CAEV’s (and relations) in Real Life: Ensuring Benefits to Society

Frank Douma, Institute for Urban and Regional Infrastructure Finance
CAV – Policy Implications

• Safety Improvement
• Massive private investment
• Potential to disrupt many accepted assumptions:
  – Land use (parking)
  – Definition of transit
  – Modal integration
  – Pay for vehicle or ride
  – Finance
  – Equity
  – And more . . .
Safety First

**Minnesota**
395 traffic fatalities in 2020 (up from 364 in 2019)

**United States**
36,096 traffic fatalities in 2019

**Worldwide**
1.35 Million Deaths in 2016

More than 90% percent of crashes caused by human error

http://resourcesforhistoryteachers.pbworks.com/w/page/138517074/The%20Rise%20of%20the%20Automobile%20and%202021st%20Century%20Self-Driving%20Cars
SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

0
No Automation
Zero autonomy; the driver performs all driving tasks.

1
Driver Assistance
Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.

2
Partial Automation
Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.

3
Conditional Automation
Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.

4
High Automation
The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.

5
Full Automation
The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.
<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
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<tbody>
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<td>0</td>
<td>No Automation</td>
<td>the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
<td>Human driver</td>
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<td>Human driver</td>
<td>n/a</td>
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<td>1</td>
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<td>the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>Human driver and system</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
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<td>Conditional Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>Human driver</td>
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<td>4</td>
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<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
</tr>
</tbody>
</table>

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Recent Regulations

• Automated Vehicle Comprehensive Plan
  https://www.transportation.gov/av/avcp

• NHTSA Rule on AV Safety Standards

• Current bills in Congress are largely silent on AV’s
SDVs might already be legal...

Bryant Walker Smith,
Automated Vehicles are Probably Legal in the United States

Not explicitly prohibited equals probably permitted
“The point is that we are gradually witnessing a coalescing toward one kind of specialty of a self-driving car, essentially a pod-on-wheels”

Zoox.com/press
So, some terms

• ACEMS
  — Automated Connected and Electrified Mobility Systems
• CAV
  — Connected and Automated Vehicles
• CAEV
  — Connected, Automated and Electric Vehicles
• ACES
  — Automated, Connected, Electric and Shared
• SEAV
  — Shared, Electric, and Automated Vehicles
3 Trends in Motor Vehicle Development

- Connected Vehicles (CV)
- Autonomous Vehicles (AV)
- Electric Vehicles

CAV’s

???

???
Our Path to an All-Electric Future

Zero Crashes, Zero Emissions, Zero Congestion
Vehicle Emissions Cut by 90%?
Possibly . . .

- 87 – 94% reduction in current vehicles

- Up to 90% of current vehicles removed if AV “taxis” and high capacity transit implemented
  - OECD International Transport Forum, “Urban Mobility System Upgrade”

- IF Policies set strategy correctly
  - Eric Bruun & Moshe Givoni, “Sustainable mobility: Six research routes to steer transport policy”
Sharing Economy = “Smart Mobility?”

- Does it make sense to own a vehicle which is used only 2 out of 24 hours?

- Shift from ownership to usership

- Commodification of individual trips

- Individuals as users of shared mobility services (car-sharing) and data generators (smartphones)
Mobility as a Service

**CURRENT INDIVIDUAL OWNERSHIP**

**PERCEPTION**
- My car, my privacy, no mileage tracking

**RELATIONSHIP WITH TRANSPORTATION**
- My vehicle serves me

**USER PAYS**
- Gas tax

**EMERGING MOBILITY-AS-A-SERVICE**

**PERCEPTION**
- Using my smartphone I'm tracking a car I will use as I need it

**RELATIONSHIP WITH TRANSPORTATION**
- A fleet of vehicles serves my community

**USER PAYS**
- Per mile
A New Way to Pay for Infrastructure?
Land Use / Infrastructure

- Congestion Reduction
  - Gap reduction- low elasticity
    - Reduced Lane width
    - Smooth merging
- Reduced Right Of Way Allocated For Vehicles?
- End of Minimum Parking Requirements?

Credit: 111 Lincoln Rd -Wikicommmons
Land Use / Infrastructure

• Increased Density or Sprawl?
  • Depends upon ownership model
  • Maybe both

• BARCLAYS: Expected car ownership in USA to reduce from 2.1 vehicles to 1.2 per person by 2040
Your Benefits May Vary . . .

Summarizing two studies funded by National Science Foundation of the USA (#1737633)


- “Autonomous Vehicle Policy with Equity Implications: Patterns and Gaps” – Katie Emory, Frank Douma, Jason Cao (under review)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Sub-groups</th>
<th>Key Disadvantages</th>
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<tbody>
<tr>
<td>Mixed</td>
<td>Low-income people</td>
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<td></td>
<td>Racial minorities</td>
<td>• Low income</td>
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<td>Immigrants</td>
<td>• Discrimination</td>
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<td></td>
<td>Women</td>
<td>• Cultural barriers</td>
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Improved Transit?

• First and Last Mile Solution?
• Complement to existing service
• Increase the impact of transit stations on adjoining properties
• Greater efficiency in low density
• From few blocks to maybe a mile?

https://meetolli.auto/manual.html
http://www.dot.state.mn.us/medcitymover/
## Usability Matrix

<table>
<thead>
<tr>
<th>User Groups</th>
<th>Central City</th>
<th>Suburban (No Centralized Core)</th>
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**Geography**

- **Central City**: County, region, with industry, for profit
- **Suburban (No Centralized Core)**: County, region, with industry, for profit
- **Isolated Small City (Core/Main street)**: County, region, with industry, for profit
- **Rural (Scattered)**: Subsidized by state/local, non-profit
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Access

- Americans with Disabilities Act
  - Requires public transit service to people with disabilities

- Minnesota’s Olmstead Plan:
  - People with disabilities will have access to reliable, cost-effective, and accessible transportation choices
What’s Next

Improved Transportation for all

– Improve equity and accessibility
– Provide affordable transportation options
– Address driver shortages
– Especially in Greater Minnesota

Private sector – a new and necessary partner

– New market opportunities
– Opportunities in the freight industry
  • Improve supply chains?
  • Address driver shortages?

Get CAVs in front of the general public and show people that this technology is real and viable in their communities.

Thank you!

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For more information: https://tpec.umn.edu/research/technology/