Measuring the Effects of Land Use on Travel Behavior and Climate Change

Jerry Walters, Fehr & Peers

April 2008
Agenda

1. Smart Growth and Climate Change

2. Measuring Effects of Smart Growth on Travel

3. Getting the Models to Get it Right

4. Focusing on Multi-Modalism and Mobility
Growth in CO₂ Emissions assuming more Stringent Vehicle and Fuel Standard
(45 mpg CAFE in 2030) + (-15% Fuel GHGs) = (24% above 1990 in 2030)

Sources: VM T: EIA with 10% rebound, MPG & Fuel: Trend Extrapolation
Neighborhood comparison: 2/3rd VMT Reduction

Daily Vehicle Miles per Person vs. Residential Density
Source: Baltimore Metropolitan Council, 2001 Travel Survey
Land use-transportation scenario planning studies in the U.S (Bartholomew 2007)
VMT vs. Density for 62 Planning Scenarios Relative to Trend

R² = 0.5575

n = 62
Site Design & Location Studies in US and Canada

- Site Design Studies
- Regional Location Studies
% Reduction in Site Density vs % Change in VMT per Capita
(density reduction accompanied by relocation of development from infill to greenfield)
SACOG Travel Generation by Density of Place

Jobs + Households within ¼ Mile of Place of Residence
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Trip generation is directly related to D’s:

**Density** dwellings, jobs per acre

**Diversity** mix of housing, jobs, retail

**Design** connectivity, walkability

**Destinations** regional accessibility

**Distance to Transit** rail proximity
Density (jobs and dwellings per acre)

- Shortens trip lengths
- More walking/biking
- Supports quality transit
Diversity (mix of housing, jobs, retail)

Links trips, shortens distances

More walking/ biking

Allows shared parking
Design (connectivity, walkability)
Destinations (accessibility to regional activities)

Development at infill or close-in locations reduces vehicle trips and miles
Distance to Transit

Transit shares higher within ¼ mile and ½ mile of station
### 4D’s (Land Use Clustering, Mixing, Traditional Design) — All Reduce Travel

<table>
<thead>
<tr>
<th></th>
<th>Reductions in VMT per 100% increase in 4D’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Density</td>
<td>1% to 17%</td>
</tr>
<tr>
<td>2. Diversity</td>
<td>1% to 13%</td>
</tr>
<tr>
<td>3. Design</td>
<td>2% to 13%</td>
</tr>
<tr>
<td>4. Destinations</td>
<td>20% to 51%</td>
</tr>
</tbody>
</table>

*Sources: National Syntheses, Twin Cities, Sacramento, Holtzclaw*
Vehicle-miles traveled, compared with regional average:

- 42% reduction for households within ½ mile of transit
- 21% reduction for households between ½ and 1 mile
Emerging research:
Other “D” factors that affect VMT

6. Development scale

7. Demographics

8. Demand management
   - parking management
   - pricing policies
   - traveler information
   - neighborhood electric vehicles
## Effects of Other “D” Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Reduction in VMT per 100% increase in “D”</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Development Scale</td>
<td>15% +/-</td>
</tr>
<tr>
<td>7. Demographics</td>
<td>11% to 23%</td>
</tr>
<tr>
<td>8. Demand Management</td>
<td>varies</td>
</tr>
</tbody>
</table>

Source: EPA study on effects of mixed use development – Portland case study
Smart Growth Trip Generation

National studies of Mixed Use, TOD and Infill development

Statistical analysis, empirical validation

<table>
<thead>
<tr>
<th>Trip Discount</th>
<th>MXD</th>
<th>TOD</th>
<th>Infill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35%</td>
<td>44%</td>
<td>36%</td>
</tr>
</tbody>
</table>

Examples: San Diego, Seattle, Portland, Sacramento, Houston, Atlanta, Boston
Direct Transit Ridership Models

Examples: BART, Caltrain, Sacramento LRT, Salt Lake LRT, Denver RTD

Model 1 - Relationship Between PM Peak Boardings and 1/2 mile Non-Retail Employment, 1/2 mile Population, and Downtown SF Indicator, R²=.985

Predicted vs Actual

- Purple: Predicted
- Red: Actual
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Shortcomings of Conventional Travel Models in Assessing Smart Growth

- Primary use is to forecast long-distance auto travel on freeways and major roads
- Secondary use is to forecast system-level transit use
- Short-distance travel, local roads, non-motorized travel modes are not addressed in model validation
Levels of Model Sophistication

Caltrans Assessment of Local Models and Tools for Analyzing Smart-Growth Strategies, 2007
Typical Model “Blind Spots”

- Abstract consideration of distances between land uses within a given TAZ or among neighboring TAZ’s

- Limited or no consideration intra-zonal or neighbor-zone transit connections

Network in Model  Network in Field
Typical Model “Blind Spots”

- Sidewalk completeness, route directness, block size generally not considered.
Typical Model “Blind Spots”

- Little consideration is given to spatial relationship between land uses within a given TAZ (density)

- Interactions between different non-residential land uses (e.g. offices and restaurants) not well represented
Conventional Ridership Modeling

Screen for Mode
Law of Small Numbers

Auto Travelers

Margin of Error

Transit Travelers
FTA Report on Conventional Forecasting

“… ridership projections for New Starts are often highly inaccurate in terms of both total ridership and the characteristics of the markets that are actually served.”
Use 4D’s to compensate for any lack of sensitivity in travel models

Source: Assessment of Local Models and Tools for Analyzing Smart-Growth Strategies, 2007
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Traffic LOS → Person Mobility

- Person accessibility and safety
- Travel time mobility for all modes
- Comfort and convenience for all users
Van Ness Ave  BRT Alternatives

Alt. 2 reduces total traveler delay by 8% with no increase in vehicle delay.
Alt. 3 increases vehicle delay by 8% but reduces delay for all travelers 5%.
Intersection LOS Improvement Study
Alternative 1 -- Conventional Treatment

PM Peak Hour Delay

<table>
<thead>
<tr>
<th></th>
<th>Vehicle</th>
<th>Buses</th>
<th>Pedestrian</th>
<th>Bicycle</th>
<th>Overall Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 3</td>
<td>30</td>
<td>29.6</td>
<td>42.7</td>
<td>47.5</td>
<td>31.4</td>
</tr>
</tbody>
</table>

HCM Intersection LOS = C
Alternative 2 – All Bike/Pedestrian Phase

![Alternative 2 Image]

### PM Peak Hour Delay

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<th>Bicycle</th>
<th>Overall Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>44.2</td>
<td>47.1</td>
<td>46.6</td>
<td>42.8</td>
<td>44.2</td>
</tr>
</tbody>
</table>

HCM Intersection LOS = D
Alternative 3 – Ped/ Bike Head-Start Phase
(balanced LOS for all modes)
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5. Case Study
Integrated Land Use/ Transportation Visioning and Planning Strategy

- Emphasize development forms known to reduce travel per capita: density, mix, transit-oriented design, infill and close-in locations.

- Concentrate land use around potential transit nodes.

- Prioritize transportation system expansions that work best with compact, transit oriented development.
Modeling Future Development Scenarios

Available Land

Jobs & Population Forecast

Development Policy Scenario

Land Use Modeling

Future Transportation & Land Use Model, 2030

Measurements and Metrics:
- Economic Analysis
- Environmental Impact
- Land Conversion
- Social/Demographic Impacts
- Other Metrics

Transportation Policies

Transportation Network

Virtual Land Use Future, 2030

Transportation Modeling

Future, 2030
"Vision Scenario" Smart Growth Scorecard

<table>
<thead>
<tr>
<th>Category</th>
<th>Vision Scenario improvements over Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>11% increase for new growth</td>
</tr>
<tr>
<td>Diversity</td>
<td>23% increase in mixing at local level</td>
</tr>
<tr>
<td>Design</td>
<td>25% greater potential for traditional design</td>
</tr>
<tr>
<td>Destinations</td>
<td>Increased development at infill locations</td>
</tr>
</tbody>
</table>
5. Distance to Transit

- 8% of new residents live within ½ mile of transit (1% under Trend Case)
- 11% of new jobs are within ½ mile of transit (8% under Trend Case)
The Smart Growth Scenario reduces VMT and improves levels of congestion on major roads.

- **Countywide VMT**: -7%

- **% of Arterial Miles Congested**: -42%
  (Peak hour LOS E or F)

- **% of Freeway Miles Congested**: -15%
  (Peak hr LOS E or F in at least 1 direction)
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Questions?