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Caltrans Division of Research,
Innovation and System Information

Research Results

How Available Data and Modeling Tools are Used to Conduct Early Studies of Automated Vehicle Systems

Developing methods which are needed to help the public and private sector understand automated vehicle technologies and their system level effects.

Transportation Safety and Mobility

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How Available Data and Modeling Tools are Used to Conduct Early Studies of Automated Vehicle Systems

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WHAT IS THE NEED?

Experts predict that vehicles could be fully automated by as early as 2025 or as late as 2035. Understanding the potential impacts of automated vehicle technologies and services is critical to maximizing multimodal accessibility and minimizing negative environmental effects. Methods are needed to help the public and private sector understand automated vehicle technologies and their system level effects.

WHAT WAS OUR GOAL?

In much in the same way that the automobile disrupted horse and cart transportation in the 20th century, automated vehicles hold the potential to disrupt our current system of transportation and the fabric of our built environment in the 21st century. The public sector is just beginning to understand AV technologies and to grapple with how to accommodate the technology in our current transportation system. The private sector has often pointed to short term congestion and environmental benefits of AV technology, and appear to be unfamiliar with longer run effects of AVs that may offset those benefits.

The goal of this study was to develop methods which are needed to help the public and private sector understand automated vehicle technologies and their system level effects. The manner in which automated vehicle systems are integrated into our regional transportation systems could have significant negative and positive effects on congestion, VMT, GHGs, energy consumption, and land development patterns.

WHAT DID WE DO?

- First, we explore the medium to long run effects of automated vehicles using the San Francisco Bay Area Metropolitan Transportation Commission's activity-based travel demand model (MTC-ABM). The simulation is unique in that it articulates the size and direction of change on travel for a wide range of automated vehicles scenarios. It is also one of a handful of studies that includes the secondary effects (trip generation, destination choice, and mode choice) in its simulations of the travel effects of automated vehicles.
- Second, we evaluate the potential to reduce the demand for personal automated vehicles given the introduction of an automated taxis service with plausible, but low per mile service costs. The analysis is conducted with an integrated model for the San Francisco Bay Area that includes the MTC-ABM combined with the agent-based MATSim model, which was customized for the region. This is the first study to evaluate the demand for an automated taxi service with individual driver values of time, the actual travel time cost they experience traveling on roadway network by time of day, and realistic but low estimates for automated vehicle taxi services.
- Third, we use the MTC-ABM and the MATSim dynamic assignment model to simulate different "first" mile transit access services, including ride-hailing (Uber and Lyft) and ridesharing (Uber Pool/Lyft Line and Via) with and without automated vehicles. The results provide insight into relative benefits of each service and automated vehicle technology and the potential market for these services.

WHAT WAS THE OUTCOME?

- First, automated vehicle technology, whether considering effects individually or collectively, are likely to increase VMT (vehicle miles traveled) and associated greenhouse gas (GHG) impacts from anywhere from 2% to 14%, may significantly improve congestion or worsen it somewhat due to induced travel, and are likely to undermine efforts to maintain or expand use of carpooling, transit, walk, and bike modes. Road pricing policies could counteract negative impacts; however, incentives for carpooling would need to be adjusted to be significant in the context of the travel time benefits of automated vehicles.
- Second, the results indicate a relatively modest market potential (4% to 6% for the automated taxi mode share) concentrated in the inner-city areas of the region, but one that expands outward as the relative cost of the automated taxi service decline. Similarly, average empty-vehicle travel time and distance is estimated to be relatively low for the region; however, as relative costs of the automated taxis service decline, these regional averages increase. Empty-vehicle distances in the outer areas of the region can be up to approximately ten times higher than inner city distances. The current study simulates a short-term time horizon and thus the increase in VMT is modest (about 1%) and GHGs are estimated to be reduced due to improved vehicle flows from automated vehicle technology. As describe above, over the longer run increases in VMT may be larger and reductions in GHG emissions from traffic flow improvements may be off-set by induced travel.
- Third, study results indicated that human driver first mile access services may benefit as many as one third or as few as about 12% of travelers who choose to travel by BART during the am peak period. Not surprisingly, when

these services use automated vehicles (with significant labor cost reductions) these shares more than triple. Our results also suggest that it may be more challenging to provide travel time savings, relative to driving a personal vehicle and parking, with shared-ride services that have a common pick-up location rather than a home location. Many of those using the transit access modes live further away from BART stations and it may be harder to find a time-efficient pick up locations in these areas. However, this scenario did garner benefits for 4% more trips than did the human driven ride-hailing service. On the other hand, when automated vehicle technology was used for these services, the single passenger home-based pick up ride-hailing service increased benefits for almost 20% more trips.

WHAT IS THE BENEFIT?

This study has been the first to simulate automate vehicles with integrated disaggregate demand and supply models in an existing urban area. Understanding the potential impacts of automated vehicle technologies and services is critical to guiding their adoption in ways that improve multi-modal accessibility for all citizens and minimize negative environmental effects. Additionally, the study provides insight into the critical societal and technological trends for consideration in future state transportation plans. It will demonstrate elements of automated vehicle systems that could enhance or hinder accessibility, livability, and environmental sustainability. It also demonstrates how available data and modeling tools can be used to conduct early studies of automated vehicle systems. This will help policy-makers and planners develop the policies and incentives most likely to encourage the types of automated vehicle systems that best align with public goals. The results are relevant to national GHG objectives as well as California's landmark legislation concerning carbon emissions reduction and land use planning, AB 32 and SB 375.