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TRANSPORTATION RESEARCH BOARD

Connected and Automated Vehicles:

Current and Future Issues for Consideration

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October 16, 2018

Transportation Research Board

Advise

Ad hoc consensus policy studies

- Since 1983
- Future of the Interstate Highway System

Convene

- Annual Meeting (13,700+)
- Webinars (25,000+)
- Conferences
- 220 standing technical committees

Research

- Cooperative Research Programs (highways, transit, airports)
- Strategic research programs

- Critical Issues: Transformational Technologies; Resilience, Public Health
- Dissemination: Bibliographic database; Peer reviewed journal, E-Newsletter

Automated & Autonomous Vehicles

- An automated vehicle is one that takes control of some or all aspects of driving tasks.
- An autonomous (or driverless) vehicle controls all driving tasks.

Five Levels of Automation

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

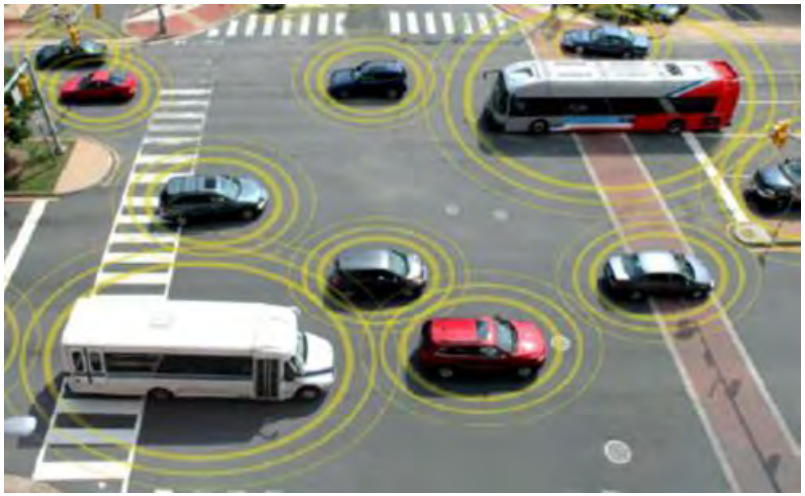
Full Automation

0	1	2	3	4	5
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**High Automation**	**Full Automation**
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	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.	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.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Connected Vehicles (CV)

Internal devices connect vehicles to other vehicles, to infrastructure, to the cloud, and to other road users

- Provides driver alerts but does not control the operation of the vehicle



Electric Vehicles (EV)

- Economics and GHG policies worldwide will increase the # of EVs dramatically
- Autonomous vehicles being developed on an EV platform

Shared Mobility Services

- Transportation Network Companies (TNCs) such as Uber and Lyft
- Other innovative shared mobility services including carsharing, bikesharing and microtransit

Shared Autonomous Vehicles (SAV)

- SAVs are on-demand self-driving vehicles that operate as part of a privately or publicly managed fleet

Mobility as a Service (MaaS)

- Almost all examples of MaaS include two elements:
  - A single account that is used to access and pay for a range of public and private travel options across multiple modes, and
  - A real time journey planner that provides information on what multi-modal travel options are available to go from origin to destination, so the traveler can choose which option best needs their travel time and cost requirements.

Other Types of AVs

- Driverless shuttles
  - New campus designs
  - First mile-last mile service
- Automated buses on separate transit ways
  - Narrow right of way – easier to fit in corridors
- Heavy truck platooning in dedicated lanes
  - Cost savings
  - Fuel/emissions reductions
- Small package delivery vehicles

Shared, Autonomous, Electric, Connected Vehicles

- Leading thinkers argue that to achieve the greatest benefits from all of these disruptive technologies, policies and planning should aim to take advantage of the benefits of all of these technologies in combination.
- Under this scenario, vehicles would no longer be privately owned, but would be available on demand and trips would be shared with other travelers.

Cooperative Automated Transportation (CAT)

- WSDOT and others are moving from referring to CV/AV or SAECV or other terms that are vehicle focused to use of the term Cooperative Automated Transportation.
- Focused on the entire multi-modal transportation system, not just vehicles
- Emphasizes achievement of broader goals

A Broad Range of Potential Outcomes

U.S. DOE 30-Year Scenarios ("Transforming the Mobility Ecosystem," 2017)

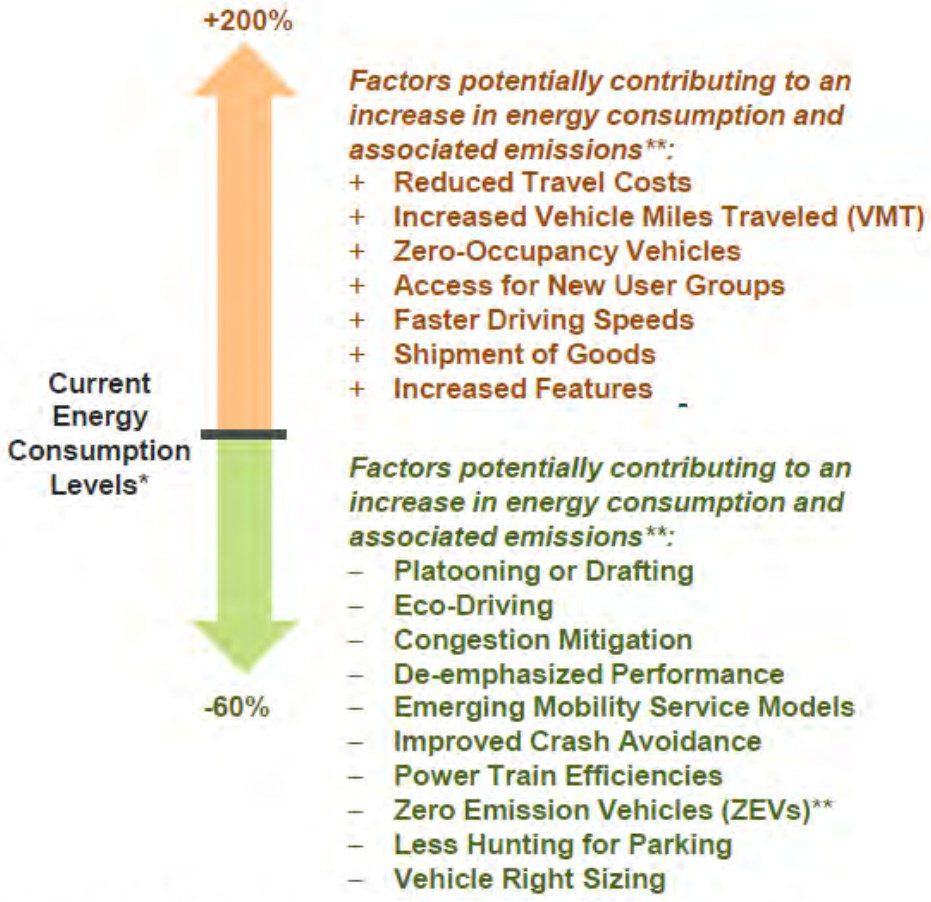


Figure 2. Energy Impacts of Connectivity and Automation

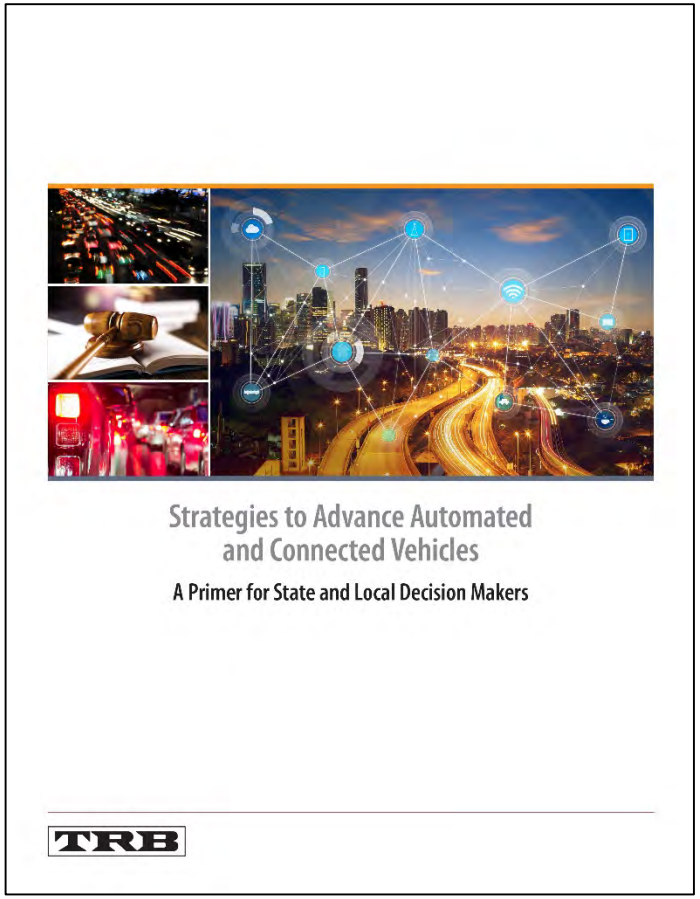
USDOT Policy Guidance

- USDOT retains regulatory role for vehicles
- States retain traditional regulatory roles:
  - Licensing drivers
  - Registering / licensing vehicles
  - Enacting and enforcing traffic laws
  - Regulating insurance

TRB Report on Policy Strategies

NCHRP Report 845:

"Strategies to Advance Automated and Connected Vehicles: A Primer for State and Local Decision Makers"



What Should State and Local Governments Do?

- State, regional and local governments use **policy levers**….
  - to ensure safe and efficient operation of public roadways
  - to foster equity across users of the system
  - to mitigate negative effects of transportation
- For automated vehicles (AV),connected vehicles (CV), electric vehicles (EV), and shared vehicles, a range of policy levers could influence private choices toward **outcomes** that would **benefit society**

Credit: NCHRP Report 845

Creating Desired Outcomes

Policy and Planning Strategies

OUTCOME: To mitigate safety risks through testing, training and public education

- Enact legislation to legalize AV testing
- Enact legislation to stimulate CV or AV testing
- Modify driver training standards and curricula
- Increase public awareness

OUTCOME: To encourage shared AV use (and mitigate increased VMT and vehicle emissions):

- Subsidize SAV use
- Implement transit benefits
- Implement a parking cash-out strategy
- Implement location-efficient mortgages
- Implement land use policies and parking requirements
- Apply road use charging

OUTCOME: To address liability issues that may impact market development:

- Implement a no-fault insurance approach
- Require motorists to carry more insurance

OUTCOME: To enhance safety, congestion, and air quality benefits by influencing market demand:

- Subsidize CV- equipped vehicles
- Invest in CV infrastructure
- Grant AV- and CV-equipped vehicles privileged access to dedicated lanes
- Grant signal priority to AV- and CV-equipped vehicles
- Grant parking access to AV- and CV-equipped vehicles
- Implement new contractual mechanisms with private service providers

Credit: NCHRP Report 845

Transportation Planning Considerations

- The exact timing, magnitude, type, and locations of the changes from SAECVs are difficult to predict, which poses new risk to infrastructure investment decisions.
- SAECV implementation is likely to influence level of demand, travel modes, planning and investment decisions, physical transportation infrastructure, and geographic areas for all personal mobility and goods movement.
  - Credit: NCHRP 20-102(9) Draft Final Report

Transportation Planning Considerations

- Change may occur quickly for certain modes, while it may take decades to realize the impacts and obtain market stability for other modes.
- Transit systems may be impacted soon as shared rides and comprehensive mobility-as-a-service (MaaS) platforms grow; however, impacts to parking and land use changes may take many years.

  - Credit: NCHRP 20-102(9) Draft Final Report

Transportation Planning Considerations

- In the past planning was predicated on the assumption that past trends in travel behavior and choices will continue two or three decades into the future with only minor alterations.
- Impact on travel of SAECVs on auto ownership, availability, and vehicle use patterns will affect demand.
- The context of planning for SAECV technology is one of deep uncertainty.
  - Credit: NCHRP 20-102(9) Draft Final Report

Uncertainties Related to CAT

- Deployment timeline
- Adoption rates
- Market penetration
- Cost of technology and vehicles
- Private vs. fleet ownership
- Willingness to share vehicles
- Impacts of crashes and cybersecurity incidents
- Public acceptance
- Induced demand
- Impacts on land use
- Liability case law
- Parking impacts
- Policy and regulatory impacts

Planning with Uncertainty

- The basic method for planning under deep uncertainty across many fields of study, including transportation, has been scenario-based planning, with various methods available.
- It is possible to manage deep uncertainty by seeking a robust decision—one that performs well across a wide range of futures, preferences, and worldviews, though it may not be optimal in any particular one.
  - Source: NCHRP 20-102(9) Draft Final Report

Suggested Planning Approach

- The key to any good planning process is establishing outcome-based goals, then policy and investment strategies to achieve those goals.
- In the case of CAT, developing a set of use cases will help inform strategies that should be developed for each goal.
- These strategies can then be tested under various scenarios based on different sets of assumptions related to the uncertainties.

WSDOT Draft CAT Policy Goals

- Organizing for innovation
- Shared mobility
- Economic vitality and livability
- Infrastructure and context sensitive street design
- Land use
- Equity
- Safety
- Environment

Goal Achievement

- Achievement of these goals is going to depend on a combination of policy and investment strategies.
- In the case of CAT, policy strategies are likely to be the most important strategies.
- Different strategies will be needed for different use cases.

Possible Use Cases

- Low speed AV transit shuttles serving downtown areas
- First/mile last mile AV shuttle services
- Priority lane system for SAEVs
- Truck platooning
- Major connected vehicle investment
- Major EV charging infrastructure investment
- AV paratransit services
- Use cases will vary by geographic area

Issues to Consider in Planning

- Lengthy transition period before SAEVs are the vast majority of the fleet.
- Consider transition issues
- Issues with mixed fleets of AVs and human drivers
- Issues with Level 3 and 4 vehicles
- Public education and managing public expectations
- Impacts of SAEVs on funding

Other Policy Considerations

- Liability
  - Personal negligence?
  - Product liability?
  - Who owns?
- Data requirements
- Insurance
- Enforcement
- Changes to vehicle codes
- Funding
  - Gas tax
  - Parking revenues

Longer Term Issues to Consider

- Impacts on jobs that depend on human drivers (truck, taxi, and bus drivers)
- Equity issues (disabled, economically disadvantaged)
- Land use impacts
- Congestion management
- Integrating SAVs with transit

Thank you!

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