Forum Agenda

- 2012 Model Calibration
- Process Controls
- Integrated Corridor Management (ICM) Update
SANDAG ABM Calibration and Validation

Wu Sun

wsu@sandag.org
Model Development Steps

- Model Estimation
- Model Calibration
- Model Validation
- Model Application
**Calibration and Validation - Why?**

- Travel models are essentially a set of mathematical formulae and relationships
- All models are less than perfect
- **REASONABLY** reproduce a snapshot of travel in the modeling area
- **REASONABLY** forecast future travel
Calibration and Validation-How?

- **Approaches**
  - Past practice vs current practice

- **Base year**

- **Data sources**
  - Socioeconomic data-Census and ACS data
  - Survey data
  - Count data
Validation & Calibration: Observed vs Estimated

- **Comparisons to Survey**
  - Model components in ABM
  - Model structure
  - Regional and sub-regional

- **Comparisons to Counts**
  - Highway volumes and transit ridership
  - Regional and sub-regional
  - Screenlines and links (with actual counts only)
Examples: Work Trip Length Frequency
### Examples: University Trip Length Frequency

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>1</td>
</tr>
<tr>
<td>1.00%</td>
<td>2</td>
</tr>
<tr>
<td>2.00%</td>
<td>3</td>
</tr>
<tr>
<td>3.00%</td>
<td>4</td>
</tr>
<tr>
<td>4.00%</td>
<td>5</td>
</tr>
<tr>
<td>5.00%</td>
<td>6</td>
</tr>
<tr>
<td>6.00%</td>
<td>7</td>
</tr>
<tr>
<td>7.00%</td>
<td>8</td>
</tr>
<tr>
<td>8.00%</td>
<td>9</td>
</tr>
<tr>
<td>9.00%</td>
<td>10</td>
</tr>
</tbody>
</table>

---

**University Location Choice TLFD**

- **Distance**
- **Normalized Frequency %**
- **Distance**
  - **observed %**
  - **estimated %**

![Graph](image-url)
Examples: Work Tours TOD Results

- Work Departure Observed
- Work Departure Estimated
- Work Arrival Observed
- Work Arrival Estimated
Examples: Escorting Tours TOD Results
Link Level (only those with actual counts)
Calibration & Validation: 2010

- Updated inputs
- Auto ownership model recalibrated
- “Regular” express bus moved to local bus mode
- Adjusted transit mode constants
- Added constants for work purpose Coaster riders to account for shuttle bus services
- Adjusted external-internal controls for cordon 10 (I-15 at Riverside County line)
## Calibration and Validation: 2010 Results

<table>
<thead>
<tr>
<th>Auto Ownership</th>
<th>2000 CTPP</th>
<th>2010 Census</th>
<th>Estimated</th>
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<tbody>
<tr>
<td>0</td>
<td>7.96%</td>
<td>6.18%</td>
<td>7.01%</td>
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<tr>
<td>1</td>
<td>34.71%</td>
<td>32.20%</td>
<td>34.65%</td>
</tr>
<tr>
<td>2</td>
<td>39.55%</td>
<td>39.51%</td>
<td>38.11%</td>
</tr>
<tr>
<td>3</td>
<td>12.59%</td>
<td>14.93%</td>
<td>13.85%</td>
</tr>
<tr>
<td>4+</td>
<td>5.19%</td>
<td>7.18%</td>
<td>6.38%</td>
</tr>
</tbody>
</table>
### Calibration & Validation: 2010 Results

<table>
<thead>
<tr>
<th>MSA</th>
<th>Observed Count</th>
<th>Estimated 2010-Initial</th>
<th>Estimated 2010-Calibrated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial</td>
<td>% Diff</td>
</tr>
<tr>
<td>Center City</td>
<td>1,494,232</td>
<td>1,720,023</td>
<td>15.11%</td>
</tr>
<tr>
<td>Central</td>
<td>12,779,042</td>
<td>13,301,895</td>
<td>4.09%</td>
</tr>
<tr>
<td>North City</td>
<td>20,930,695</td>
<td>23,005,980</td>
<td>9.92%</td>
</tr>
<tr>
<td>South Suburban</td>
<td>3,987,233</td>
<td>3,789,093</td>
<td>-4.97%</td>
</tr>
<tr>
<td>East Suburban</td>
<td>6,933,773</td>
<td>6,996,865</td>
<td>0.91%</td>
</tr>
<tr>
<td>North County West</td>
<td>8,223,219</td>
<td>8,324,373</td>
<td>1.23%</td>
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<tr>
<td>North County East</td>
<td>7,525,720</td>
<td>7,849,298</td>
<td>4.30%</td>
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<tr>
<td>East County</td>
<td>119,304</td>
<td>185,016</td>
<td>55.08%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>61,993,218</strong></td>
<td><strong>65,172,543</strong></td>
<td>5.13%</td>
</tr>
</tbody>
</table>
## Calibration & Validation: 2010 Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>2010 Boardings</th>
<th>Estimated -Initial</th>
<th>% Diff</th>
<th>Boardings Adj</th>
<th>Estimated -Calibrated</th>
<th>% Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>195,246</td>
<td>203,787</td>
<td>4.37%</td>
<td>205,863</td>
<td>218,048</td>
<td>5.92%</td>
</tr>
<tr>
<td>Express</td>
<td>15,186</td>
<td>21,929</td>
<td>44.40%</td>
<td>4,568</td>
<td>3,350</td>
<td>-26.66%</td>
</tr>
<tr>
<td>Light Rail</td>
<td>119,870</td>
<td>100,450</td>
<td>-16.20%</td>
<td>119,870</td>
<td>108,916</td>
<td>-9.14%</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>4,709</td>
<td>2,836</td>
<td>-39.77%</td>
<td>4,709</td>
<td>4,460</td>
<td>-5.29%</td>
</tr>
<tr>
<td>Total</td>
<td>335,010</td>
<td>329,002</td>
<td>-1.79%</td>
<td>335,010</td>
<td>334,774</td>
<td>-0.07%</td>
</tr>
</tbody>
</table>
Calibration & Validation: 2012 Summary

- Updated inputs
- Revised HOV and toll mode constants to be consistent with 4-step model
- Adjusted auto operating cost to make it consistent across all model components
- Calibrated cross border model to make Tecate POE volume matched better to observed
- Added reliability factor for SR125
Calibration & Validation: 2012 Summary

- Active transportation related changes
  - All street network based walk and bike impedances
  - Included bike and walk logsums in mode choices
  - Adjusted density variables for bike mode
  - Included coastal attraction factor in bike mode choice
  - Adjusted bike tour targets for university and discretionary purposes
## Calibration & Validation: 2012 Results

<table>
<thead>
<tr>
<th>Tour Mode</th>
<th>Observed Targets</th>
<th>Calibrated Tours</th>
<th>Difference</th>
</tr>
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<tbody>
<tr>
<td></td>
<td># tours</td>
<td>Percent</td>
<td># tours</td>
</tr>
<tr>
<td>Drive-Alone</td>
<td>1,446,194</td>
<td>34.0%</td>
<td>1,448,985</td>
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<tr>
<td>Shared 2</td>
<td>1,095,800</td>
<td>25.8%</td>
<td>1,092,180</td>
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<tr>
<td>Shared 3+</td>
<td>1,097,417</td>
<td>25.8%</td>
<td>1,104,460</td>
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<tr>
<td>Walk</td>
<td>403,784</td>
<td>9.5%</td>
<td>403,745</td>
</tr>
<tr>
<td>Bike</td>
<td>42,849</td>
<td>1.0%</td>
<td>42,810</td>
</tr>
<tr>
<td>Walk-Transit</td>
<td>79,572</td>
<td>1.9%</td>
<td>79,115</td>
</tr>
<tr>
<td>PNR-Transit</td>
<td>9,020</td>
<td>0.2%</td>
<td>8,690</td>
</tr>
<tr>
<td>KNR-Transit</td>
<td>8,007</td>
<td>0.2%</td>
<td>8,035</td>
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<tr>
<td>School Bus</td>
<td>65,101</td>
<td>1.5%</td>
<td>64,880</td>
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<tr>
<td>Total</td>
<td>4,247,743</td>
<td>100.0%</td>
<td>4,252,900</td>
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</table>
# Calibration & Validation: 2012 Results

<table>
<thead>
<tr>
<th>MSA</th>
<th>Observed Count</th>
<th>Estimated 2012-Initial</th>
<th>Estimated 2012-Calibrated</th>
<th>Estimated 2012-Calibrated_AT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>initial</td>
<td>Calibrated</td>
<td>Calibrated_AT</td>
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<tr>
<td></td>
<td></td>
<td>% Diff</td>
<td>% Diff</td>
<td>% Diff</td>
</tr>
<tr>
<td>Center City</td>
<td>1,617,111</td>
<td>1,730,914</td>
<td>7.04%</td>
<td>1,613,109</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,568,802</td>
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<tr>
<td>Central</td>
<td>12,086,035</td>
<td>12,479,387</td>
<td>3.25%</td>
<td>11,845,340</td>
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<td></td>
<td></td>
<td></td>
<td>11,687,955</td>
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<td>North City</td>
<td>20,829,984</td>
<td>22,918,886</td>
<td>10.03%</td>
<td>21,873,766</td>
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<td></td>
<td>21,649,193</td>
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<tr>
<td>South Suburban</td>
<td>3,839,731</td>
<td>3,763,128</td>
<td>-2.00%</td>
<td>3,504,477</td>
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<td></td>
<td></td>
<td>3,399,301</td>
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<tr>
<td>East Suburban</td>
<td>6,477,887</td>
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<td>6,235,726</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,150,739</td>
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<tr>
<td>North County West</td>
<td>8,258,592</td>
<td>8,478,942</td>
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<td>8,174,715</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7,993,572</td>
</tr>
<tr>
<td>North County East</td>
<td>8,563,272</td>
<td>9,194,727</td>
<td>7.37%</td>
<td>8,910,338</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8,732,777</td>
</tr>
<tr>
<td>East County</td>
<td>137,862</td>
<td>225,803</td>
<td>63.79%</td>
<td>195,578</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>182,544</td>
</tr>
<tr>
<td>Total</td>
<td>61,810,474</td>
<td>65,369,906</td>
<td>5.76%</td>
<td>62,353,049</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61,364,882</td>
</tr>
</tbody>
</table>
# Calibration & Validation: 2012 Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>2012 Boardings</th>
<th>Estimated-Initial</th>
<th>% Diff</th>
<th>Estimated-Calibrated</th>
<th>% Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>216,435</td>
<td>223,901</td>
<td>3.45%</td>
<td>228,260</td>
<td>5.46%</td>
</tr>
<tr>
<td>Express</td>
<td>1,430</td>
<td>1,034</td>
<td>-27.69%</td>
<td>1,146</td>
<td>-19.86%</td>
</tr>
<tr>
<td>Light Rail</td>
<td>123,729</td>
<td>108,517</td>
<td>-12.29%</td>
<td>107,446</td>
<td>-13.16%</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>5,482</td>
<td>5,472</td>
<td>-0.18%</td>
<td>4,154</td>
<td>-24.22%</td>
</tr>
<tr>
<td>Total</td>
<td>347,076</td>
<td>338,924</td>
<td>-2.35%</td>
<td>341,006</td>
<td>-1.75%</td>
</tr>
</tbody>
</table>
Questions?

- Wu Sun
- Wu.Sun@sandag.org
- 619-6995757
Process Controls

Clint Daniels

cdan@sandag.org
You Won’t Believe These Simple Tricks to a Better Model Development Process

THE MODEL HAS WORKED

2 DAYS WITHOUT CRASHING

THE BEST PREVIOUS RECORD WAS

5 DAYS

DO YOUR PART TO HELP MAKE A NEW RECORD
One Source of Reality

(My consultants are working on two different projects, how do I get the projects back together?)
Always Have a Historical Record

(The press called, and they want a model run from last year! Now!)

GitHub Network Graph

SourceTree
Keep the Roadmap Handy

(Caltrans just called, and they want to know where their model development money went.)
One Build Task

(I just got a new computer, and now the build doesn’t work.)
Test All the Time
(I swear it worked yesterday, what happened?)
Prioritize Testing Legacy Systems

(I have a bunch of old code, but I don’t have time or money to start writing tests for it.)
Write Uniform Code

(Calvin likes his brackets on a new line. Audrey likes her brackets on the same line.)
Keep It Simple!!!

(That’s some fancy stuff you got there, it seems like overkill for my tiny little shop!)
San Diego Evaluation Criteria

(Translation: Yeah, but does all that fancy stuff work?)
You Won’t Believe These Simple Tricks to a Better Model Development Process

THE MODEL HAS WORKED

2 DAYS
WITHOUT CRASHING

THE BEST PREVIOUS RECORD WAS

5 DAYS

DO YOUR PART TO HELP MAKE A NEW RECORD
Integrated Corridor Management Update

Alex Estrella
aes@sandag.org
San Diego I-15 Integrated Corridor Management Project Update
Outline

1. Background
   1. Project Overview and Vision

2. ICM System and Decision Support System (DSS) Overview

3. What’s happening now
ICM is about management of a corridor. Management implies more than monitoring. Management implies planning for, and responding to, what is happening across all networks.
I-15 ICM Vision

- Pro-actively Manage Congestion
- Provide Choices
- Maximize System Capacity
- Improve Coordination/Interoperability
ICMS Context Diagram

- **RAMS**
  - Regional Arterial Mgmt System
    - Arterial Congestion
    - Intersection status
    - System alarms
    - Local traffic advisories

- **FMS**
  - Freeway Mgmt System
    - Freeway Congestion
    - Freeway Incidents
    - Travel Times
    - Planned Events
    - CCTV Imagery
    - CMS Status

- **REMS**
  - Regional Event Mgmt System
    - CHP
    - Transit
    - Express Lanes
    - Congestion Pricing
    - Arterial Construction

- **CPS**
  - Congestion Pricing System
    - Toll
    - Travel Times
    - Events

- **RTMS**
  - Regional Transit Mgmt System
    - Bus AVL
    - Schedule Adherence
    - Selected Stop/Route Data
    - Panic alarms

- **SPS**
  - Smart Parking System

- **LCS**
  - Lane Closure System
- **RMIS**
  - Ramp Meter Information System
  - Meter Timing Plans
  - Construction/Maint Status
  - Signal timing plans

- **NPS**
  - Network Prediction System

- **RTSS**
  - Real-Time Simulation System

- **511**
  - Arterial travel times
  - 511 Usage Statistics
  - Alert messages

- **Weather NWS**
  - Weather/NEXRAD
  - Predictions
  - Real-Time Data

- **ATTS**
  - Arterial Travel Time System
  - 511 Usage Statistics
  - Alert messages

- **ICM**
  - Intelligent Virtual Corridor TMC (User Screen)
  - XML Data (3rd Party Applications)

- **One-way IMTMS interface**
- **Two-way IMTMS interface**
- **DSS control interface**

= New or Upgraded System
I-15 ICM Key System Components

System Services
- ICMS Data Stores (includes Library of a-priori plans)
  - RSDS/RAC

DSS
- iNet (GUI, Response Plans)
- Aimsun Online (Real-Time Simulation and Predictive Analysis)

ICMS Data Hub

Interfacing Systems (Context Diagram)
- Data Hub Servers
- 511

Enhancements to serve as the corridor performance management element of DSS
Decision Support System

- Micro-simulation in **real-time** to predict and evaluate the response plans
- Business Rules to **propose** and **monitor**
- Workflow engines to **control**
**Decision Support System**

- **Algorithmic Prediction**
  - 1 hour every 35-70 seconds
  - Uses sensed network
  - Uses “real-time” data
  - Captures changes in demand

- **Micro-Simulation Prediction**
  - 1 hour every 300 seconds
  - Uses ICM network
  - Uses asset information – real time field environment
  - Uses adjusted demand
  - Captures prediction
Decision Support System

- **System Supply / Demand**
  - Arterials
  - Freeways
  - Express Lanes
  - Bus

- **System Operations**
  - Signals
  - Ramps
  - DMS
  - Barrier
  - Toll
Decision Support System

- **Posture**
  - Assets are restricted based on the rate of change in the congestion profile. An event can be approached in either a Conservative / Moderate / Aggressive posture.

- **Operator**
  - Partner specified business rules that enable or disable system access to assets based on:
    - Schedule
    - Capacity
    - Land Use

- **Status**
  - Offline / Failure
  - First Responder Override
  - Owner Activation Priority
Decision Support System

- **Congestion**
  - Best route, Event Management
  - Measured vs. Free Flow
  - Measured vs. Historical
  - Primary measures
    - Speed
    - Delay
    - V/C
    - LOS

- **Execution**
  - Time based thresholds used for asset selection, variable persistence, and partner engagement
1.5 Billion Combinations!
- 156 Alternate Routes
- 260 Local Arterial Intersections
- 18 Ramp Metered Interchanges
- 20 Dynamic Message Signs (DMS)
- 5 Bus Rapid Transit (BRT) Stations
- 20 Miles HOT – Reversible Lanes
- 30 Miles Traffic Responsive
- 511

Limited to 15 Response Plans by:
- Using Asset Restrictions
- Using Availability Conditions
- Using Thresholds to select “next move”
- Logic / Rules Based
Trip Based Delay Scoring

- Link Delay = 
  \((SV_{SOV} + HV_{HOV} + TV_{Truck} + BV_{Bus}) * D_{Avg}\)

- Where
  
  - \(D_{Avg}\) = Average Link Delay
  - Configurable Static Occupancy Factors:
    - \(S\) = Single Occupancy Vehicle
    - \(H\) = High Occupancy Vehicle
    - \(T\) = Truck
    - \(B\) = Bus
  
  - \(V_{SOV}\) = Link Volume of SOVs
  - \(V_{HOV}\) = Link Volume of HOVs
  - \(V_{Truck}\) = Link Volume of Trucks
  - \(V_{Bus}\) = Link Volume of Buses
In order to compare response plans the Corridor Score for each Response Plan id determined

- $D_0 =$ Delay under Do Nothing case
- $Z$ Corresponds to the response plan evaluated
  - $D_1 =$ Delay under Response Plan 1
  - $D_2 =$ Delay under Response Plan 2
  - Etc.

- Response Plan with the **HIGHEST** score is recommended for implementation
Summary DSS Logic

- **Assets**
  - Network and Routes
  - Systems and Capabilities
  - Availability

- **Response Plans**
  - Flexibility of Postures
  - Action Plans
  - Interagency Coordination
### Posture

<table>
<thead>
<tr>
<th>Posture</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservative</td>
<td>1 mile</td>
<td>1 mile</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.5 miles</td>
<td>2 miles</td>
</tr>
<tr>
<td>Aggressive</td>
<td>2 miles</td>
<td>3 miles</td>
</tr>
</tbody>
</table>

### Availability

- **Existing School Location**: Reduced corridor capacity during school begin/end
- **Existing School Location**: May require coordinated timing plan
- **Existing School Location**: With ADA Population requiring extended crossing times
- **Existing School Location**: Reduced corridor capacity during school begin/end
- **Existing Network Constraints**: Central-to-field communications may not be complete
- **Existing School Location**: Reduced corridor capacity during school begin/end
DSS Operational Strategies Employed on I-15 with ICM

- En-Route Traveler Information
- Pre-Trip Traveler Information
- Corridor Ramp Metering
- Signal Coordination on Arterials and Ramp Meters
- Enhanced Transit Network Information
- Pro-Active Corridor Congestion Management during recurring and incidents

A combination of Action Plans defines an individual Response Plan.
What’s Happening Now – DSS – ICM Response Plan Example
What’s Happening Now -

- ICM system operational – March 2014
  - Established Weekly Operational Review Meetings
  - Over 300 Response Plans
  - Early May – Set to System Automation Approval
  - Operational Corridor Threshold Initiated 18% then to 8% (May 21st)

- Released 511 – ICM App (May 9th)
  - 20K+ downloads
ICMS Response Plans Thru May 20

Event ID Timeline

Response Plan Scores

-20,000
-15,000
-10,000
-5,000
0,000
5,000
10,000
15,000
20,000

606000
608000
610000
612000
614000
616000
618000
620000
622000
624000
511 Mobile Application - Release
Integrated Corridor Management

Demonstration
Open Discussion
Forum Agenda Recap

- 2012 Model Calibration
- Process Controls
- Integrated Corridor Management (ICM) Update

Next Transportation Modeling Forum:
December 10, 2014
Transportation Modeling Forum

June 11, 2014