
</tr>
<tr>
<td>MD 9:00 am - 3:59 pm</td>
<td>4%</td>
<td>48%</td>
<td>12%</td>
<td>21%</td>
<td>8%</td>
<td>7%</td>
<td>100%</td>
</tr>
<tr>
<td>PM 4:00 pm - 6:59 pm</td>
<td>1%</td>
<td>52%</td>
<td>13%</td>
<td>21%</td>
<td>7%</td>
<td>5%</td>
<td>100%</td>
</tr>
<tr>
<td>EV 7:00 pm and later</td>
<td>2%</td>
<td>35%</td>
<td>13%</td>
<td>26%</td>
<td>11%</td>
<td>13%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>4%</td>
<td>46%</td>
<td>12%</td>
<td>21%</td>
<td>8%</td>
<td>8%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Conclusions

• Full run of MORPC ABM – 4.8 million trips
• 84% of trips found representative trajectories better than conventional skims
• Further substantial improvement of coverage:
  – Gradual freezing of HHs, persons, and trips
  – Accumulation of trajectories from multiple global iterations
• What may reduce coverage stats:
  – Segmentation by VOT and Occupancy
• Two ways to resolve unmatched trips:
  – Use background crude skims (probably preferred)
  – Apply further aggregation (technically works but may produce unreasonable results)
  – Internal loop will resolve inconsistencies anyway
Contact Information

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