Automated and Connected Vehicles: Planning for Uncertainty

Tim Burkhardt
APA Minnesota
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PLANNING IMPLICATIONS

- We plan for 20 years (or more)
- We design for 50 years (or more)
  - Elon Musk is not waiting!
  - AVs mainstream by 2030?
DECISION MAKING CHALLENGE!

- More uncertainty than usual
- We are just learning the questions…but what are the answers?
  - Technical
  - Policy
- Traditional tools and methods may not be adequate
1. Florida Automated Vehicle Initiatives (Statewide, FL)
2. TransFuture (Orlando, FL)
3. Autonomous Vehicles & Shared Mobility (Jacksonville, FL)
4. FHWA Connected Vehicle Benefit/Cost (Washington, DC)
5. Transit Alternatives Analysis (Rochester, MN)
6. On-Demand Rideshare ATCMTD Grant (Arlington, TX)
7. Integrated Corridor ATCMTD Grant App. (Riverside, CA)
8. Interstate 80 Automated Corridors (Statewide, IA)
9. Innovation Corridor I-380 (Cedar Rapids, IA)
10. Technology Corridor Assessment (El Paso, TX)
12. ITS Strategic Plan Update (Bellevue Washington)
13. Downtown Mobility Study (Denver, CO)
14. Planning & Environmental Linkages I-25 (Denver, CO)
15. Autonomous and Connected Vehicles Support (Berea, OH)
16. Interstate 24 Smart Corridor (Nashville, TN)
17. iFlorida Turnpike Sunshine Highway Design (Orlando, FL)
18. ITS America Smart City Leadership Circle (Columbus, OH)
19. Interstate 80 Master Plan (Statewide, Wyoming)
01 TransFuture
Introducing TransFuture

- Next-generation scenario planning tool
- Prepare for multiple futures
- Explicitly account for uncertainty
- Support a desirable future by incorporating flexibility
- Add-on lens to improve decision-making
Planning for Multiple Futures

Traditional planning for most likely future

Considering multiple futures and uncertainties

Acknowledging uncertainty

Composite Uncertainty Cone

Scenario I
Scenario II
Scenario III

Future Baseline

Possible
Plausible
Probable
Preferable

Today
Time
Development Approach

- Identify Trends
- Quantify Trends
- Deterministic to Probabilistic
- Understand Uncertainties
- Make Informed Decisions
- Implementation Plan
Emerging Trends

Changing Demographics
- Millennial travel behavior
- Aging population
- Generation Z

Improved Technology
- Automated vehicles
- Electric vehicles
- Workplace automation
- Improved user information & navigation
- Smart City

Shifting User Preferences
- Urbanization
- Shift from individual ownership to fleet ownership
- Telecommuting
- E-commerce & delivery options

Improved Travel Options
- Better walking and biking options
- Improved public transit
- Shared mobility
TREND: Automated Vehicle Adoption

What % market penetration is the tipping point?

Penetration Rate

- Kockelman - Aggressive
- VTPI - Conservative
- VTPI - Aggressive
- Kockelman - Conservative
- Kockelman - Moderate
- Goldman Sachs
TREND: Shared Mobility

- Reduction in auto ownership
- Potential increase in trips
- Fleet size reduction
TREND: Workforce Automation

• Jobs at risk for automation
• Transformation of the labor force
• Jobs of Generation Z (1995-today)
Conceptual Framework

Front End
- Regional travel demand model files
- Define scenarios

Process
- Probabilistic results and confidence intervals - AADT, VMT, VHT, etc.
- Scenario comparison
- Facility footprint

Input

Back End
- Regression analysis
- Elasticity analysis
- Monte Carlo Simulation

Output
Accounting for Uncertainty

\[ F = f(A, B, C, D, \ldots) \]

- Impact of Aging on Demand, %
- Impact of Autonomous Vehicles (AV) on Effective Capacity, %
- Impact of Telecommuting on Demand, %
- Impact of Enhanced Navigation, %

2035 LOS

Jointly Determined Probabilities

A strike zone is not a single point.

• Joint probability distribution
Hypothetical Freeway Corridor Analysis

Baseline Scenario

- 6-lane capacity
- 8-lane capacity
- 10-lane capacity

AADT

8 lane by 2045;
10 lane by 2056
Hypothetical Freeway Corridor Analysis

Build Scenario

- 6-lane capacity
- AADT
- 8 lane by 2048
02 I-80 Automated Corridors
I-80 Automated Corridor Study Goals

- Develop a range of expectations for future automated vehicle (AV) adoption
- Estimate AV benefits to traffic operations and safety on rural I-80
- Determine the impact of AV on I-80 system planning and design
Introducing automated vehicles reduces crashes

- Reductions near 70% of total crashes for 85% AV

- Crash rates (normalized for volume) also drop substantially
Traffic Analysis

- DOT Statewide travel model runs
  - 2040 4-lane I-80
  - 2040 6-lane I-80

- Research on AV impact to demand
  - Induced trips due to AV
  - Potentially longer trips as well

Traffic Demand by Future Year and AV Market Penetration

<table>
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<tr>
<th>Year</th>
<th>Scenario</th>
<th>Average Daily Traffic Volume</th>
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<tr>
<td>2014</td>
<td>No-Build</td>
<td>33,500</td>
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<tr>
<td>2025</td>
<td>20% AV</td>
<td>49,500</td>
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<tr>
<td>2025</td>
<td>50% AV</td>
<td>60,100</td>
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<tr>
<td>2030</td>
<td>No-Build</td>
<td>51,900</td>
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<td>2040</td>
<td>Build 0%</td>
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<tr>
<td>2040</td>
<td>Build 85%</td>
<td>77,100</td>
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Interstate 80 Automated Vehicle Simulation
Automated Vehicles in Mixed Traffic with Human Drivers

- Dark Blue – AV Car
- Light Blue – AV Car in platoon
- Green – Manual Car
- Purple – AV Truck
- Yellow – Manual Truck
FUTURE PROOFING

• Don’t over build – cost savings
• Preserve ROW for potential future need
• Invest in technology – future proof investments
  • Cable, power, machine vision (reference markers), data management
DESIGN FOR UNCERTAINTY

- Modular lanes
  - Dynamic lane markings
  - Right pavement design
  - Full depth shoulder
- Technology roadmap
Thank you

Tim Burkhardt, AICP
HDR
tim.burkhardt@hdrinc.com
(763) 591-5434