Overview.

1. Shortcomings of Conventional Methods
2. Background on EPA’s MXD Trip Generation Methodology
3. MXD Trip Generation Model
4. MXD+ including NCHRP Report 684
5. Conclusion
Limitations of current practice

- One variable only - Size
- Scale of development disregarded
- Land use context disregarded
- Possibility of mode shift disregarded
Limitations of current practice.

Conventional trip generation methods overestimate mixed-use project traffic by 35% (traffic impacts, VMT, air quality, GHG, noise, etc.)

- Do not account for fact that trip generation varies with development density, mix, design, transit availability, and other factors
- Limited empirical validation

Strengths of the conventional method
- Objective,
- Logical, and
- Fast
Mistreatment of MXD.

Consequence is overestimation of trip generation for mixed-use, in-fill, and transit oriented development:

- Escalate development costs
- Skew public perception
- Heighten community resistance
- Favor isolated single use development
- Oversizing infrastructure
Conventional Method’s Shortcomings.
Factors Associated with Reduced Trip Rates

- Density
- Diversity
- Design
- Destinations
- Distance to Transit
- Development Scale
- Demographics
7Ds – Features Associated with Reduced Trip Rates.

- **Density** of population and employment
- **Diversity**: jobs/housing relative to regional balance
- **Diversity**: balance of commercial, office, and public
- **Design**: intersections per square mile
- **Destination Accessibility**: jobs within 1 mile
- **Destination Accessibility**: jobs within a 30 min by transit
- **Distance to Transit**: rail station, bus stops within ¼ mile
- **Development Scale**: MXD population and employment
- **Demographics**: household size, vehicle ownership

• Trip generation,

• Mode choice, and

• Trip length for trips produced and attracted by mixed use developments.
**EPA MXD Model.**

**What is the MXD Model?**

- A model for percent reduction in internal to external (IX) and external to internal (XI) vehicle trips
- Framework for immediate and continuing improvement to estimating mixed-use trip generation
- Still uses ITE (or other) trip rates
- Replaces current ITE mixed-use method but uses ITE trip rates
EPA MXD Model.

• Selected regionals included Atlanta, Boston, Houston, Portland, Sacramento, and Seattle.

• 239 MXD that met the ITE definition of multi-use development.

• Represents a wide range of urban scale, form, and climatic conditions.

• Accuracy verified through traffic generation comparisons at 27 mixed-use sites.
Sample MXD Model Validation Sites.

Atlantic Station, Atlanta
Uptown District, San Diego
Irvine California

Plano Texas
Celebration Florida
Otay Ranch California
EPA MXD Model Validation

- Gross Trips
- Net Trips
- MXD Model
- Observed

External Vehicle Trips (1000s)

Site 1 to Site 28
## EPA MXD Model Inputs

<table>
<thead>
<tr>
<th>D Variable</th>
<th>MXD Model Input</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Activity Density</td>
<td>Land Use Program</td>
</tr>
<tr>
<td>Diversity</td>
<td>Diversity</td>
<td>Land Use Program</td>
</tr>
<tr>
<td>Design</td>
<td>Intersection Density</td>
<td>EPA Smart Location Database (SLD)</td>
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<tr>
<td>Destinations</td>
<td>Employment within 1 mile</td>
<td>Local or Regional Travel Model</td>
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<tr>
<td></td>
<td>Employment within 30 minutes by transit</td>
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</tr>
<tr>
<td>Distance to Transit</td>
<td>Percentage of project within ¼ mile of transit</td>
<td>GIS Analyst</td>
</tr>
<tr>
<td>Development Scale</td>
<td>Building footprint</td>
<td>Site Plan</td>
</tr>
<tr>
<td>Demographics</td>
<td>Household size</td>
<td>Census Data</td>
</tr>
<tr>
<td></td>
<td>Auto ownership</td>
<td>American Community Survey</td>
</tr>
</tbody>
</table>
EPA MXD Model Outputs.

- Raw External Trips
- Net External Trips
- Internal trip reductions
- Non auto mode reductions (Transit, Bike, Walk)

- Raw Vehicle Miles Traveled (VMT)
- Net VMT
- Internal trip reductions
- Non auto mode reductions (Transit, Bike, Walk)

- Raw VMT per Household
- Net VMT per Household

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**SAMPLE DEVELOPMENT PROJECT PRELIMINARY TRANSPORTATION SUMMARY**

- **GROSS TRIP GENERATION**
  - Daily: Gross 64,036, Net 44,054
  - AM: Gross 5,288, Net 3,903
  - PM: Gross 6,168, Net 4,368

- **TRIP GENERATION REDUCTIONS**
  - Daily: 31%
  - AM: 25%
  - PM: 29%

- **SUMMARY OF TRIPS (FROM MXD)**
  - Daily: External Walk Trips 107,946, External Transit Trips 49,362, Internal Trip Capture 9,554, Net External Auto Trips 44,054
  - AM: 726, PM: 551
  - Net External Auto Trips 4,368

- **SUMMARY OF VMT REDUCTIONS (FROM MXD)**
  - Daily: Raw 270,446, Net 196,767
  - AM: Raw 26,099, Net 20,004
  - PM: Raw 27,555, Net 20,553
  - Daily: Raw 64,054, Net 44,054

- **SHARED PARKING MODEL**
  - Potential Cost Savings
    - Shared Parking Demand Reduction
      - Weekday: 13%
      - Weekend: 27%
    - Potential Cost Savings
      - Soft Paid: $8,150,000
      - Assigned: $28,250,000
      - Guaranteed Structure: $82,000,000

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**TOP ISSUES/CONCERNS**
- Congestion at freeway ramps and intersections adjacent to the project.
- Parking intrusion into the neighborhood north of the project.
- Cut-through traffic through the neighborhood.

**POTENTIAL TDM OPPORTUNITIES**
- Ride Share Programs
- Parking Cash Out
- Flextime/Telecommuting Opportunities
NCHRP Report 684.


- Analyzed internal-capture relationships of MXD sites, and 
- Examined the travel interactions among six individual types of land-uses:
  - Office 
  - Retail 
  - Restaurant 
  - Residential 
  - Cinema 
  - Hotel
NCHRP Report 684.

- Established interactions among the six land-use types of interest and compared them with site characteristics
- Examined percentage visitors to each land-use type who also visited each of the other uses during the same trip
- Considered site context factors and described percentage reductions in total traffic generations attributable to availability of transit service and other factors
- Compared results to the three sites in Florida provided in the ITE handbook
## NCHRP Report 684

### Percent Internal Capture

<table>
<thead>
<tr>
<th>Development</th>
<th>AM Peak Period</th>
<th></th>
<th>PM Peak Period</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>At Trip Origin</td>
<td>At Trip Destination</td>
<td>At Trip Origin</td>
<td>At Trip Destination</td>
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<tr>
<td>Mockingbird Station</td>
<td>31%</td>
<td>22%</td>
<td>36%</td>
<td>38%</td>
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<tr>
<td>Atlantic Station</td>
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<td>Legacy Town Center</td>
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<td>Country Isles</td>
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<td>Village Commons</td>
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<td>Boca del Mar</td>
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<td>8</td>
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</table>
# MXD+ - MXD and NCRRP-684 Combined

<table>
<thead>
<tr>
<th>Feature</th>
<th>EPA MXD Method</th>
<th>NCHRP 684 Method</th>
<th>MXD+ Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of Development</td>
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<td>✅</td>
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<tr>
<td>Diversity of Uses: Jobs/Housing</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<tr>
<td>Diversity of Uses: Housing/Retail</td>
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<td>✅</td>
<td>✅</td>
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<tr>
<td>Diversity of Uses: Jobs/Services</td>
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<td>✅</td>
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<tr>
<td>Diversity of Uses: Entertainment, Hotel</td>
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<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Design: Connectivity, Walkability</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<tr>
<td>Design: Separation Among Uses</td>
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<td>✅</td>
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<tr>
<td>Destination Accessibility by Transit</td>
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<tr>
<td>Destination Accessibility by Walk/Bike</td>
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<td>Distance from Transit Stop</td>
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<td>✅</td>
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<tr>
<td>Development Scale</td>
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<tr>
<td>Demographic Profile</td>
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### MXD⁺ - MXD and NCHRP-684 Combined

<table>
<thead>
<tr>
<th></th>
<th>EPA MXD Method</th>
<th>NCHRP 684 Method</th>
<th>MXD⁺ Method¹</th>
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<tbody>
<tr>
<td><strong>Daily Traffic Generation</strong></td>
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<tr>
<td>R-squared</td>
<td>96%</td>
<td>--</td>
<td>96%</td>
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<tr>
<td>Average Error</td>
<td>2%</td>
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<td>2%</td>
</tr>
<tr>
<td>Root Mean Square Error</td>
<td>17%</td>
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<td>17%</td>
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<tr>
<td><strong>AM Peak Traffic Generation</strong></td>
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<tr>
<td>R-squared</td>
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<td>93%</td>
<td>97%</td>
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<tr>
<td>Average Error</td>
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<tr>
<td>Root Mean Square Error</td>
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<td><strong>PM Peak Traffic Generation</strong></td>
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<tr>
<td>R-squared</td>
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<td>81%</td>
<td>97%</td>
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<tr>
<td>Average Error</td>
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<td>18%</td>
<td>4%</td>
</tr>
<tr>
<td>Root Mean Square Error</td>
<td>18%</td>
<td>36%</td>
<td>15%</td>
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</tbody>
</table>

¹ MXD⁺ - MXD and NCHRP-684 Combined
MXD⁺ Acceptance
MXD+ Tool

• Improved accuracy of trip generation estimates
• Provides substantial evidence
• Eliminates overestimation of trips
• VMT calculations
  • VMT by land-use
  • SB743
• GHG calculations
Conclusion.

• ITE trip generation rates are not default. ITE Handbook recognizes that land use context is the biggest variable influencing trip generation rate differences in the manual.

• ITE rates include only one variable, the amount of land use.

• MXD/MXD\(^+\) allows users to consider seven variables that directly address the Handbook recommendations to consider context while using ITE rates as the starting point.

• MXD/MXD\(^+\) also includes the ability to calculate VMT with the simple integration of trip lengths by purpose consistent with the new SB743 guidelines.
Thank You.

Questions?

Helpful Links:

• [https://www.epa.gov/smartgrowth/mixed-use-trip-generation-model](https://www.epa.gov/smartgrowth/mixed-use-trip-generation-model)
