Connected and Automated Cars: What They Can and May Do to Our Way of Life

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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
McKinsey: Autonomous Cars One of 12 Major Technology Disruptors

Source: Disruptive Technologies: Advances that will transform life, business, and the global economy
McKinsey Global Institute
May 2013

Automated Vehicles and Transportation

Technology
Infrastructure
Traveler Behavior
Automated Vehicle Technology

Two Types of Technology

<table>
<thead>
<tr>
<th>Self-Driving Vehicle (e.g., Google)</th>
<th>Connected Vehicle</th>
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<tbody>
<tr>
<td>AI located within the vehicle</td>
<td>AI wirelessly connected to an external communications network</td>
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<tr>
<td>“Outward-facing” in that sensors blast outward from the vehicle to collect information without receiving data inward from other sources</td>
<td>“Inward-facing” with the vehicle receiving external environment information through wireless connectivity, and operational commands from an external entity</td>
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<tr>
<td>AI used to make autonomous decisions on what is best for the individual driver</td>
<td>Used in cooperation with other pieces of information to make decisions on what is “best” from a system optimal standpoint</td>
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<tr>
<td>AI not shared with other entities beyond the vehicle</td>
<td>AI shared across multiple vehicles</td>
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<tr>
<td>A more “Capitalistic” set-up</td>
<td>A more “Socialistic” set-up</td>
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</table>
Autonomous (Self-driving) Vehicle

- Google cars driven 500,000 miles – Release Date Expected 2018

Elon Musk: Tesla’s driverless car will be street-ready in three years

Volvo plans self-driving cars in 2014, envisions accident-free fleet by 2020

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

- Addresses suite of technology and applications using wireless communications to provide connectivity
  - Among vehicle types
  - Variety of roadway infrastructure

A “Connected” Vehicle

Data Sent from the Vehicle
Real-time location, speed, acceleration, emissions, fuel consumption, and vehicle diagnostics data

Data Provided to the Vehicle
Real-time traffic information, safety messages, traffic signal messages, eco-speed limits, eco-routes, parking information, etc.

Improved Powertrain
More fuel efficient powertrain including; hybrids, electric vehicles, and other alternative power sources
Incident

Present Day

Lane blocking, traffic slow down

Present Day
PRESENT DAY

Congestion buildup, late lane changes

PRESENT DAY

Congestion propagation to frontage, ramp backed up
Regular Traffic Conditions

Icy Patch
Incident: Information propagation

Preemptive lane changing, freeway exit
Re-optimization of signal timing, upstream detours

V2I

AUTONOMOUS

Regular Traffic Conditions
Icy Patch

Avoidance of icy patch, no incident
Traffic slowdown, late lane changing, congestion

AUTONOMOUS + V2X

Icy Patch
Avoidance of icy patch, no incident

AUTONOMOUS + V2X

Information propagation, preemptive lane changing, freeway exit

AUTONOMOUS + V2V
Infrastructure Needs/Planning Driven By...

- Complex activity-travel patterns
- Growth in long distance travel demand
- Limited availability of land to dedicate to infrastructure
- Budget/fiscal constraints
- Energy and environmental concerns
- Information/communication technologies (ICT) and mobile platform advances

**Autonomous vehicles leverage technology to increase flow without the need to expand capacity**
Technology and Infrastructure Combination Leads To...

- Safety enhancement
  - Virtual elimination of driver error – factor in 80% of crashes
  - Enhanced vehicle control, positioning, spacing, speed, harmonization
  - No drowsy, impaired, stressed, or aggressive drivers
  - Reduced incidents and network disruptions
  - Offseting behavior on part of driver

- Capacity enhancement
  - Platooning reduces headways and improves flow at transitions
  - Vehicle positioning (lateral control) allows reduced lane widths and utilization of shoulders; accurate mapping critical
  - Optimized route choice

- Energy and environmental benefits
  - Increased fuel efficiency and reduced pollutant emissions
  - Clean fuel vehicles
  - Car-sharing
**BUT LET’S NOT FORGET TRAVELER BEHAVIOR ISSUES!**

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**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 of personal vehicle for long distance travel
  ➢ Purchase large multi-purpose vehicle with amenities to work and play in vehicle
Impacts on Mode Choice

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

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

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?

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Impacts on Mode Choice

- Driving personal vehicle more convenient and safe
- 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 and car sharing:
  - Lower cost of operation (driverless) and can cut out low volume routes
  - More personalized and reliable service - smaller vehicles providing demand-responsive transit service
  - No parking needed – kiss-and-ride; no vehicles “sitting” around
  - 20-80% of urban land area can be reclaimed
  - Chaining may not discourage transit use
Activity Chaining Issues

Drive Alone

Very Good Transit Service

Home

Work

Drive Alone

Shopping

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

Mixed Vehicle Operations

- Uncertainty in penetration rates of driverless cars
- Considerable amount of time of both driverless and traditional car operation
- When will we see full adoption of autonomous? Depends on regulatory policies
- Need infrastructure planning to support both, with intelligent/dedicated infrastructure for driverless
Figure 3: Autonomous Vehicle Planning Impacts Time Line

1. Develop performance and data collection requirements for autonomous vehicle operating on public roads path.
2. Study and define appropriate support, autonomous vehicle implementation for specific applications such as tax, trucking, and demand responsive services.
3. If autonomous vehicle proves overall beneficial and are the majority of vehicles, it may be possible to change roadway design and management practices.

This timeline summarizes how autonomous vehicles will impact transport planning.

THANK YOU!