Forum Agenda

- Activity-Based Model Overview
- Comparing the ABM with Four-Step Model
- ABM Structure, Components and Flow
Activity-Based Model Overview

Clint Daniels
Modeling Choices in ABM

1. Select Primary Destination
2. Select Departure/Arrival Period
3. Select Primary Mode
4. Select Stop Location
Tours vs. Trips

Home-Based Work Trip

Zone 1
Origin
Home-Based Shop Trip

Zone 2
Intermediate Stop

Non-Home-Based Trip

Zone 3
Primary Destination

Non-Home-Based Trip

Zone 4
Primary Destination

Work-Based Tour

Work Tour
Mode Choice Consistency

Zone 1 → Work Tour → Zone 3 → Work-Based Tour → Zone 4

Zone 2
Temporal Consistency

Work Tour
8:00am - 5:00pm

Zone 1

Zone 2
2:30pm

Zone 3
2:00pm

Work-Based Tour
8:00am - 5:00pm

Zone 4

8
Why ABM?

• Increased Sensitivity

• Richer Analysis
  • Environmental Justice / Social Equity

• More Intuitive Modeling Approach

• New Model ↔ New Answers
ABMs in the U.S

Developed & used

Being developed
Model Development Status

- **ABM**
  - All Core Models are Complete
  - Calibration Fall 2012
  - Online Summer / Fall 2013

- **PECAS**
  - Complete
  - Forecast Underway

- **CVM**
  - Spring 2013
Comparing the ABM With Four Step Models

Wu Sun
Four Step Transportation Model

1. Trip Generation
2. Trip Distribution
3. Mode Choice
4. Trip Assignment
Year 1
- Pop Synthesis & Long-Term Models
- Coordinated Daily Activity Pattern
- Simplified Tour Frequency Models
- 4-Step Integration and Testing

Year 2
- Remaining Tour Frequency Models
- Remaining Mobility Models
- Joint & Allocated Tours
- Destination and Tour Mode Choice

Year 3
- Stop Frequency
- Stop Location Choice
- Trip Mode Choice
- Parking Location Choice

Year 4
- Special Market Models
- Calibration & Validation
- Integration with PECAS
- Integration with Truck, CVM and EMFAC
- Sensitivity Testing
- Documentation and Final Report
Worker or student status (from census)

Work and school locations selected

Household auto ownership level chosen

Daily activity patterns chosen jointly

Mandatory tours generated

Sharp Hospital

Qualcomm

East Lake Elementary

Two cars

Not work

Work

1 Tour

School

1 Tour

Not school

1 Tour

1 Tour
Mandatory tours are scheduled
Non-mandatory travel is generated
Destinations for non-mandatory tours are selected
Non-mandatory tours are scheduled

- **2 Joint Tours**
  - **Zoo, Market**
  - **8 to 11, 3 to 4**

- **7 to 7**
  - **1 At-work Tour**
  - **Karl Strauss**
  - **12 to 1**

- **8 to 4**
  - **1 Non-mandatory Tour**
  - **Jimmy’s House**
  - **5 to 6**

- **2 Joint Tours**
  - **Zoo, Market**
  - **8 to 11, 3 to 4**
Drive to zoo; walk to market → No stops → Shared ride 2; Walk
Drive to work; drive to lunch → Starbucks near office → Drive; Drive; Drive
Transit to school; bike to Jimmy’s → No stops → Transit; Bicycle
Ride to zoo; walk to market → No stops → Shared ride 2; Walk

Mode choice for all tours
Stop frequency; stop location; stop time
Trip mode choice
Modeling Travel Choices

Choice Probabilities

• Probability of choosing alternative \( i \) from a set of choice alternatives \( C \)

\[
P(i : C) = \text{Prob}(U_i \geq U_j, \ \forall j \in C)
\]

\[
= \text{Prob}(V_i + \varepsilon_i \geq V_j + \varepsilon_j, \ \forall j \in C)
\]

• Under general assumptions, the model is…

\[
P(i : C) = \frac{\exp(V_i)}{\sum_{\forall j} \exp(V_j)}
\]

• Probability is based on the difference in utility between alternatives

\[
\frac{\exp(V_i)}{\exp(V_j)} = \exp(V_i - V_j)
\]
Monte Carlo Draw

- Predict the probability and cumulative probability of each alternative

<table>
<thead>
<tr>
<th></th>
<th>Auto</th>
<th>Transit</th>
<th>Non-Motorized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob.</td>
<td>0.8</td>
<td>0.05</td>
<td>0.15</td>
</tr>
<tr>
<td>Cum Prob.</td>
<td>0.8</td>
<td>0.85</td>
<td>1.0</td>
</tr>
</tbody>
</table>

- Draw a random number between 0 and 1
  - e.g. Rand() = 0.82

- Select an alternative if the random number falls in the cumulative range of that alternative
  - Pick ‘Transit’ as 0.82 falls between 0.8 and 0.85
ABM Structure, Components and Flow

Wu Sun
SANDAG ABM Features

- Full set of travel modes
- Unique regional features: such as border crossing model
- A set of special market models
- Integrates with the commercial vehicle model (CVM)
- Integrates with the land-use model (PECAS)
SANDAG ABM Features

- An advanced CT-RAMP platform that model individual travel choices with behavioral realism
- Detailed temporal & spatial resolutions
- Sensitive to socio-demographic changes
- Explicit intra-household interactions
## Surveys & Data I

<table>
<thead>
<tr>
<th>Survey</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Travel Behavior Survey</td>
<td>2006/2007</td>
</tr>
<tr>
<td>Transit On-Board Survey</td>
<td>2009</td>
</tr>
<tr>
<td>Air Passenger Survey (SDIA)</td>
<td>2009</td>
</tr>
<tr>
<td>Parking Inventory Survey</td>
<td>2010</td>
</tr>
<tr>
<td>Parking Behavior Survey</td>
<td>2010</td>
</tr>
<tr>
<td>Border Crossing Survey</td>
<td>2010</td>
</tr>
<tr>
<td>Visitor Survey</td>
<td>2011</td>
</tr>
<tr>
<td>Special Events Survey</td>
<td>2011</td>
</tr>
</tbody>
</table>
Household Travel Behavior Survey

- Household activity-travel diary
  - Trip/tour starting/ending time
  - Trip/tour purposes
  - Trip/tour locations
  - Trip/tour modes

- Person attribute file
  - Gender, age, ethnicity
  - Employment status
  - Occupation

- Household attribute file
  - Income
  - Auto ownership
  - Household size
  - Household composition
Surveys & Data II

- 2000 Census and Census Journey-to-Work
- American Community Survey
- Toll transponder ownership data
- Land use data
- Built environment data
- Traffic counts and transit boardings
Treatment of Space: TAZs and MGRAs

- MGRA (grey lines)
- 21,633 MGRA
- 4,682 TAZs

MGRA: Master Geographic Reference Area (Grey Lines)
TAZ: Transportation Analysis Zone (Orange Line)
Development Schedule

Year 1
- Pop Synthesis & Long-Term Models
- Coordinated Daily Activity Pattern
- Simplified Tour Frequency Models
- 4-Step Integration and Testing

Year 2
- Remaining Tour Frequency Models
- Remaining Mobility Models
- Joint & Allocated Tours
- Destination and Tour Mode Choice

Year 3
- Stop Frequency
- Stop Location Choice
- Trip Mode Choice
- Parking Location Choice

Year 4
- Special Market Models
- Calibration & Validation
- Integration with PECAS
- Integration with Truck, CVM and EMFAC
- Sensitivity Testing
- Documentation and Final Report
Population Synthesizer

Create control targets

Create Sample HHs

Balance HH Weights

Discretize HH Weights

Allocate HHs

Validate PopSyn

Create validation measures
## Person Types

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>PERSON-TYPE</th>
<th>AGE</th>
<th>WORK STATUS</th>
<th>SCHOOL STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full-time worker</td>
<td>18+</td>
<td>Full-time</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>Part-time worker</td>
<td>18+</td>
<td>Part-time</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>Non-working adult</td>
<td>18 – 64</td>
<td>Unemployed</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>Non-working senior</td>
<td>65+</td>
<td>Unemployed</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>College student</td>
<td>18+</td>
<td>Any</td>
<td>College +</td>
</tr>
<tr>
<td>6</td>
<td>Driving age student</td>
<td>16-17</td>
<td>Any</td>
<td>Pre-college</td>
</tr>
<tr>
<td>7</td>
<td>Non-driving student</td>
<td>6 – 15</td>
<td>None</td>
<td>Pre-college</td>
</tr>
<tr>
<td>8</td>
<td>Preschooler</td>
<td>0-5</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
## Household Income Types

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
<th>HOUSEHOLD INCOME (2006 $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low income</td>
<td>0-$30k</td>
</tr>
<tr>
<td>2</td>
<td>Low medium income</td>
<td>$30k - $60k</td>
</tr>
<tr>
<td>3</td>
<td>Medium income</td>
<td>$60-100k</td>
</tr>
<tr>
<td>4</td>
<td>High income</td>
<td>$100-150k</td>
</tr>
<tr>
<td>5</td>
<td>Very high income</td>
<td>$150k+</td>
</tr>
</tbody>
</table>
Development Schedule

Year 1
- Pop Synthesis & Long-Term Models
- Coordinated Daily Activity Pattern
- Simplified Tour Frequency Models
- 4-Step Integration and Testing

Year 2
- Remaining Tour Frequency Models
- Remaining Mobility Models
- Joint & Allocated Tours
- Destination and Tour Mode Choice

Year 3
- Stop Frequency
- Stop Location Choice
- Trip Mode Choice
- Parking Location Choice

Year 4
- Special Market Models
- Calibration & Validation
- Integration with PECAS
- Integration with Truck, CVM and EMFAC
- Sensitivity Testing
- Documentation and Final Report
**Daily Activity Pattern Type**

- **Mandatory**: At least one out-of-home mandatory activity (tour) and any other activities
- **Non-mandatory**: No mandatory activities; at least one out-of-home non-mandatory activity (tour)
- **Home**: No out-of-home activities (tours) or absence from home/town
# Activity Types

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PURPOSE</th>
<th>DESCRIPTION</th>
<th>CLASSIFICATION</th>
<th>ELIGIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Work</td>
<td>Working at regular workplace or work-related activities outside the home.</td>
<td>Mandatory</td>
<td>Workers and students</td>
</tr>
<tr>
<td>2</td>
<td>University</td>
<td>College +</td>
<td>Mandatory</td>
<td>Age 18+</td>
</tr>
<tr>
<td>3</td>
<td>High School</td>
<td>Grades 9-12</td>
<td>Mandatory</td>
<td>Age 14-17</td>
</tr>
<tr>
<td>4</td>
<td>Grade School</td>
<td>Grades K-8</td>
<td>Mandatory</td>
<td>Age 5-13</td>
</tr>
<tr>
<td>5</td>
<td>Escorting</td>
<td>Pick-up/drop-off passengers (auto trips only).</td>
<td>Maintenance</td>
<td>Age 16+</td>
</tr>
<tr>
<td>6</td>
<td>Shopping</td>
<td>Shopping away from home.</td>
<td>Maintenance</td>
<td>5+ (if joint travel, all persons)</td>
</tr>
<tr>
<td>7</td>
<td>Other Maintenance</td>
<td>Personal business/services, and medical appointments.</td>
<td>Maintenance</td>
<td>5+ (if joint travel, all persons)</td>
</tr>
<tr>
<td>8</td>
<td>Social/Recreational</td>
<td>Recreation, visiting friends/family.</td>
<td>Discretionary</td>
<td>5+ (if joint travel, all persons)</td>
</tr>
<tr>
<td>9</td>
<td>Eat Out</td>
<td>Eating outside of home.</td>
<td>Discretionary</td>
<td>5+ (if joint travel, all persons)</td>
</tr>
<tr>
<td>10</td>
<td>Other Discretionary</td>
<td>Volunteer work, religious activities.</td>
<td>Discretionary</td>
<td>5+ (if joint travel, all persons)</td>
</tr>
</tbody>
</table>
Scheduling

1. **Schedule Work Tour**

2. **Calculate residual time windows**

3. **Schedule Discretionary Tour**

4. **Schedule trip departure times**
Treatment of Time

- On the demand side: half hourly
- Traffic assignment: 6 TODs

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>DESCRIPTION</th>
<th>BEGIN TIME</th>
<th>END TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Early A.M.</td>
<td>3:00 A.M.</td>
<td>5:59 A.M.</td>
</tr>
<tr>
<td>2</td>
<td>A.M. Peak</td>
<td>6:00 A.M.</td>
<td>8:59 A.M.</td>
</tr>
<tr>
<td>3</td>
<td>Early Midday</td>
<td>9:00 A.M.</td>
<td>11:59 A.M.</td>
</tr>
<tr>
<td>4</td>
<td>Late Midday</td>
<td>12:00 P.M.</td>
<td>3:29 P.M.</td>
</tr>
<tr>
<td>5</td>
<td>P.M. Peak</td>
<td>3:30 P.M.</td>
<td>6:59 P.M.</td>
</tr>
<tr>
<td>6</td>
<td>Evening</td>
<td>7:00 P.M.</td>
<td>2:59 A.M.</td>
</tr>
</tbody>
</table>
Development Schedule

Year 1
- Pop Synthesis & Long-Term Models
- Coordinated Daily Activity Pattern
- Simplified Tour Frequency Models
- 4-Step Integration and Testing

Year 2
- Remaining Tour Frequency Models
- Remaining Mobility Models
- Joint & Allocated Tours
- Destination and Tour Mode Choice

Year 3
- Stop Frequency
- Stop Location Choice
- Trip Mode Choice
- Parking Location Choice

Year 4
- Special Market Models
- Calibration & Validation
- Integration with PECAS
- Integration with Truck, CVM and EMFAC
- Sensitivity Testing
- Documentation and Final Report
Year 1
- Pop Synthesis & Long-Term Models
- Coordinated Daily Activity Pattern
- Simplified Tour Frequency Models
- 4-Step Integration and Testing

Year 2
- Remaining Tour Frequency Models
- Remaining Mobility Models
- Joint & Allocated Tours
- Destination and Tour Mode Choice

Year 3
- Stop Frequency
- Stop Location Choice
- Trip Mode Choice
- Parking Location Choice

Year 4
- Special Market Models
- Calibration & Validation
- Integration with PECAS
- Integration with Truck, CVM and EMFAC
- Sensitivity Testing
- Documentation and Final Report
Model Results

Tour Data

<table>
<thead>
<tr>
<th>HH #</th>
<th>Per #</th>
<th>Tour #</th>
<th>Purpose</th>
<th>Origin Zone</th>
<th>Destin. Zone</th>
<th>Outbound Stop1 Zone</th>
<th>Return Stop1 Zone</th>
<th>Mode</th>
<th>Outbound Time</th>
<th>Return Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1023</td>
<td>1</td>
<td>1</td>
<td>Work</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>Transit</td>
<td>7:30AM</td>
<td>5:00 PM</td>
</tr>
<tr>
<td>1023</td>
<td>1</td>
<td>2</td>
<td>Work-Based</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>Walk</td>
<td>12:00 PM</td>
<td>1:00 PM</td>
</tr>
</tbody>
</table>
Standard Model Output
Average Daily Traffic (ADT)
Customized Model Output
Travel Time Analysis
Model Validation

- Validation Report

![Scatter plot showing model validation results]
ABM Resources

- TMIP ABM Webinars-http://tmiponline.org/
- SANDAG: http://www.sandag.org/models
- Contact: Wu.Sun@sandag.org
Feedback

https://www.surveymonkey.com/s/SANDAGForum
OPEN DISCUSSION