The Future of Driving in the Land of Freeways

Susan Handy
Center for Transportation Studies Annual Research Conference
Minneapolis, MN
November 2018

27,476 lane-miles of freeways
24.8 million licensed drivers
27.7 million cars & trucks
38.8 million residents

The California Experiment to reduce vehicle travel
Annual VMT per Capita in US
(VMT = vehicle miles traveled)

Source: Bureau of Transportation Statistics, U.S. Census

Annual VMT per Capita – CA vs US
(VMT = vehicle miles traveled)

Source: Bureau of Transportation Statistics, U.S. Census, CA Dept of Finance
AB32 The California Global Warming Solutions Act of 2006

80% reduction of GHG from 1990 levels by 2050
+SB 32 of 2016: 40% below 1990 by 2030

Source: CARB, California GHG Inventory for 2000-2008; Scoping Plan, 2020 Emissions Forecast
SB375 Sustainable Communities and Climate Protection Act of 2008

Targets for reducing per capita GHG emissions from cars and light trucks for metropolitan areas by reducing vehicle-miles-traveled (VMT)

<table>
<thead>
<tr>
<th>Examples</th>
<th>2020</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sacramento</td>
<td>-7%</td>
<td>-16%</td>
</tr>
<tr>
<td>San Francisco Bay Area</td>
<td>-7%</td>
<td>-15%</td>
</tr>
<tr>
<td>Los Angeles region</td>
<td>-8%</td>
<td>-13%</td>
</tr>
<tr>
<td>San Diego</td>
<td>-7%</td>
<td>-13%</td>
</tr>
</tbody>
</table>

Sustainable Communities Strategies (SCSs)
San Diego Example

1999 - Conventional vision for 2020

2013 - Post-SB375 vision for 2050

How do we know what will work?
"The impacts from the studies that used California data [lead us to the] conclusion that doubling density is associated with VMT reductions that range from approximately 5 to 12 percent (an elasticity of -0.05 to -0.12).
Research Contribution: Syntheses of Findings

Volker and Fang

Cutting Greenhouse Gas Emissions Is Only the Beginning: A Literature Review of the Co-Benefits of Reducing Vehicle Miles Traveled

March 2017

National Center for Sustainable Transportation

Boarnet

The Economic Benefits of Vehicle Miles Traveled (VMT)-Reducing Placemaking: Synthesizing a New View

November 2017

National Center for Sustainable Transportation

Research Contribution: Planning Tools

Evaluation of Sketch-Level VMT Quantification Tools
Handy, Fang, Lee for the California Strategic Growth Council, 2015-2017

- 12 tools initially identified
- 6 tools selected for application to case studies (in bold)
- Widely different estimates
- Pros and cons for each method

Watch it on YouTube!
https://ncst.ucdavis.edu/events/webinar-quantifying-vehicle-miles-traveled/
Research Contribution: Planning Tools

Quantification Methods for Estimating Greenhouse Gas and Air Pollutant Emission Reductions
Handy, Kendall, Barbour, and Volker For the California Air Resources Board, 2017-2019

Quantification methods used to estimate GHG emissions for proposed land development and transportation projects for Greenhouse Gas Reduction Fund Programs.

Reviews of methods for:
- Infill development
- Transit investments
- Bicycle facilities
- Pedestrian facilities
- More to come...

Research Contribution: Before-and-After Studies

Driving Reduction After the Introduction of Light Rail Transit
Spears, Boarnet, Houston for the California Air Resources Board, 2011 - 2014

“At 18 months after opening, daily mileage for households close to the line was approximately 30 percent lower than that of control households. This change appears to have resulted primarily from changes in car trip lengths. Average car trip length declined in each wave for the households within 1 km of new light rail stations, resulting in a difference of nearly four miles per trip...”
Research Contribution: Before-and-After Studies

Measuring the Impact of Local Land Use Policies on Vehicle Miles of Travel
Handy, Lovejoy, Salon, Mokhtarian, Sciara for UC Davis Sustainable Transportation Center, 2010-2011

It will take all of these strategies.

It will take action at all levels of government.

The benefits will go far beyond GHG reductions.

Significance for t-test of means (across years): * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. 

Vehicle-miles (per capita monthly)
The future of driving in California and beyond

VMT in the future?

“The aggregate trends discussed do not allow us to forecast with any certainty the car use that we can expect in the future.” – Goodwin and Van Dender, 2013
Autonomous Vehicles

Predictions of the past
Predictions of the past

“There’s talk among tech insiders that it could be bigger than the PC. [Inventor Dean] Kamen says it ‘will be to the car what the car was to the horse and buggy.’”

- Wall Street Journal 9/27/10

Technology as a social construct

“Technology does not act as a kind of traffic policeman that is distinct in nature from the traffic it directs.”

“Technological development should be viewed as a social process, not an autonomous occurrence.”
– Wiebe Bijker, “Of Bicycles, Bakelites, and Bulbs”
What do AVs mean for the future of driving?

Point 1: It depends on what people decide to do with them

How do we as individuals and households make choices about travel?

How and why are these choices changing?

How can we nudge them in the right direction?

Nested choices

<table>
<thead>
<tr>
<th>Long-term Choices</th>
<th>Mid-term Choices</th>
<th>Short-term Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifestyle</td>
<td>Driver’s license</td>
<td>Trip frequency</td>
</tr>
<tr>
<td>Residential</td>
<td>Auto ownership</td>
<td>Trip destination</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td>Mode choice</td>
</tr>
</tbody>
</table>
Choice process

Knowledge, perceptions

Set of choices available
- Drive alone
- Shared ride
- Bus
- Rail
- Bicycle
- Walk
- Skateboard

Qualities of choices available
- Cost
- Time
- Comfort
- Safety

Value placed on different qualities
- Cost vs. Time
- Time vs. Comfort
- Comfort vs. Safety

Needs, constraints

Changes in all cells

<table>
<thead>
<tr>
<th></th>
<th>Choice Sets</th>
<th>Choice Qualities</th>
<th>Value of Qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term Choices</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Mid-term Choices</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
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<tr>
<td>Short-term Choices</td>
<td>▲</td>
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WHAT IS MAAS? Mobility as a Service

MOBILITY OPERATOR

Car Share
Bike Sharing
Pods
Ride-Sharing
Bikesharing
Commuter
Autonomous
Transport System
Multimodal
Transportation System
Smart Payment System
Connected Vehicles
Smarter Parking
Incentives
Road Traffic
Connected
Transit
E-Calls
Airports
Health
Education
E-Government
Real-Time
Traffic Management
Smart
Living

Neighborhood Electric Vehicles
Dynamic Ridesharing
Carsharing
Bike Sharing
Smart Paratransit
Changes in all cells

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<td></td>
<td></td>
</tr>
<tr>
<td>Short-term Choices</td>
<td></td>
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</table>

Research Contribution: Behavioral Research

California Panel Study of Emerging Transportation Trends
Led by Giovanni Circella for the ITS-Davis 3 Revolutions Future Mobility Program

- Statewide longitudinal study with rotating panel
- 2015 survey: Millennials (18-34) and Generation X (35-50)
- 2018 survey: All age groups
- Quota sampling by geographic region and neighborhood type
- Focus on changing lifestyles, travel behavior, adoption of shared mobility and propensity to use AVs
Adoption of Shared Mobility: 2015-2018

2015 - Bike Sharing
- I use it 3 or more times a week
- I use it 1-2 times a week
- I use it 1-3 times a month
- I use it less than once a month
- I used it in the past, but not anymore
- It's familiar but I've never used it
- I am not familiar with it

2018 - Bike Sharing
- I use it 3 or more times a week
- I use it 1-2 times a week
- I use it 1-3 times a month
- I use it less than once a month
- I used it in the past, but not anymore
- It's familiar but I've never used it
- I am not familiar with it

2015 - Car Sharing
- I use it 3 or more times a week
- I use it 1-2 times a week
- I use it 1-3 times a month
- I use it less than once a month
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2018 - Car Sharing
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2015 - Ride Hailing
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2018 - Ride Hailing
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2018 - Shared Ride Hailing
- I use it 3 or more times a week
- I use it 1-2 times a week
- I use it 1-3 times a month
- I use it less than once a month
- I used it in the past, but not anymore
- It's familiar but I've never used it
- I am not familiar with it
Changes in Use of Ridehailing by Region

On average, the adoption and frequency of use of ridehailing almost doubled from 2015 to 2018:

Use of Ridehailing by Place Type

Ridehailing is far lower in rural areas, regardless of region:
Impact of Ridehailing on VMT

What Would You Have Done if Ridehailing Was Not Available?

- Car
- Public bus
- Light rail/tram/subway
- Commuter rail
- Bike or walk
- Taxi
- I would not have made this trip

Impact of Ridehailing on VMT

Attitudes Towards Autonomous Vehicles

“Be one of the first people to buy a self-driving vehicle...”

- Very unlikely
- Somewhat unlikely
- Neither unlikely nor likely
- Somewhat likely
- Very likely
Attitudes Towards Autonomous Vehicles

Expectations about the Adoption of Autonomous Vehicles and Changes in Vehicle Ownership

- Keep the vehicle(s) that I/my household owns (if any) and not use a driverless taxi or shuttle
- Get rid of one (or more) of my household vehicles and use a driverless taxi or shuttle.

<table>
<thead>
<tr>
<th>Expectation Level</th>
<th>Very unlikely</th>
<th>Somewhat unlikely</th>
<th>Neither unlikely nor likely</th>
<th>Somewhat likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
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<tr>
<td>30%</td>
<td></td>
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<tr>
<td>40%</td>
<td></td>
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<td>50%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Research Contribution: Behavioral Research

Behavioral Experiment to Simulate Life with an Autonomous Vehicle
Walker and Circella for the UC Institute of Transportation Studies program

Results from pilot study:
- 83% increase in VMT
- 21% of increase: ghost trips
- 17% of increase: driving friends/family solo
- 62% of increase: prime subject traveling
What do AVs mean for the future of driving?

Point 1: It depends on what people decide to do with them
Point 2: It depends on what society decides to do about them

Set of choices available + Qualities of choices available + Value placed on different qualities

Things policy can influence

Minnesota examples...
What do AVs mean for the future of driving?

Point 1: It depends on what people decide to do with them

Point 2: It depends on what society decide to do about them

<table>
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<tr>
<th>Set of choices available</th>
<th>Qualities of choices available</th>
<th>Value placed on different qualities</th>
</tr>
</thead>
</table>

Knowledge, perceptions                                  Policy can also influence these

Minnesota examples...

http://www.minneapolismn.gov/publicworks/saferoutes/WCMS1P-132920
Research Contribution: Before-and-After Studies

Impact of Bike Share on Bicycling Behavior and Attitudes: Assessment of the Sacramento Region Bike Share System
Fitch and Handy for Caltrans and the National Center for Sustainable Transportation

Before-and-after household survey
Panel survey of Jump bike users

- How do people use Jump bike?
- What impact does Jump bike have on bicycling in general?
- How important is electric assist?

Research Contribution: Policy Possibilities

Opportunities for Shared-Use Mobility Services in Rural Disadvantaged Communities in California's San Joaquin Valley: Existing Conditions and Conceptual Program Development Rodier for the National Center for Sustainable Transportation

“In this study, the cost-effectiveness of existing inter-city transit service in rural disadvantaged communities in the San Joaquin Valley (California) is compared to hypothetical ridesharing and carsharing services. The results show significant potential to reduce transit costs and reinvest those cost saving to expand shared mobility services.”
Research Contribution: Policy Possibilities

Active Transportation in and Era of Sharing, Electrification and Automation  Handy and others for the 3 Revolutions Initiative at UC Davis

“To maximize the societal benefits of the three revolutions, policies should prioritize human mobility and community livability over vehicle mobility. Communities should be designed for people, not vehicles; AVs should serve the community, rather than the community serving AVs.”

Policies with respect to...
- Built environment
- Automated vehicles
- Planning processes and practices

At all levels of government...

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Research Contribution: Simulations

Automated Vehicle Scenarios: Simulation of System-Level Travel Effects Using Agent-Based Demand and Supply Models in the San Francisco Bay Area  Rodier for the National Center for Sustainable Transportation

Table ES-1. Percentage change in daily vehicle miles traveled (VMT), vehicle hours of delay (VHD), and drive alone, shared-ride, transit, walk, and bike trips for the automated vehicle scenarios relative to the base case.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>VMT</th>
<th>VHD</th>
<th>Drive Alone</th>
<th>Shared Ride</th>
<th>Transit</th>
<th>Walk and Bike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase Highway Capacity (100%)</td>
<td>4%</td>
<td>78%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>-2%</td>
</tr>
<tr>
<td>Reduce Value of Drive Time (25%)</td>
<td>3%</td>
<td>7%</td>
<td>1%</td>
<td>1%</td>
<td>-5%</td>
<td>-6%</td>
</tr>
<tr>
<td>Reduce Operating Vehicle Costs (20%)</td>
<td>3%</td>
<td>5%</td>
<td>1%</td>
<td>1%</td>
<td>-4%</td>
<td>-4%</td>
</tr>
<tr>
<td>New Drivers</td>
<td>2%</td>
<td>3%</td>
<td>6%</td>
<td>-5%</td>
<td>-12%</td>
<td>-4%</td>
</tr>
<tr>
<td>Combined Effects</td>
<td>11%</td>
<td>70%</td>
<td>9%</td>
<td>-8%</td>
<td>-30%</td>
<td>-12%</td>
</tr>
<tr>
<td>Road Pricing and Combined Effects</td>
<td>-7%</td>
<td>4%</td>
<td>2%</td>
<td>-10%</td>
<td>8%</td>
<td>22%</td>
</tr>
</tbody>
</table>
Research Contribution: Policy Possibilities

Three Revolutions in Urban Transportation
Fulton, Mason, Meroux for the ClimateWorks Foundation, Hewlett Foundation, Barr Foundation

“The 3R scenario builds on the 2R scenario, with policy support for both electrification and automation, but also substantial policy support for shared-use mobility and urban planning that supports shorter trip lengths and high levels of walking, cycling, and public transport use, even in a future where vehicular travel is significantly less expensive. Without strong policy support for compact cities, even a scenario with fairly high levels of vehicle sharing in smaller vehicles could result in significantly higher vehicle kilometers and lower levels of access.”

Lew Fulton, UC Davis Institute of Transportation Studies and the Institute for Transportation & Development Policy

https://steps.ucdavis.edu/three-revolutions-landing-page/
AVs and other technological innovations - a threat and an opportunity for communities

How do we as a society push their development and their use toward the desired outcome – toward the community vision?
Thanks!
Questions? slhandy@ucdavis.edu