The Case for Software-Assisted Calibration

NJDOT Research Showcase (West Windsor, NJ)

October 25th, 2017

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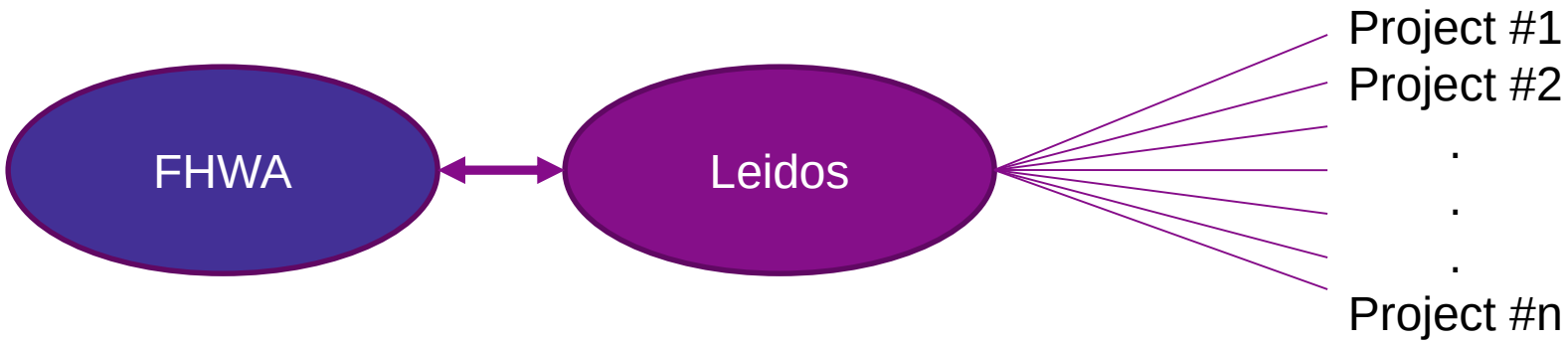
My Goals Today

- Convince you that:
  - Software-assisted calibration is important
  - Could revitalize the practice of traffic simulation in this country
  - The patent-pending method is special
  - Grass-roots support may be necessary

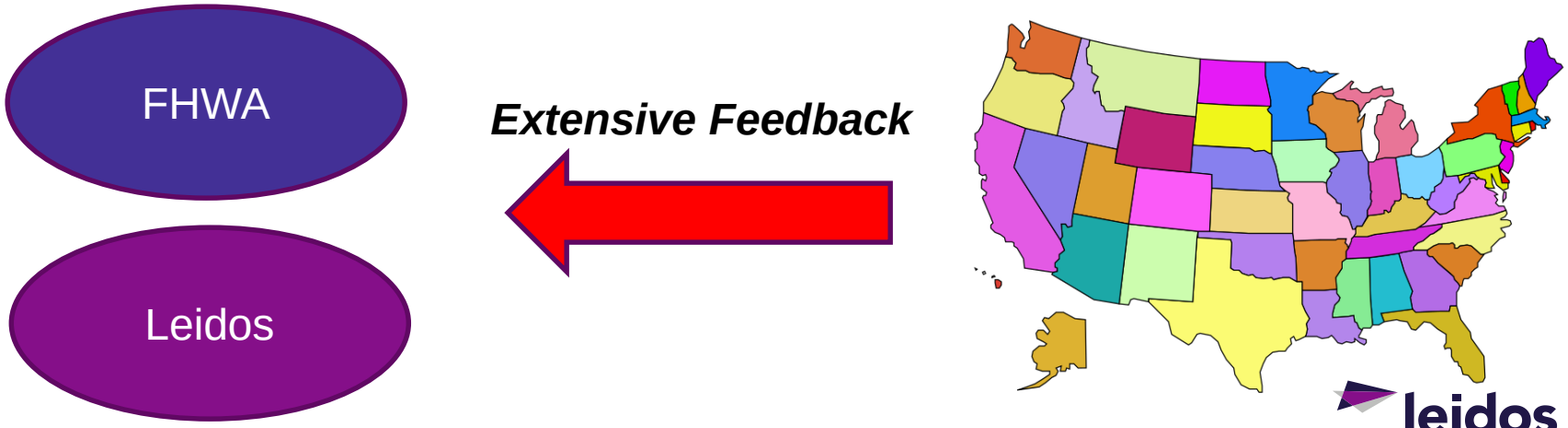
Background

- Leidos executes FHWA research projects
- For example, two of our ongoing projects:
  - Model Curriculum for Traffic Analysis Tools (TAT)
  - Transportation Systems Simulation Manual (TSSM)



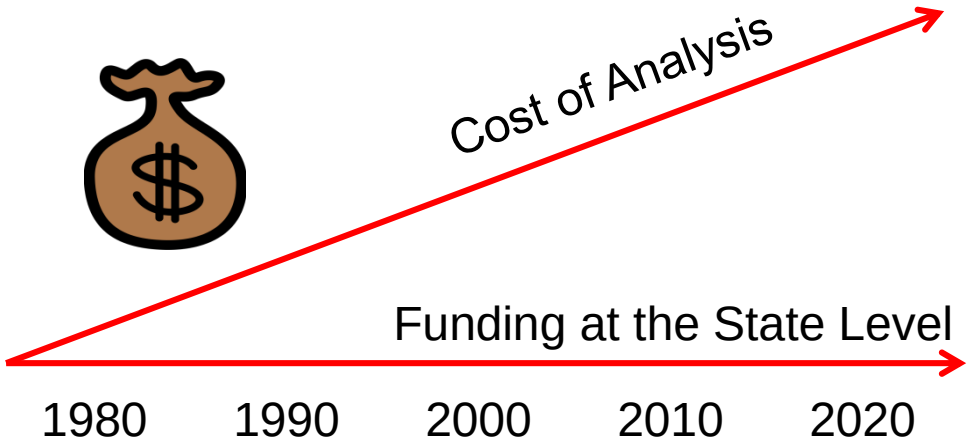
Recent Project Outreach

- TAT project
  - 5 virtual roundtables, 119 participants from at least 25 states, TAT stakeholders from ITE, TRB, state & local governments
- TSSM project
  - Interviewed 16 states from traffic analysis Pooled Fund Study (PFS), receiving input from the TRB Simulation Task Force, held 3 stakeholder webinars (so far)



What We Heard

- The most commonly cited challenge:
  - Calibration of complex traffic analysis models
- The most commonly cited reasons:
  - Insufficient funding, training, staffing, expertise
- FHWA pressing for advanced analyses requiring more costs
  - But at the state level, resources & funding not increasing



What We Heard (cont'd)

- "Simulation modeling is increasing. The challenge is policing that (calibrated) parameters are used, rather than national or software embedded defaults." – Scott Thomson P.E., KY Transportation Cabinet
- "As the tools are getting more complicated their price goes higher and the effort required for their use at the moment also goes higher." – Dr. John Hourdos, Minnesota Traffic Observatory
- "Simulation is increasingly needed due to increasing complexity of congestion issues. Calibration guidance is a critical need." – Sanhita Lahiri P.E., VDOT
- "Over half of simulation models are not calibrated at all." – David Petrucci P.E., FHWA
- "Automation in the calibration process is an urgent need." – Professor Alexander Skabardonis, UC Berkeley

What We Heard (cont'd)

- "Our top 3 priorities for the TSSM are 1) calibration and validation of the models, 2) model inputs, and 3) how to prepare simulation reports." – Skyler Waaso P.E., Louisiana DOT
- "Use of simulation has decreased in WI, largely because of complexities in the calibration process." – Dr. John Shaw, University of Wisconsin
- "Simulation is considered a last resort in Ohio. The models submitted to us for review are never calibrated." Dirk Gross P.E., Ohio DOT
- "Our two biggest problems with microsimulation, both for our own staff and for the consultants whose work we check, are 1) ensuring appropriate and sufficient data is collected, and 2) calibrating properly." – Diane Jacobs P.E., CalTrans
- "MoDOT does not have specific guidance for the development of microsimulation models from a calibration/validation standpoint." – Raymond Shank P.E., Missouri DOT

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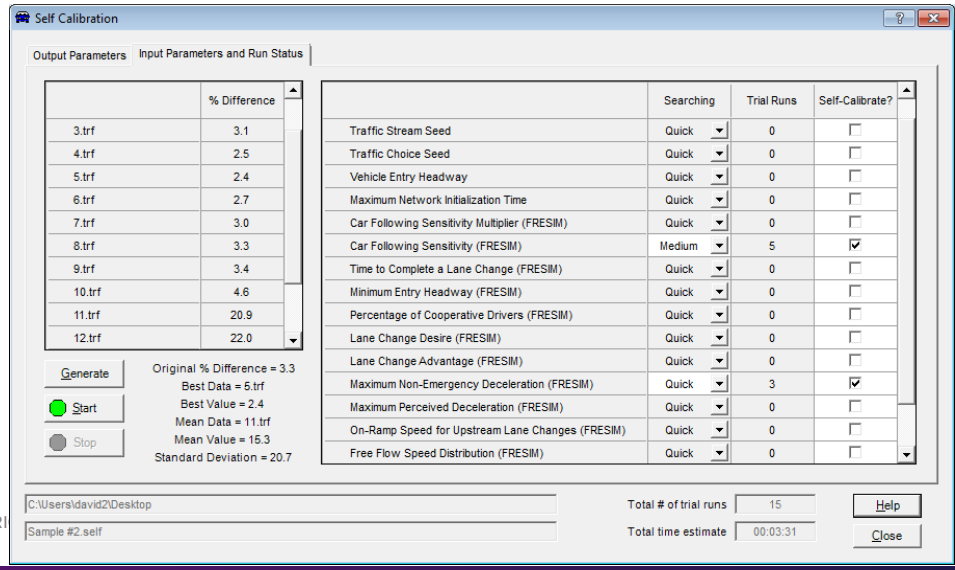
What We Heard (cont'd)

- "Our top 3 TSSM priorities are calibration discussion (i.e., what types of changes to get desired affects for a various situations, generally what is and what is not acceptable types of changes to make), ranges to change inputs (for) calibration, and standardized (simulation) output." – Casey Sylvester P.E., Nevada DOT
- "WisDOT's top priorities for inclusion in the 1st Edition of the TSSM (includes) additional guidance on determining the most appropriate parameters (and their acceptable ranges) to adjust during calibration." – Vicki Haskell P.E., Wisconsin DOT
- "The tools in the TAT (and similar resources) generally require greater resources than we have available. Guidance on how to apply best practices when resources are limited (or on smaller projects) would be helpful." – Andrew Warren P.E., Arkansas DOT

Proposed Architecture

- Software-assisted calibration method
  - Designed to make calibration super-easy
  - Automatically documents all calibration decisions
  - Can be customized for any situation
- Patent-pending (US 61/859,819)
- Has been offered to major vendors



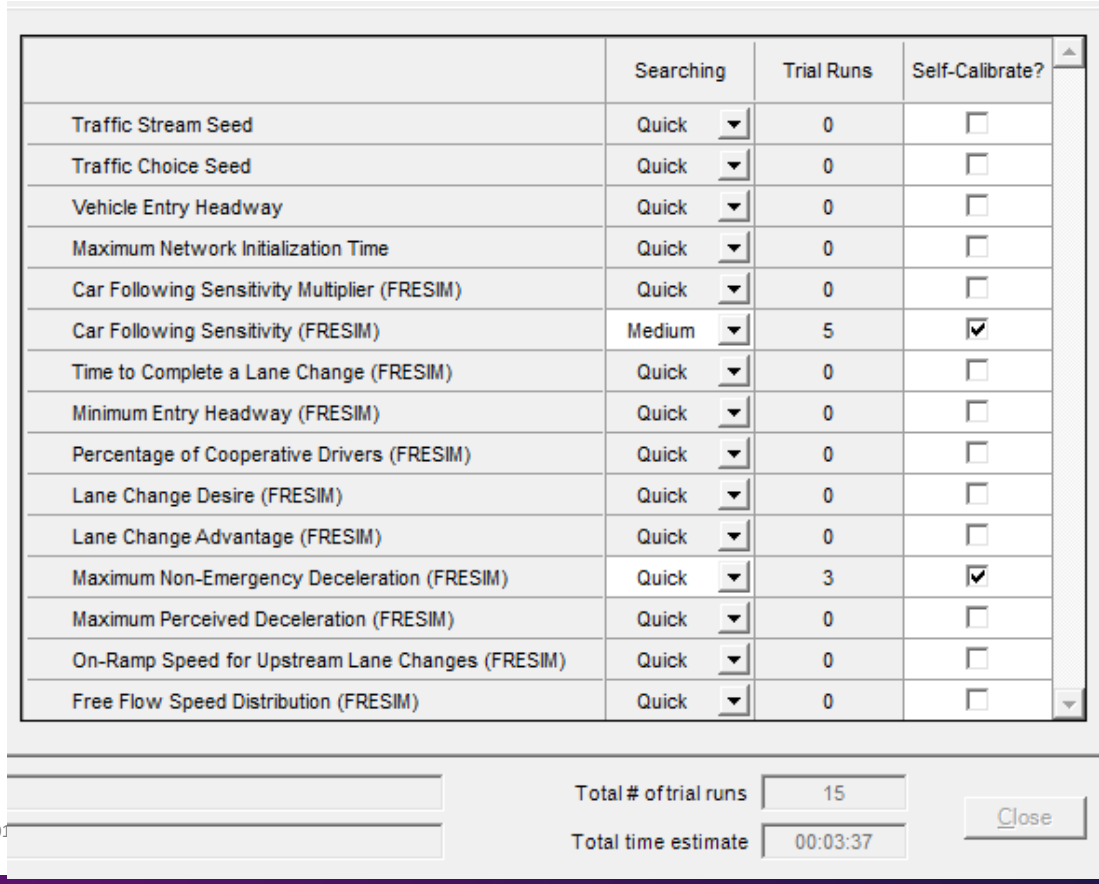
Similar Concepts

- Orbitz™
  - Billions of available plane tickets
  - Purchase yours within minutes (easy)
- Synchro™
  - Made a complex problem easy
  - Engineering judgment still important!

Critical Input Data Features

- Database of calibration input parameters
- Specify relevant inputs within seconds
- Custom run time!

- Choose from:
  - ***Quick***
  - ***Medium***
  - ***Thorough***



	Searching	Trial Runs	Self-Calibrate?
Traffic Stream Seed	Quick	0	☐
Traffic Choice Seed	Quick	0	☐
Vehicle Entry Headway	Quick	0	☐
Maximum Network Initialization Time	Quick	0	☐
Car Following Sensitivity Multiplier (FRESIM)	Quick	0	☐
Car Following Sensitivity (FRESIM)	Medium	5	☑
Time to Complete a Lane Change (FRESIM)	Quick	0	☐
Minimum Entry Headway (FRESIM)	Quick	0	☐
Percentage of Cooperative Drivers (FRESIM)	Quick	0	☐
Lane Change Desire (FRESIM)	Quick	0	☐
Lane Change Advantage (FRESIM)	Quick	0	☐
Maximum Non-Emergency Deceleration (FRESIM)	Quick	3	☑
Maximum Perceived Deceleration (FRESIM)	Quick	0	☐
On-Ramp Speed for Upstream Lane Changes (FRESIM)	Quick	0	☐
Free Flow Speed Distribution (FRESIM)	Quick	0	☐

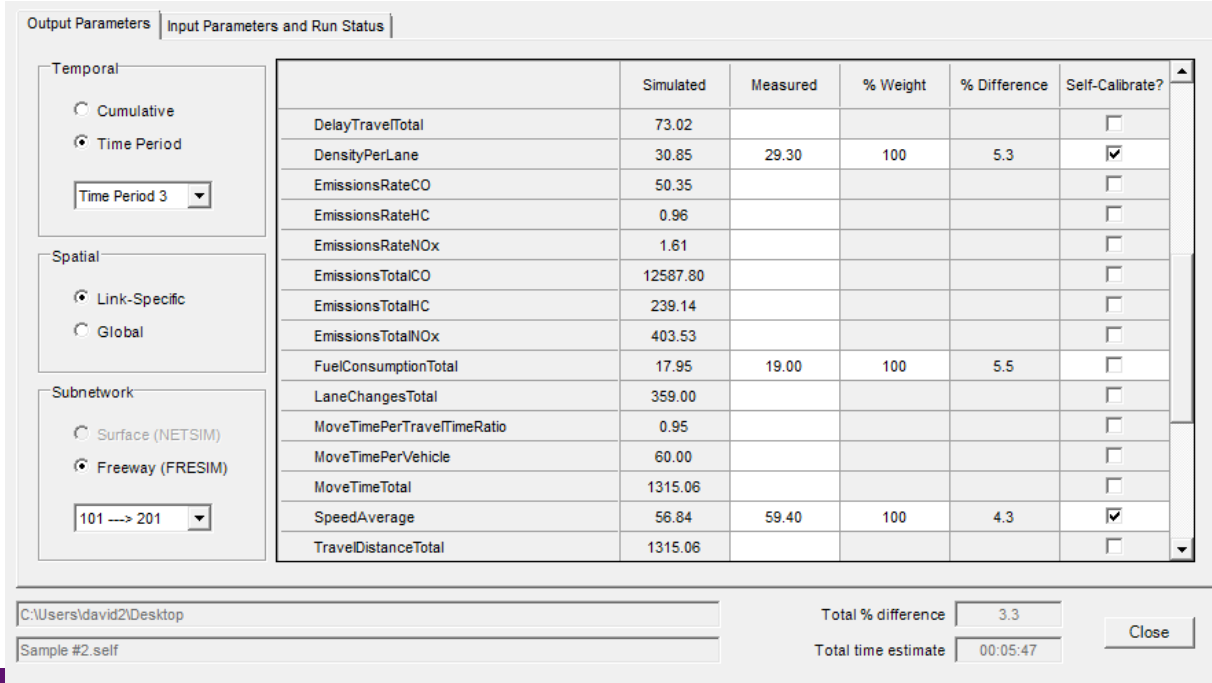
Total # of trial runs: 15

Total time estimate: 00:03:37

Close

Critical Output Data Features

- Specify relevant outputs within seconds
  - Any number of desired outputs
- Supply ‘ground truth’ outputs
- Include priority weightings (optional)



Other Critical Features

- Automatically document all calibration settings
  - Very important to the client
- View calibration progress in real time
- Calibration output statistics
  - Mean, variance, accuracy improvements
- Import calibrated settings
- Sensitivity analysis reports

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Architecture for Software-Assisted Calibration of Traffic Analysis Tools

Provides Sensitivity Analysis, Self-Calibration, and Optimization of Traffic Analysis Tool Frameworks Using a Database of Input Parameters

This architecture for software-assisted calibration facilitates the use of traffic analysis tools that manage a significant number of input and output parameters, such as traffic simulation programs. U.S. Federal Highway Administration guidelines for applying micro-simulation modeling software encourage traffic engineers to embrace calibration, in which they reconcile simulated and field-observed traffic

http://technologylicensing.research.ufl.edu/technologies/14656.pdf

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Other Solutions Being Offered

- Future automation & user-friendliness
  - No specificity, or “one-size fits all”
- Guidance documents
  - E.g., the TSSM, Traffic Analysis Toolbox, Multitude final report, state-specific guidelines
- Cost to develop software-assisted calibration
  - Much lower than cost to develop TSSM or other guidebooks
  - Yet, it could be argued that software would be more helpful

Cost to develop guidebook(s)

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Cost to develop software

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Related Outreach

- Transportation Research Part C, May 2015, pp. 100-115

- NJDOT Research Showcase (West Windsor, NJ), Oct. 2017
- Mid-Colonial ITE Annual Meeting (Baltimore, MD), Apr. 2017
- TRB Annual Meeting (Washington, DC), Jan. 2015
- Conference on Optimization (Kos Island, Greece), Jun. 2014
- FSITE Winter Workshop (Orlando, FL), Feb. 2014
- Penn State TESC (State College, PA), Dec. 2013

- Social Media (LinkedIn, ResearchGate)

Next Steps

- Continued outreach to vendors

– AND –

- Seek champions at the grass-roots level

Thank you

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