Scenario Planning for Connected and Automated Vehicles

A Pending Report for the FHWA Office of Policy

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Project Purpose and Objectives

**Purpose** - Equip agencies with information and tools to consider uncertainties of CV/AV deployment

- **Research** current literature
- **Create** scenarios of potential CV/AV deployment
- **Conduct** workshops to refine and test scenarios
- **Assess** overarching scenario impacts and implications
- **Summarize** scenario development and testing approach
Motivation

- Agencies are developing **performance-oriented** policies, plans, and investment decisions

- **Disruptive and transformational forces** are rapidly altering the transportation landscape
  - Connectivity
  - Autonomy
  - Sharing

- **Decisions** must account for these uncertainties
Scenario Planning Process

1. Establish scope
2. Assess current conditions
3. Identify values and goals
4. Envision potential futures
5. Evaluate impacts
6. Decide vision/ next steps

FHWA Scenario Planning Guidebook, 2011
Scenario Development Ground Rules

- DO NOT attempt to predict the future
- DO NOT try to pick winners
- DO envision several possible futures
- DO keep in mind the agency’s spheres of influence
- DO keep the focus on CV/AV
- DO factor in revolutionary change, but remember the timeline

Bottom right image: Ohio-Kentucky-Indiana (OKI) 2040 Regional Plan
Scenario Building Blocks

Forces
- environment...
- economy...
- society...
- technology...

Levers
- infrastructure conditions...
- travel choices...

Outcomes
- congestion...
- reliability...
- safety...
- quality of life...
Scenario Time Horizon

- Near enough to be relevant
- Far enough to be visionary
- Capture the trajectories
  - Tipping points
  - Trends

Tipping points include watershed events or “critical mass” evolutionary shifts that indicate a significant change in direction or magnitude.
Forces and Levers

Technological Advances
Lifestyle/Consumer Preferences
Socio-Economic Factors
Policy/Regulations

Importance  Uncertainty  Tipping Points

... fuel sources.. energy systems ... climate conditions ... funding ...
Technology Advancements

- Machine learning/AI growth
- Sensorization (cheap, low cost sensors support AV tech)
- Battery + charging technology
- Growth in mobile platforms
- Mapping
- New modes (flying cars, drones)
- 5G + wireless technology
- Big data / analytics
- VR and augmented reality
- Industrial automation
- DSRC adoption
- Cybersecurity
- TMC tech (AV-readable signage)
- New vehicle types

Three key trends: Artificial Intelligence, Transparently Immersive Experience, Digital Platforms

www.gartner.com
Lifestyle/Consumer Preferences

- Acceptance levels of technology
- Car ownership
- Affinity for sharing economy
- Preference for nonmotorized transport
- Desire for on-demand services
- Preferred urban form
- Eco-consciousness
- Nature of working habits
- Trust in government/regulations
Socio-Economic Factors

- Mobility as service business models
- Aging baby boomers
- Non-driving urban population
- Housing prices
- Employment levels/ workforce trends
- Market forces (fuel and materials, international leapfrogging)
- Car manufacturing trends/ vehicle prices
- Liability / insurance frameworks
- Urbanization
- Immigration
National/ Global Policy

- Trade policy
- International carbon trading or climate policy
- Other international regulations on engines or other technology
- Tax incentives and credits
- Technology mandates (such as DSRC on light-duty vehicles)

"Sure, it's a great invention, but does it comply with all government guidelines?"
State/ Regional/ Local Policy

- Restrictions or bans on technology types
- Incentives for activities or technologies
  - Parking policy
  - Housing policy
  - VMT / travel pricing
- Infrastructure investments
- Operational strategies
- Public transit investments/ upgrades

Categories of AV Legislation Across US

Source: Adopting and Adapting State Policies for Automated Vehicles, Eno Center for Transportation www.enotrans.org

Executive Order, Limited Pilots, or Advisory Committee
No AV Law or AV Law Under Consideration
Enacted broad piloting or testing laws
Full AVs explicitly allowed

Source: National Conference of State Legislatures and Individual state legislation 11
Created by: Ann Henenberg / Eno Center for Transportation
2035 CV/AV Scenarios

Enhanced Driving Experience
- Managed Autonomous Lane Network
  AV lane networks
  AV travel is consolidated to a large-scale lane network with significant consumer adoption
- Ultimate Driver Assist
  Ultra-Connectivity
  AV adoption stalls, CV becomes ubiquitous

Slow Roll
- Slow Roll
  Minimal Plausible Change
  Accounts for advances in safety technology, TSMO and mobility services

Driver Becomes Mobility Consumer
- Niche Service Growth
  High AV/CV in certain cases
- Competing Fleets
  Automated TNC fleets compete
- RoboTransit
  Automated mobility-as-service
  Strong public-private partnership for system optimization

Trajectories towards CV/AV Advancements
TODAY
<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>Scale Ratings</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Connectivity</strong></td>
<td><strong>Automation</strong></td>
<td><strong>Cooperation</strong></td>
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<tr>
<td>Slow Roll</td>
<td></td>
<td>Minimum change beyond currently available technology and investments already in motion</td>
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<tr>
<td>Niche Service Growth</td>
<td></td>
<td>Innovation proliferates, but only in special purpose or “niche” applications</td>
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<tr>
<td>Overall System</td>
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<tr>
<td>Niche Service Areas</td>
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<tr>
<td>Ultimate Traveler Assist</td>
<td></td>
<td>CV technology progresses rapidly, but AV stagnates</td>
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<td>Overall System</td>
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<tr>
<td>Managed AV Lane Network</td>
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<td>Certain lanes become integrated with CV and AV</td>
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<tr>
<td>Overall System</td>
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<tr>
<td>AV lanes</td>
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<tr>
<td>Competing Fleets</td>
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<td>TNC-like services proliferate rapidly, but do not operate cooperatively</td>
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<tr>
<td>RoboTransit</td>
<td></td>
<td>On-demand shared services proliferate and integrate with other modes via cooperative data sharing, policies, and infrastructure</td>
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Common Assumptions

- Mobile technology continues rapid advance
- 5G cellular connectivity available nationwide except some rural areas
- Mobility applications (multimodal routing, real-time travel info) are prevalent.
- Accepted international V2X standards enable interoperability among key industry players (automakers, construction companies, technology vendors, etc)
- CV/AV systems pass rigorous cybersecurity tests; industry-standard security system in place.
Next Steps: Test-run Scenarios, Report Findings

What kinds of decisions do agencies want to address?
- Long range policies/strategies
- Short term infrastructure investments
- Multimodal operations
- Incentives / regulations

What types of plans are most relevant?
- LRTP
- Asset Management
- Freight Plan
- TIP/STIP
- ITS Master Plan

How might impacts/issues differ by placetype?
- Mega-region
- State
- Large / medium/ small urban
- Small town/ rural
For More Information …

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