Planning for Uncertainty

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Lorna Parkins AICP
30 Years of Planning

Explain the past ➔ Predict the future
A funny thing happened around 2004...

→ 2013 Real US GDP

→ 2013 US Vehicle Miles Traveled

Where do we go from here?
Disruptors cause uncertainty

- Technology Advances
- Changing Values
- Globalization

Uncertainty
Exploratory Planning for uncertain times

- What is the range of outcomes?
- What are the risks?
- What are the opportunities?
Normative vs Exploratory Planning

Normative scenarios envision what SHOULD happen?

EXPLORATORY scenarios ask what COULD happen?

→ Discerning preferences, articulating values, shaping vision, strategizing preferred outcomes

→ Discovering opportunities, identifying risks, shaping tactics, optimizing chances of success

What SHOULD Happen?

How should we grow?

How should we invest?

What COULD Happen?

What if we grow much faster or slower?

How might new technologies change the game?
What are the big disruptors?
Generational changes
There is a new demographic profile
Different values govern life choices
Millennials and Boomers alike want:
Economic Disruptors
Economic Disruptors
Supply Chain Dynamics

1. **Driver**
   - Information Technology in Transport & Warehousing

2. **Operating Effects**
   - *Increased Efficiency* (e.g. higher capacity/lower costs)

3. **Transportation Effects**
   - *Decreased VMT*
   - *Decreased Efficiency* (shorter, smaller, & time-sensitive deliveries)
   - *Increased VMT*

VMT: Vehicle Miles Traveled
Tell me about economic...

**OPPORTUNITIES**
- Technology
- Workforce
- Training
- Transportation

**THREATS**
- Technology
- Workforce
- Training
- Transportation

Intercity Service
Technology Disruptors

- Connected vehicles
- Autonomous vehicles
- Mobility as a service
- Information systems
Connected and Automated Vehicles (CAV)

55 international cities are hosting CAV tests or have committed to doing so in the near future

29 international cities are undertaking long-range surveys of the regulatory, planning, and governance issues raised by CAVs, but have not yet started piloting
Autonomous Shuttles/Transit

Dozens of international cities are conducting autonomous shuttle pilot/deployment programs
Mobility as a Service
Information Systems
Hype Cycle for Emerging Technologies

Source: Gartner 2017
Levels of Vehicle Automation

Source: SAE and Michael Baker International
Connected vehicles

**Vehicle-to-Network**
e.g. traffic 5 miles ahead

**Vehicle-to-Pedestrian**
e.g. pedestrian in walkway ahead

**Vehicle-to-Infrastructure**
e.g. traffic signal ahead turning red

**Vehicle-to-Vehicle**
e.g. emergency vehicle approaching
Highly automated vehicles

HOW WAYMO'S SELF-DRIVING CAR WORKS

One of Waymo’s three lidar systems that shoots lasers so the car can see its surroundings. Waymo says this lidar can detect a helmet two-football fields away.

A forward facing camera works with 8 others stationed around the car to provide 360 degrees of vision.

Radar sensors can detect objects in rain, fog, or snow.

Waymo’s self-driving sensors are tightly integrated into the hybrid minivan created by Fiat Chrysler.

SOURCE: Waymo
Vehicles will be connected and automated

Connected Automation for Greatest Benefits

Autonomous Vehicle
- Operates in isolation from other vehicles using internal sensors

Connected Vehicle
- Communicates with nearby vehicles and infrastructure

Connected Automated Vehicle
- Leverages autonomous and connected vehicle capabilities
Red Light Violation Warning

Vehicle approaching intersection too fast, signal is turning red

Approaching vehicle receives SPaT message, identifies threat

Driver Vehicle Interface (DVI) alerts driver to brake

Smart signal broadcasting Signal Phase and Timing (SPaT)
How Transportation Technology Could Impact Travel Demand

Technology could contribute to roadway travel demand by increasing mobility options for those who cannot currently drive, generating new zero-occupancy vehicle trips, facilitating longer distance commutes, generating additional convenience-based trips, and by potentially reducing time and miles spent searching for parking.
As we think about disruptors...

We begin to see potential causes and effects ...

...and the benefits of exploring the range of outcomes
Preparing for Uncertainty: Exploratory Planning

OVERVIEW
Start with drivers

DRIVERS (What drives change globally)

- DEMOGRAPHIC
- ECONOMIC
- TECHNOLOGICAL
- ENVIRONMENTAL

TRANSPORTATION OUTCOMES (How global change can affect transportation)

- DEMAND/BEHAVIOR
- SUPPLY / DELIVERY
- OPERATIONS / PERFORMANCE
- SYSTEM / USER COSTS

Impact on Transportation

Uncertainty

We Make a Difference
Assessing drivers

Example of Public Input Received on Technology Drivers

Y-Axis – Impact on Transportation

X-Axis – Degree of Uncertainty
Chain of logic from inputs to outputs

Driver

Behavior

Impact

Research, data analysis, extract data from models

Research, expert input, public input

Research, data analysis, apply models
Iterative process to define scenarios

- Iterative Process
- Adapt to achieve:
  - Internal consistency
  - Range of outcomes
Potential exploratory planning outputs

Person Travel
- Person Trips
- Person Miles
- Mode Mix

Freight Movement
- Freight Trips
- Ton Miles
- Mode Mix

All Travel
- Recurring Congestion
- Vehicle Miles
- Non-Recurring Congestion

Costs
- User Costs
- System Costs
Exploratory Planning Toolkit

<table>
<thead>
<tr>
<th>DRIVERS</th>
<th>COMMUNITY TYPES</th>
<th>GENERATIONS</th>
<th>INDUSTRY MIX</th>
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<tbody>
<tr>
<td>Demographic</td>
<td>V6 – Multimodal Urban</td>
<td>Baby Boomer</td>
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<tr>
<td></td>
<td>V5 – High Density Suburban</td>
<td>Generation X</td>
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<td></td>
<td>V4 – Multimodal Suburban</td>
<td>Millennial</td>
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<td>V3 – Small Town/Suburban</td>
<td>Generation Z</td>
<td>Generation Z</td>
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<td></td>
<td>V2 – Low-Density Suburban</td>
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<td>V1 – Rural</td>
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<td>Generation X</td>
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<tr>
<td>Technology/Mobility</td>
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<td>Generation Z</td>
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</tbody>
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Example Exploratory Scenarios

High Growth Industrial
- Less Urban
- Higher VMT Assumptions

High Growth High Tech
- More Urban
- More Multimodal

Moderate Growth
- Older Demographics
- Walkable Places

Reduced Growth
- Federal Spending Reduced
- Slower adoption of technology
Two Key Criteria to Define Placetypes

1. People + Jobs Per Acre (Density)
2. Transit Accessibility

The Placetypes reflect areas with noticeable differences in travel behavior as it relates to land use patterns.
Linking land use and transportation

VTrans2040 Placetypes
- V1 - Rural
- V2 - Low Density Suburban
- V3 - Small Town/Suburban
- V4 - Multimodal Suburban
- V5 - High Density Suburban
- V6 - Multimodal Urban
- PDC Boundaries

Differentiate:
- Mode Split
- Demographics
- Trip Rates
- Technology Implementation
Baseline Technology Assumptions

[Image: Bar chart showing technology assumptions for different regions.]

- V1 Rural
- V2 Low Density Suburban
- V3 Small Town/Suburban
- V4 Multimodal Suburban
- V5 High Density Suburban
- V6 Multimodal Urban

% Automation [1]
% Mobility on Demand [2]

[1] [2] Information above was inspired by public input

V2V connectivity. I-95 Corridor Coalition
Technology and travel behavior

Assumptions become more robust when applied differently to different placetypes.
Technology and roadway capacity

CAV Capacity Benefits

Although VMT is expected to increase, vehicle technology & infrastructure improvements will help increase travel efficiency and throughput (effectively increasing roadway capacity)
What about transit?

Anticipate a Spectrum of Services...

- Rail
- BRT
- Fixed-Route Bus
- Custom Route Bus
- Circulator Shuttles
- Personal Transit

Fixed Route
High Capacity

Demand-Responsive
Lower Capacity
Chain of logic from inputs to outputs

Driver
Research, data analysis, extract data from models

Behavior
Research, expert input, public input

Impact
Research, data analysis, apply models
Exploratory Planning Outcomes
Comparing scenarios – high level insights

- Industrial Renaissance
- Techtopia
- Silver Age
- General Slowdown

DEMAND
- Pop. VMT

SYSTEM CAPACITY
- PTP

PTP: Person Through-put
Inter-City Corridors

Parallel U.S. Highway, designated for CAV & conventional vehicles and cyclists/pedestrians (via shared-use path). Includes a managed lane (middle) for trucks.

CAV-only interstate that maximizes efficiency for passenger vehicles, trucks, and transit vehicles (via full-depth shoulder during peak period). Interstate is equipped with sensors that communicate with vehicles. Managed lanes (middle) provide flexibility, serving as reversible HOT lanes with mobile charging.

Parallel rail corridor, offering enhanced passenger service and freight capacity.
Envisioning the Future...

1. Separated bike lanes and walkways
2. High quality rapid transit systems with dedicated lanes or tracks
3. Autonomous transit shuttles to connect to high volume transit corridors
4. Inductive charging strips in pavement offers charging boost for electric vehicles
5. Mobility-on-demand services, like bikeshare
6. “Smart intersections”, equipped with sensors that seamlessly relay traffic and safety information to motorists
7. Smaller freight vehicles (trucks, vans) and drone delivery
Small Towns

Envisioning the Future...

1. Smaller vehicle, flexible-route transit service
2. Mobility-on-demand services, like bikeshare and carshare
3. Pedestrian/bike-friendly intersections that alert vehicles/motorists of pedestrian and cycling activity
4. Designated pick-up and drop-off areas for autonomous vehicles
5. “Smart intersections”, equipped with sensors that seamlessly relay traffic and safety information to motorists
Key Findings: How can we prepare for the future?

Anticipate Increased Demand

- Automated and on-demand vehicles will unleash growth in travel demand
- Foreseeable changes in travel behavior with connected and automated vehicles (CAV) will increase travel demand
- Tech. innovations in the economy as well as transportation will spur growth in freight traffic

Technology Will Enhance System Performance

- Safety improvements will reduce congestion from incidents
- Information will improve efficient use of the whole system
- Vehicles will become safer, smaller, and able to travel closer together

Timing is Key – Balancing these two sides of the technology future is critical

Design is also Key – Walkable and multimodal places have the most balanced outcomes
Focus on risks and opportunities

Risks

Opportunities

Safety

Mobility

Security

Funding

Data
Monitor trends, impacts and investments
Questions and Discussion