The 3 Transportation Revolutions

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30 November 2016
Vehicle Electrification
+ Shared Mobility
+ Automation
= ??
Revolutions?

Societies and economies were transformed by British and American industrial revolutions, and then information revolution

• **Electrification?**
  – Long lead time (since 1990) softens disruptions
  – Huge impact on auto industry, but impacts on society and economy are limited

• **Shared Mobility?**
  – Disruptive to taxis, likely automakers, and probably transit (in positive way)
  – If directed toward high load factors (Lyftline, Uberpool, micro-transit) then potential for broad transformations

• **Automation**
  – Potentially greatest impact of the 3
  – Could transform lifestyles, cities, economies

*Industrial revolutions comprise not just technical innovations but stream of economic, social, and political changes.*
Challenge

• How to direct these “revolutions” toward the public interest?
  – Social equity
  – Sustainable cities (economics, lifestyles, livability)
  – GHG reduction
Policy Briefs (Outputs of the Conference)

1. Maximizing the Social Equity Benefits of these Innovations
2. Clean Car Policies for Automation and Sharing
3. Synergies with Public Transit
4. Reducing Overall Vehicle Use with Automation and Shared Mobility
5. Road Pricing for Shared Use, ZEV, and Automated Vehicles
6. Active Transportation
7. Governance: Who’s in Charge?
Transportation Heaven ... when the 3 “revolutions” are integrated so that vehicles are shared, electric, and automated!

- Much safer (because automated)
- Less VMT (because of sharing)
- Much smaller/lighter vehicles (no need for steel frames, safety equipment)
- Much less traffic congestion (lanes narrower, vehicle headway shorter)
- More urban space (less parking, roadspace)
- EVs more economical because intensively used

➢ **Much less GHGs!**
Expand Traveler Choice Using ICT (Plus Automation)

- Increase vehicle occupancy
- Improve multi-modal connections
- Introduce new options to poorly served areas
- Reduce individual ownership
- Converting fixed costs into variable costs (for travelers)
- Reduces VMT and Emissions
Vehicle Automation Increases or Reduces Energy Use/GHGs?!
Some Evidence for Sustainability ... but minimal so far

• Carsharing participants own fewer vehicles than others (Martin et al. 2010)
• Those who use ride-sourcing services may have lower VMT (Rayle et al. 2014), and
• ... in some cases reduced levels of vehicle ownership (Dutzik et al. 2013)
• Those who use on-demand ridesharing services also tend to use transit (American Public Transportation Association 2016)
Key Questions

1. How many people at what price are willing to share rides?
   - More or less willing with AVs?

2. Under what conditions will people give up their cars?
   - More or less willing with AVs?

Key “risk”: AVs would be mostly personally owned

- Much more VMT (including “zombie” cars)
- Greater split between rich and poor
Do Travelers Want to Share a Ride?

Carpooling has largely failed!

Will a generation, many of whom haven’t shared bathrooms or bedrooms or phones or televisions or dorm rooms, share small vehicles with strangers?
### Is Low Price Enough to Induce “Pooling”? Cost of Car vs Transit vs Uber/Lyft (adapted from Polzin, 2016)

<table>
<thead>
<tr>
<th>Cost Analysis</th>
<th>Description</th>
<th>Cost Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auto Capital and Operating Cost (business)</strong></td>
<td>$0.57/mile</td>
<td></td>
</tr>
<tr>
<td><strong>“Out of Pocket” (defined by IRS for charity)</strong></td>
<td>$0.14</td>
<td></td>
</tr>
<tr>
<td><strong>BLS Consumer Expenditure Survey</strong></td>
<td>$0.44/vmt</td>
<td>$0.26/pmt</td>
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<tr>
<td><strong>Transit Fares</strong></td>
<td>~$0.24/mi</td>
<td></td>
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<tr>
<td><strong>TNC “Glorified Taxis” (Uber/Lyft)</strong></td>
<td>~$0.65-2.00/mi</td>
<td></td>
</tr>
<tr>
<td><strong>TNC Pooling (UberPool, LyftLine)</strong></td>
<td>~$0.35-1.00/mi</td>
<td></td>
</tr>
<tr>
<td><strong>Automated Vehicle (shared ride)</strong></td>
<td>~&lt;$0.20-???? (plus benefits of “free time”)</td>
<td></td>
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</tbody>
</table>

*Source: IRS*
Ownership Not Just a Mobility Decision (slide by Steve Polzin)

Functional transportation

Transportation plus?

Ego
Investment
Image
Hobby
Entertainment
Hype Cycle for Emerging Technologies

Source: Gartner (August 2014)
AV Sales Promised by 2019-2021
& New Companies Emerging

Old guard:
- GM
- Ford
- Toyota
- Nissan
- Volvo
- BMW
- Audi
- Volkswagen

New companies:
- Google
- Tesla
- Uber
- Apple
- Many startups

Driverless Car Market Predictions

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Year in the Market (Year Announced)</th>
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</thead>
<tbody>
<tr>
<td>Google's founder Sergey Brin</td>
<td>2018 (2012)</td>
</tr>
<tr>
<td>Volkswagen head of Digitalization Strategy, Johan Jungwirth (not necessarily Volkswagen brand)</td>
<td>2019 (2016)</td>
</tr>
<tr>
<td>General Motors head of foresight, Richard Holman</td>
<td>2020 (2016)</td>
</tr>
<tr>
<td>Ford's head of production development, Raj Nair</td>
<td>2020 (2016)</td>
</tr>
<tr>
<td>Toyota</td>
<td>2020 (2015)</td>
</tr>
<tr>
<td>Andy Palmer, the Executive Vice President of California-based Nissan Motors Ltd</td>
<td>2020 (2013)</td>
</tr>
<tr>
<td>Ford CEO, Mark Fields</td>
<td>2021 (2016)</td>
</tr>
<tr>
<td>BMW CEO, Harald Krueger</td>
<td>2021 (2016)</td>
</tr>
<tr>
<td>Baidu's Chief Scientist</td>
<td>2021 (2016)</td>
</tr>
<tr>
<td>Tesla's Founder, Elon Musk</td>
<td>2021 (2015)</td>
</tr>
<tr>
<td>Justin Rattner, CTO of Intel</td>
<td>2022 (2012)</td>
</tr>
<tr>
<td>Jaguar and Land Rover's Director of Research and Technology</td>
<td>2024 (2014)</td>
</tr>
<tr>
<td>U.S. Department of Transportation</td>
<td>2025 (2015)</td>
</tr>
<tr>
<td>Dieter Zetsche, Chairman of Daimler</td>
<td>2025 (2014)</td>
</tr>
<tr>
<td>Automotive Supplier Continental</td>
<td>2025 (2012)</td>
</tr>
<tr>
<td>Robert Hartwig, President of the Insurance Information Institute</td>
<td>2028 (2013)</td>
</tr>
<tr>
<td>Institute of Electrical and Electronics Engineers (IEEE)</td>
<td>2040 (2012)</td>
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Will There be a Backlash?

Modification to the Second Amendment to the U.S. Constitution

A well regulated militia being necessary to the security of a free State, the right of the People to keep and bear arms shall not be infringed.

Adopted December 15, 1791

Amended June 20, 2021
What is Likely?

• Minimal public benefits until cars are fully driverless
  • Traffic congestion, VMT, GHGs, safety
• Fully automated cars are inevitable
• Fully driverless cars will be introduced in early 2020s, but very few and only in very limited circumstances
  • e.g., Lyft/Uber cars on select routes
  • How many individuals would buy expensive automated cars?
  • Policy challenges (safety regulations, opposition by many?)
With a little advertisement on California test track...
Connected Vehicle and Autonomous Vehicle (CV/AV) Program and Test Facility

Randy Iwasaki
Executive Director
Contra Costa Transportation Authority
December 1, 2016
Over 5000 acres with 2100 acres available for testing
Over 20 miles of paved roadways including a 7-mile long spine road for high speed testing
Randy Iwasaki
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@riwasaki2
Thank You