North Carolina Statewide Model

Recent and Upcoming Enhancements

Roberto Miquel, AICP
Vince Bernardin, Ph.D.

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Agenda

- Introductions
- Status of Study
- Short Term Enhancements
- Long Term Enhancements
- Q & A / Discussion
Introductions
Who We Are

- CDM Smith
  - Roberto Miquel, AICP
- RSG
  - Vince Bernardin, Ph.D.
Status of the Study
Tasks Completed

- Project Kick-Off
  - The project kick-off meeting was held March 1, 2017 at the NCDOT Highway Building
  - Representatives from the Transportation Planning Division and the SPOT Office were present

- Model Replication
  - Consultant team acquired NCSTM Gen 2.3
  - A number of projects from P4.0 were run to ensure that the model was being run correctly
Tasks Completed (cont.)

- Model Review
  - NCSTM Gen 2.3 was thoroughly reviewed for opportunities for short-term (during the P5.0 evaluation cycle) enhancements
  - Suitable enhancements were identified
  - Recommended enhancements were presented to NCDOT

- P5.0 Project Analysis Preparations
  - CDM Smith attended three P5.0 Workgroup meetings in the Spring of 2017
  - An updated E+C highway network was coded
  - Traffic growth rates were developed from the model and submitted to NCDOT Congestion Management
Tasks Completed (cont.)

- **Short Term Enhancements**
  - The enhancements identified during model review were approved by NCDOT and implemented into the model
  - This includes converting the model to TransCAD 7 Build 12375
  - Additional enhancements detailed later in this presentation
Tasks in Progress

- P5.0 Project Evaluations
  - P5.0 Carryover Projects have been run and are undergoing internal QA/QC
  - P5.0 submittals have been completed and are being assessed by the SPOT Office
Upcoming Tasks

- P5.0 Project Evaluations
  - Run and analyze submitted P5.0 projects

- Long Term Road Map
  - Assess model enhancement needs suitable for longer-term implementation
  - Develop a multi-year model improvement roadmap that will take the NCSTM through P6.0 and beyond
Short Term Enhancements
Streamline Macro Calls to Reduce Runtime

- Converting Skims from Matrix to CSV
  - Was running in every iteration for long distance
  - Will now run only in the first iteration
- Similarly converting the long distance trips from CSV to Matrix was also being repeated
  - Will now happen only in first iteration
- There were cases where only partial long distance files were being read from the CSV when converting to matrix form
  - This has now been corrected
- The long distance trucks macro now updates the messages on screen and waits for only the necessary amount of time to read outputs from external JAVA model
Robust JAVA – TransCAD Handshake

- Critical components of the NCSTM written in JAVA instead of GISDK

- JAVA would write out files and GISDK would begin scanning for this file periodically before advancing to the next model step

- On occasion, the JAVA output files would be written but incomplete when GISDK scanned for the files and found them
A more robust handshake protocol was introduced.

JAVA now writes out a “working file” while it is running and deletes it when complete; TransCAD waits to proceed while this file still exists.

This allows GISDK to continue only when certain that the JAVA components of the model have successfully completed.

Additional checks have been introduced to make sure JAVA outputs are converted in entirety from CSV to matrix form.
Traffic Assignment Algorithms

- Several changes were made to the traffic assignment procedure
  - Parallel processing of four time periods (two at a time) to save run time
  - Using tri-conjugate Frank-Wolfe algorithm
  - Using relative gap = $10^{-6}$ and 500 iterations to ensure the assignments converges
  - Using VOT based vehicles classes

- The long distance trucks and autos are always preloaded while the short distance trucks are assignment with remaining trips

- The GISDK scripts were edited to properly model toll roads and were tested on Triangle Expressway for validation
Traffic Assignment Algorithms

NCSTM v. 2.3 (5 x 10^{-4})

NCSTM v. 2.3 (1 x 10^{-6})
Destination Choice Enhancements

- Focus on runtime improvements (15min down to 3min)
- Validation of trip length frequency distribution
Toll Choice Modeling

- Three stated preference surveys were combined to estimate value-of-time distributions
- A mixed logit model was estimated and scaled using a multinomial logit model

### Average Peak Period VOT by Income and Distance

<table>
<thead>
<tr>
<th>Income Category Midpoint</th>
<th>Trip Distance (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>$12,500</td>
<td>$8.97</td>
</tr>
<tr>
<td>$37,500</td>
<td>$11.01</td>
</tr>
<tr>
<td>$62,500</td>
<td>$11.96</td>
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<tr>
<td>$125,000</td>
<td>$13.24</td>
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<tr>
<td>$175,000</td>
<td>$13.87</td>
</tr>
<tr>
<td>$250,000</td>
<td>$14.53</td>
</tr>
</tbody>
</table>
This VOT distributions estimated from the surveys were applied to the NCSTM and used to divide auto trips in to five market segments with the following average VOTs:

<table>
<thead>
<tr>
<th>PeakVOT</th>
<th>OffPeakVOT</th>
<th>Avg. Auto VOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.28</td>
<td>3.22</td>
<td>3.24</td>
</tr>
<tr>
<td>7.15</td>
<td>7.08</td>
<td>7.11</td>
</tr>
<tr>
<td>12.29</td>
<td>12.21</td>
<td>12.24</td>
</tr>
<tr>
<td>19.53</td>
<td>19.41</td>
<td>19.46</td>
</tr>
<tr>
<td>38.58</td>
<td>36.37</td>
<td>37.28</td>
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</table>
Toll Choice Modeling (cont.)

- Similarly, five market segments were developed for multi-unit trucks and three for single unit trucks.

<table>
<thead>
<tr>
<th>Single Unit Truck VOT</th>
<th>Multi Unit Truck VOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.52</td>
<td>12.57</td>
</tr>
<tr>
<td>38.79</td>
<td>31.12</td>
</tr>
<tr>
<td>56.75</td>
<td>49.54</td>
</tr>
<tr>
<td>-</td>
<td>67.95</td>
</tr>
<tr>
<td>-</td>
<td>88.34</td>
</tr>
</tbody>
</table>
The toll model was calibrated for volumes on the Triangle Expressway by adding a calibration constant to scale up the travel time savings of toll roads to account for travel time reliability, and other factors ignored in this version of the model.

The final adjustment was a 50% increase in the benefit of toll roads, which is reasonable and broadly consistent with the contribution of reliability in other toll models.
Re-Calibration

- NCSTM v. 2.3 was out of calibration, substantially different from documented v. 2.0 results
- Whole model was re-calibrated to 2011 base year (in addition to toll model calibration to Triangle Expressway in 2015)
- Adjustments to free-flow speeds changed (mostly reduced)
- Weight on length term in generalized cost adjusted
- Trip rates had to be adjusted by area type and region
- Destination choice had to be recalibrated to reproduce TLFDs
- Posted speeds, ramp coding, etc., corrected near Triangle
User Benefit Calculations

- NCSTM uses select link analysis on the project links to identify project benefits
- Original method uses select link volumes
  - Select link analysis is used to build a critical link matrix
  - The matrix shows origins-destinations of trips using the project
  - Select link volumes are compared against build vs. no-build travel time matrices to identify savings
- Select link volumes are not a unique solution
  - This could lead to potentially misleading results
User Benefits Calculations (cont.)

- New method still uses select links, but in a different way
  - Select link analysis is used to identify project origins-destinations
  - Actual select link volumes are disregarded
  - All trips are analyzed if they possess an origin and destination identical to those revealed by the select link analysis
  - Captures the direct and some indirect benefits of the project
  - Still restricts the set of beneficiaries to those who could reasonably benefit, less strictly than before, but still excluding some legitimate beneficiaries
  - Still avoids spurious benefits due to model noise
Usability Enhancements

- Converted project-level evaluation and post-processing out of R and into GISDK
- Manual interventions (updating files paths in scripts, changing properties tokens) have been either eliminated or transferred to TransCAD interfaces
- All project analysis conducted via a new interface in the NCSTM
Long Term Enhancements
Long Term Enhancements

- Implement method to better analyze potential freight diversion from non-NC ports to NC ports
- Accounting for inter-commuting phenomenon
- Use of HERE data. Other speed data?
- Reduce reliance on STI normalization
- Other needs?
Questions/Discussion
Contact Information:
Calibration – Trip Generation Adjustments

- Trip generation rates were adjusted by:
  - Region
  - Area type

<table>
<thead>
<tr>
<th>Region</th>
<th>Area Type</th>
<th>Adjustment</th>
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</thead>
<tbody>
<tr>
<td>Coastal</td>
<td>Urban</td>
<td>0.91</td>
</tr>
<tr>
<td>Piedmont</td>
<td>Suburban</td>
<td>1.16</td>
</tr>
<tr>
<td>Piedmont</td>
<td>Rural</td>
<td>1.59</td>
</tr>
<tr>
<td>Mountain</td>
<td>Urban</td>
<td>0.88</td>
</tr>
<tr>
<td>Mountain</td>
<td>Rural</td>
<td>1.15</td>
</tr>
</tbody>
</table>
Calibration Steps – Adjustments to FF Speed

- The table used to adjust free flow speed was also edited by region and area type:

<table>
<thead>
<tr>
<th>AreaType</th>
<th>CTP_CD</th>
<th>Old</th>
<th>New</th>
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<tbody>
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<td>3</td>
<td>4</td>
</tr>
<tr>
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<td>2</td>
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<tr>
<td>1</td>
<td>3</td>
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<tr>
<td>1</td>
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<tr>
<td>3</td>
<td>7</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>
Calibration Steps – Other Adjustments

- During calibration, in addition to changes listed above, some additional things were adjusted and are listed below.
  - Several missing ramps were coded in the master network for Triangle Expressway;
  - The posted speeds on Triangle Expressway and parallel roadways were adjusted to match the correct information from Google street view;
  - The centroid connector near Triangle Expressway were adjusted in length to calibrate the volumes on the toll roadway;
  - During network setup, the length penalty for calculating Fixed Toll (impedance) was reduced by 20%.