Automated Vehicles and Infrastructure Planning/Policy

Chandra R. Bhat* and Ram M. Pendyala**

* Center for Transportation Research, The University of Texas at Austin
** Arizona State University, Tempe, AZ

Presentation at the Florida Automated Vehicle Summit, Tampa, Florida, Nov. 14, 2013
Presentation Overview

1. Motivation
2. Automated Vehicle Technology
3. Infrastructure Planning
4. Traveler Behavior Considerations
5. The Bottom Line
Motivation
The Context

- **Automated Vehicles**: Vehicles that are able to guide themselves from an origin point to a destination point desired by the individual.

- Individual yields near-full or partial control to artificial intelligence technology:
  - Individual decides an activity-travel plan (or tour-specific information)
  - The plan is keyed into the car’s intelligence system
  - The car (or an external entity connected to the car) decides on a routing and circuit to complete the plan

- User will still retain some control (even during a single trip):
  - Possibility of changing her/his activity plan enroute

- Individual may make more “on-the-fly” decisions regarding her/his daily activity-travel pattern
## Motivation for Automated Driving

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| **1** | **Zero Emission** | - Optimization of traffic flow management  
- Reduction of fuel cons. and CO2 emission | ![Car Icon] |
| **2** | **Demographic change** | - Support unconfident drivers  
- Enhance mobility for elderly people | ![Person Icon] |
| **3** | **Vision Zero** | - Potential for more driver support by avoidance of human driving errors | ![Sign Icon] |
| **4** | **Increasing traffic density** | - Optimization of traffic flow management  
- Convenient, time efficient driving via automation | ![Traffic Icon] |
| **5** | **Economy** | - Ensure unique selling proposition  
- Attractive products by technological leadership | ![Money Icon] |
| **6** | **Maturity of driver assistance systems** | - Sensors are approved and cost-effective  
- Actuators (steering, ...) in series production | ![Paper Icon] |

Source: Bartels, 2013
Automated Vehicles and Transportation

- Technology
- Infrastructure
- Traveler Behavior
Automated Vehicle Technology
Two Broad Types

**Autonomous (Self-Driving Car)**

Artificial Intelligence is:
- completely located within the vehicle
- “outward-facing” in that sensors blast outward from the vehicle to collect information without receiving data inward from other sources
- used to make autonomous decisions on what is best for the individual driver
- not shared with other entities beyond the vehicle
- “Capitalistic” set-up

**Connected Vehicle**

Artificial Intelligence is:
- wirelessly connected to an external communications network
- “inward-facing” with the vehicle receiving external environment information through wireless connectivity, and operational commands from an external entity
- used in cooperation with other pieces of information to make decisions on what is “best” from a system optimal standpoint
- shared across multiple vehicles
- “Socialistic” set-up
Autonomous (Self-Driving) Vehicle

- Google cars have successfully driven 500,000 miles
- Set 2018 as expected release date for self-driving car

Sight to behold: a blind man behind wheel of self-driving car

Google self-driving car takes legally blind man over ‘carefully programmed route’
Autonomous (Self-Driving) Vehicle

Elon Musk: Tesla’s driverless car will be street-ready in three years. Tesla raises the stakes with a bold about driverless cars.


Nissan Sets Goal of Introducing First Self-Driving Cars by 2020.
Connected Vehicle Research

Connected vehicle research addresses a suite of technologies and applications that use wireless communications to provide connectivity:

- Among vehicles of all types
- Among vehicles and a variety of roadway infrastructures
- Among vehicles, infrastructure, and wireless consumer devices

An initiative of the USDOT Intelligent Transportation Systems Joint Program Office
Connected Vehicle Research
A “Connected” Vehicle

Data Sent from the Vehicle

Real-time location, speed, acceleration, emissions, fuel consumption, and vehicle diagnostics data

Improved Powertrain

More fuel efficient powertain including; hybrids, electric vehicles, and other alternative power sources

Data Provided to the Vehicle

Real-time traffic information, safety messages, traffic signal messages, eco-speed limits, eco-routes, parking information, etc.

Source: USDOT
Levels of Vehicle Automation

- **Level 0**: No automation
- **Level 1**: Function-specific Automation
  - Automation of specific control functions, e.g., cruise control
- **Level 2**: Combined Function Automation
  - Automation of multiple and integrated control functions, e.g., adaptive cruise control with lane centering
- **Level 3**: Limited Self-Driving Automation
  - Drivers can cede safety-critical functions; not expected to monitor roadway constantly
- **Level 4**: Full Self-Driving Automation
  - Vehicles perform all driving functions and can operate without human presence or intervention
Government Recognition

- Several states in the US passed legislative initiatives to allow self-driving cars to navigate roadways
  - California, Nevada, and Florida

- National Highway Traffic and Safety Administration Policy Statement
  - Policy guidance on licensing, safety, testing

- Autopilot Systems Council in Japan

- Citymobil2 initiative in Europe
Infrastructure Needs/Planning Driven by…

- Potentially increasingly complex activity-travel patterns
- Growth in long distance travel demand
- Limited availability of land to dedicate to transport infrastructure
- Budget/fiscal constraints
- Energy and environmental concerns
- ICT and mobile processing platform advances
Smarter Infrastructure

The Automated Road

Source: http://www.foreveropenroad.eu/
Technology and infrastructure combination can lead to many benefits

Potential safety enhancements

- Virtual elimination of driver error (primary factor in 80 percent of crashes)
- Enhanced vehicle control, positioning, spacing, and speed harmonization
- How about offsetting behavior on part of drivers? Need to eliminate possibility of offsetting behavior…
- No drowsy drivers, impaired drivers, stressed drivers, or aggressive drivers
- Reduced number of incidents and network disruptions
Potential capacity enhancements

- Vehicle platooning greatly increases density (reduced headways) and improves flow at transitions
- Vehicle positioning (lateral control) allows reduced lane widths and utilization of shoulders; accurate mapping critical
- Optimization of route choice, passage through intersections, and navigation through and around work zones

Potential energy and environmental benefits

- Increased fuel efficiency and reduced pollutant emissions through vehicle operation improvement
- Clean-fuel vehicles
- Car-sharing provides additional benefits
But Let’s Not Forget Traveler Behavior Issues!
Impacts on Land-Use Patterns

- Live and work farther away
  - Use travel time productively
  - Access more desirable and higher paying job
  - Attend better school/college

- Visit destinations farther away
  - Access more desirable destinations for various activities
  - Reduced impact of distances and time on activity participation

- Influence on developers
  - Sprawled cities?
  - Impacts on community/regional planning and urban design
Impacts on Household Vehicle Fleet

- Potential to redefine vehicle ownership
  - No longer own personal vehicles; move toward car sharing enterprise where rental vehicles come to traveler

- More efficient vehicle ownership and sharing scheme may reduce the need for additional infrastructure
  - Reduced demand for parking

- Desire to work and be productive in vehicle
  - More use personal vehicle for long distance travel
  - Purchase large multi-purpose vehicle with amenities to work and play in vehicle
Impacts on Household Vehicle Fleets
Impacts on Mode Choice

Automated vehicles combine the advantages of public transportation with that of traditional private vehicles

- Flexibility
- Comfort
- Convenience
- Catching up on news
- Texting friends
- Reading novels

What will happen to public transportation?

Also Automated vehicles may result in lesser walking and bicycling shares

Time less of a consideration

So, will Cost be the main policy tool to influence behavior?
Impacts on Mode Choice

- Driving personal vehicle more convenient and safe
- Finding parking space no longer onerous
- Traditional transit captive market segments now able to use auto (e.g., elderly, disabled)
- Reduced reliance/usage of public transit?

However, autonomous vehicles may present an opportunity for public transit

- Reliable transit service
- Lower cost of operation (driverless)
- More personalized service - smaller vehicles providing demand-responsive transit service
Impacts on Long Distance Travel

- Less incentive to use public transportation?

- Should we even be investing in high capital high-speed rail systems?
  - Individuals can travel and sleep in driverless cars
  - Individuals may travel mostly in the night
  - Speed difference?
Impacts on Commercial Vehicle Operations

- Enhanced efficiency of commercial vehicle operations
- Driverless vehicles operating during off-peak and night hours reducing congestion
- Reduced need for infrastructure
Diffusion Effects

- Uncertainty in pace of technology availability, affordability, and adoption (market penetration rate)

- Will automated vehicles completely replace individual-driven vehicles?

- Need for mixed vehicle operations for considerable amount of time

- Infrastructure that accommodates both manual and automated vehicles

- Intelligent infrastructure with dedicated lanes for driverless cars
  - Managed lanes offer opportunity to accommodate self-driving vehicles (dedicated technology-equipped lanes)
The Bottom Line
The Bottom Line

- Uncertainty, Uncertainty, Uncertainty
- More uncertainty implies more need for planning
- But planning must recognize the uncertainty (need a change in current thinking and philosophy)
- Conduct studies to understand possible behavioral responses and develop scenarios
- Will policy tool primarily be cost-based?
Thank You