Applying Micro-simulation tools for Project Development-Documentation & QA/QC

University of Florida
Traffic Seminar
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RS&H
Overview

- Principles
- Types of Projects
- Correctly Scoping the Model
  - Spatial limits
  - Temporal limits
  - Budgeting the work
- Maintaining Credibility in the Process
  - Verifiable and reproducible
  - Documentation
- QA/QC
- 95 Express-Case Study
Traffic Engineering Principles

- Knowledge of Traffic Flow Theories
- Knowledge of the Right Tool for the Right Job
- Verifiable & Reproducible
- Strategic Use of Automation
- “Pass the Dish” - Share your Ideas
- Redundancy
Jaimie’s Nuggets of Wisdom

• “If you don’t have the time to do it right the first time, when are you going to have the time to do it over again?”

• Begin with the End in Mind

• Verifiable and Reproducible

• “Don’t do as I do, do as I say”
Definition of Quality

• **Quality** is never an accident, it is always the result of:
  – High Intentions
  – Sincere Effort
  – Intelligent Direction
  – Skillful Execution
The Problem

- Spending in Highway construction is declining
- Ability to expand Highways is limited for environmental and right-of-way constraints
- Vehicle Miles of Travel is growing
Practitioner Point of View: Types of Projects

- **Intersection studies**
  - Adding capacity
  - Changing intersection Control
  - Adding new intersections

- **Systems and Service Interchange Studies**
  - Modifying existing Interchange Type
  - Adding new Interchanges

- **Freeway Corridor Studies**
  - Multiple Interchanges
  - Capacity Expansion
  - HOT lane Facilities
Why Micro-simulation?

- HCM techniques do not directly address interaction between facilities
- Simulation models provide other meaningful performance measurements
  - Travel time
  - VHT/VMT
- Animation is a Valuable Communication Tool
Traffic Analysis Tools

- Microscopic Simulation Tools
  - Synchro
  - Transyt 7f

- Increased Generalized Tables
- Highway Capacity Manual

Increasing Effort & DATA

Increased Accuracy
Microsimulation 7-step Process

- 7-step process developed by FHWA Traffic Analysis Tools Team
- Based on best practices of modeling efforts from around the country
- Foundation of the FDOT CORSIM Handbook
Correctly Scoping the Model

- **Model Limits-Spatial**
  - Small Projects
  - Large Projects
  - Congested Urban Areas

- **Model Limits-Temporal**
  - Peak 15 minutes
  - Peak periods
Boundary Limits: Small Projects

Vehicles dispersed based on entering headway into model:
Valid assumption if there is no intersection within 1-mile

Boundary Intersection

Vehicles platooned based on upstream intersection in model
Boundary Limits: Congested Urban Freeway Projects

Boundary Condition

Subject Interchange
Model Limits: Temporal

I-95 Northbound Mainline Speed

15 min data

Peak Hour
Credibility

- **Verifiable & Reproducible**
  - Documentation, Documentation Documentation

- **Data Driven**
  - Were Traffic Counts, speed studies and observations collected at the same time?

- **Timeliness**
  - Will it take a year to complete a modeling project?

- **Cost Effective**
  - Will the budget to do a model be “reasonable”
Which Model is Correct?
They Both Are

Too often, a screen capture of the animation is all the evidence provided for displaying the model results

Model of 95 Express, Miami, Fl
Animation vs. MOE’s

- Animation is a tool that can be deceptive
- MOE’s should be output driven
How Do We Use Microsimulation Tools?
Base Model Development

- Systematic Method
- Documentation requirements
- Organization Criteria
  - Link node numbering conventions
Calibration

• **Objective of Calibration**
  – To achieve adequate reliability or validity of model by establishing suitable parameter values that replicated local traffic conditions.

• **Calibration Approach**
  – It is a two-step process
    • change the model parameters, run the model and check statistics. If statistics are acceptable, the model is calibrated.
    • If not, modify the model until the statistics are acceptable
  – The approach consists of three steps
    • Modifying known global parameters
    • Modifying local or link length parameters
    • Global changes - unknowns
**Model Run 1: Base**

- Default Car Following Factors
- Estimated Free Flow Speeds
### Model Run 12

- Car Following Factors modified
- Free Flow Speeds modified

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<tr>
<th>Link Description</th>
<th>Link Geometrics</th>
<th>Car Following Factor</th>
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<tr>
<td>From</td>
<td>To</td>
<td>Node From</td>
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<td>TH 55 On Ramp</td>
<td>WB I-94/64 On Ramp</td>
<td>310</td>
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<td>177</td>
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### Graphs

- Actual (detected) Speed
- Simulated Speed
Carrying forward Calibration Parameters to Future Designs

SR 826 Southbound Existing

SR 826 Southbound Build Scenario

Overall capacity increase (ML+SUL) for the entire corridor

Reducing capacity on ML, but overall capacity (ML+LUL) increase

Increasing capacity on ML, and overall capacity (ML+LUL) increase

Exit moved

New Exit

Entry From SR 110th St

Entry From SR 110th St

Entry To SR 110th St

Entry To SR 110th St

Entry From SR 110th St

Entry From SR 110th St

Exit To WSDOT Pkwy

Exit To WSDOT Pkwy

Exit To WSDOT Pkwy

Exit To WSDOT Pkwy

Exit To WSDOT Pkwy

Exit To WSDOT Pkwy

Entry From SR 110th St

Entry From SR 110th St
Error Checking – Model Review Overview

• Two Parts
  – Modeler Requirements
  – CDOT Reviewer
ISO 9001

• What is ISO 9001?
• ISO 9001:2008 is part of the ISO 9000 family of standards, and is the document that lists the requirements an organization must comply with to become ISO 9001 Registered. ISO 9001 is an internationally recognized Quality Management System.

• ISO 9001:2008 is focused on meeting customer expectations and delivering customer satisfaction so you must pay attention to the customer.
• ISO9001 evaluates whether your quality management system is appropriate and effective, while forcing you to identify and implement improvements.
• Continuous improvement assures your customers benefit by receiving products/services that meet their requirement, and that you deliver consistent performance.
• Internally, the organization will profit from increased job satisfaction, improved morale, and improved operational results (reduced scrap and increased efficiency).
• Meeting legal and regulatory requirements benefit the community.
Error Checking - Modeler Requirements

• **What is the Requirement of Modeler**
  – Independent review of models should be conducted prior to submittal to CDOT

• **Error checking involves various reviews of the coded network, coded demands, and default parameters**

• **The analyst should document the errors and the approach and techniques used for resolving them**
Error Checking - Modeler Requirements

• Error checking proceeds in three basic stages:
  – Reviewing software errors
  – Reviewing input data
  – Reviewing animation

• Modeler Required to document inputs for CDOT Review
Error Checking - Modeler Requirements

- Reviewing Software Errors
  - Should use the latest version and “patch” of CORSIM
  - Check the McTrans website for known problems, issues, and updates of TSIS/CORSIM

(http://www-mctrans.ce.ufl.edu/)
Error Checking/QA-QC/Model Review

- Reviewing Input Data
  - Take help from another analyst to detect data coding errors
  - Data entry errors, eg. entering turn percentage 63% instead of 36% will have a huge impact on the outcome
  - Changing the default values to represent actual travel conditions, eg. Different posted speed values will have impact on level of service
Error Checking - Modeler Requirements

• Reviewing “Freeway” Input Data
  – Node locations and link lengths
  – Accel/Decell lane lengths
  – Number of lanes and lane alignment
  – Lane drops/lane adds
  – Ramp meter locations
  – Ramp meter timings
  – Free flow speeds
  – Curvature
  – Grades
Error Checking - Modeler
Requirements

- **Reviewing “Arterial” Input Data**
  - Link distances, Stop bar to Stop bar
  - Lane utilization
  - Storage lane lengths
  - Free flow speeds
  - Signal timings

- **Reviewing “Traffic volume” Input Data**
  - Prepare volume database in spreadsheets for easy review
Error Checking/QA-QC/Model Review

• Reviewing Animation
  – Run the animation at extremely low demand
    • Trace unexpected slow down of vehicles
    • Uncharacteristic vehicle behavior such as unexpected braking
  – Run the animation 50% of the existing demand level
    • Check for congestion, if occurs then it indicates coding error
    • Check entry/exit links flows through the network
Error Checking - Modeler Requirements

- Documentation
  - QA/QC Sheets (display of geometry inputs)
  - Diagrams and schematics
  - Confirmation (QA) that Quality Control was conducted
Model Review - CDOT

- Objectives?
- Goals
  - Ultimately our goal is to correctly analyze and evaluate projects that can move forward in the planning, design, implementation, and operations phase.
- Discussion
Model Review – CDOT

- Expect that models are turned in with accompanying documentation
- Be systematic with Review Process
  - Standardized checklists
  - Reject inadequate model submittals (Don’t waste your time!)
  - Formally Accept and acknowledge good modeling efforts
- Look for Common Mistakes
Model Reviewer Checklist

- Create a TSIS project folder on local hard drive, copy *.trf (CORSIM input files) into TSIS projects folder
- Run a single *.trf file with animation activated.
  - If Fatal Errors are observed and the *.trf file does not run, contact the submitter and stop all reviews until a working file with the correct documentation is re-submitted.
  - If the model runs go to next step
- Review warning messages that are posted in the dialogue box, these will be green text. Warning Messages that require attention and corrective action include the following
  - Warning messages associated with warning signs being located beyond the start of the freeway
  - The model must reach equilibrium
  - Warning messages that indicate vehicles are altering their intended path, e.g. they miss their destination
  - Warning messages indicating no agreement between the calculated link length and the input link length
- Review Global Parameters in *.trf file. If these parameters are adjusted then look for corresponding documentation as to why those parameters were modified.
Model Reviewer Checklist

☐ Conduct Cursory Review of Animation
   ☐ Compare model documentation of Geometry against the animation
   ☐ Review desired traffic volume inputs against model animation display of inputs
   ☐ Review signal timings in model against documentation
   ☐ Observe Animation, look for expected congestion, look for unexpected congestion
   ☐ If gross error's are observed stop all reviews, provide information to submitter and continue with the review after the model and documentation is re-submitted.
   ☐ If there are no Gross Error's continue review

☐ Thorough Review of model inputs
   ☐ Compare lane schematic and link-node information against QA/QC forms
   ☐ Compare Volume Databases against model inputs
   ☐ If there are error's in coding stop all reviews, provide information to submitter and continue with the review after the model and documentation is re-submitted.
   ☐ If there no errors continue review.
Model Reviewer Checklist

☐ Review model outputs
  ☐ Review the summaries of model outputs provided.
  ☐ Compare results to field observations (if the model is the calibrated model). Do the results make sense?
  ☐ Locations where the results are suspect examine the animation closer
  ☐ If there are model coding issues and/or issues with the performance of the model, inform the submitter of the issues and discuss a course of action. When the issues are resolved move to the next step.

☐ Model Approval
Model Reviewer – Most Common Issues

1. Traffic Volume Inputs incorrect
2. Geometry Incorrect
3. Traffic Data Incorrect. Look at RT 50’s
4. Signal Timings incorrect or less than optimal
5. Traffic Patterns (volumes) do not seem right, look at O-D or conditional turning %’s
6. No congestion? Check volume inputs
7. No congestion after checking volumes, review model limits
Verifying Geometry

Blue dots are the model nodes. They do not match real world coordinates. Background image in TRAFED was off by 20%!
Model Reviewer – Exercise

- Open up *.TRF files
- Run models
- Look at documentation
95 Express
95 Express Spatial Limits

Terminal Access Segment (1/2 Mile)

Managed Lane System (10 Miles)

Intermediate Access Segment (1/2 Mile)

Terminal Access Segment (1/2 Mile)
Temporal Limits:
Northbound Peak Periods

I-95 - NORTHBOUND DIRECTION

Flow Rate (vph)

Time of Day

AM PEAK PERIOD

PM PEAK PERIOD

HOURLY TRAFFIC VOLUME VERSUS TIME OF DAY

FIGURE
Calibration

- Iterative Process
- Calibration Targets
  - Less then 5% error in volumes
  - Approximate the speed profile
  - Replicate congestion
- Primary adjustments
  - Car Following Factors link level
  - Warning Signs

Process Within Each Calibration Step

- Field MOE's
- Model MOE's
- Acceptable Match?
- No
  - Adjust Model Parameters
- Yes
  - Go to Next Calibration Step

Am All Calibration Targets Met?

Yes

Model is Calibrated

No
Speed Calibration

I-95 Northbound Speeds
PM Peak

Miles (CORSIM Model)
Existing Base Model Operations: PM Peak Northbound
Access Justification

• Critical Design Features
  – Existing freeway congestion
  – Ingress/egress design
  – Proximity of service interchanges

• Traffic Analysis Results
  – NB HOT intermediate access at NW 81st Street
Traffic Analysis Results

81st Street Intermediate Access
Proximity to Local Access

- **Interchange Spacing**
  - 10 interchanges/8 miles = 1 ¼ mile
  - 81st on-ramp to HOT access 1,350 feet
  - Weaving lane length 770 feet
  - HOT access to 95th Street off-ramp 550 feet
Operational Consideration

Type A Weave

Type C Weave
NB HOT Access at 81st Street

- Operational Characteristics
  - Type C Weave 4 Service Interchanges 950 vph

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<tr>
<td>I-195/SR 112</td>
<td>2,350 vph</td>
<td>465 vph</td>
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<tr>
<td>NW 62nd St</td>
<td>780 vph</td>
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<td>220 vph</td>
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<tr>
<td>Total</td>
<td>4,260 vph</td>
<td>950 vph</td>
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NB HOT Access at 81st Street

- Operational Characteristics
  - Type A Weave 950 vph + 1,400 vph
NB HOT Access at 81st Street

- Operational Characteristics
  - Type C Weave 6 Service Interchanges 1,400 vph
NB HOT Access at 81st Street

- **Operational Characteristics**
  - Type C Weave 4 Service Interchanges 950 vph
  - Type A Weave 950 vph + 1,400 vph
  - Type C Weave 6 Service Interchanges 1,400 vph
NB HOT Access at 81st Street

- Lane Schematic CORSIM Results
NB HOT Access at 81st Street

- Lane Schematic CORSIM Results
NB HOT Access at 81st Street
Results Summary

- Type C Weaves Add Congestion to General Purpose Lanes (GPL)
- GPL Congestion Causes HOT Congestion
- HOT Speed Reduction and Egress Queuing
- Speed Differential is Safety Concern