The Future of the Automobile
Autumn Quarter 2013

Section 4: Infrastructure and Traffic
### Challenges Resulting from Automobile Traffic

#### Accidents:
Motor vehicle crashes led to 32,310 fatalities in 2011, in 95% of the cases human error was at least a contributing factor\(^1,2\)

#### Pollution:
Economic impact of health damages from motor vehicle emissions in the U.S. totals to over $40b (64b) per year\(^3\)

#### Consumption:
9m barrel every day (10% of the global petroleum production) are consumed as gasoline in U.S. light duty vehicles\(^4\)

#### Congestion:
Average commuter gets delayed 36 hrs per year due to congestion, total 2.8b gal of fuel wasted, overall loss $87.2b\(^5\)

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Infrastructure and Traffic
U.S. Traffic Statistics – Passenger Travel by Mode

Source: U.S. Transportation and Energy since 1920”, A. Schäfer, Sustainable Transportation Seminar, Stanford University, 09/14/2012
What Infrastructure does personal mobility need?

>> Space (roads, parking…)

>> Energy (fuel, electricity…)

>> Data (storage, transmission…)

>> Rules (regulation, policies…)
U.S. Traffic Statistics – More Miles, More Roads???

## EV Charging Network in the United States

<table>
<thead>
<tr>
<th>Status</th>
<th>Region</th>
<th>Provider</th>
<th>Number</th>
<th>FastCharge</th>
<th>Started</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Functional</td>
<td>U.S. Alternative Fuels Data Center Summary 11/2012</td>
<td></td>
<td>4,756</td>
<td></td>
<td>1992</td>
</tr>
<tr>
<td>1 Functional</td>
<td>California</td>
<td>Tesla</td>
<td>15</td>
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<tr>
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<td>Portland</td>
<td>Portland G. Electric</td>
<td>20</td>
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<tr>
<td>1 Functional</td>
<td>California</td>
<td>ChargePoint</td>
<td>237</td>
<td>Level 2 (240 V 30 A)</td>
<td>2011</td>
</tr>
<tr>
<td>1 Functional</td>
<td>Washington State</td>
<td>ChargePoint</td>
<td>103</td>
<td>Level 2 (240 V 30 A)</td>
<td>2011</td>
</tr>
<tr>
<td>1 Functional</td>
<td>Boston</td>
<td>ChargePoint</td>
<td>123</td>
<td>Level 2 (240 V 30 A)</td>
<td>2011</td>
</tr>
<tr>
<td>1 Functional</td>
<td>New York / New Jersey</td>
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<td>164</td>
<td>Level 2 (240 V 30 A)</td>
<td>2011</td>
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<tr>
<td>1 Functional</td>
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<tr>
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<td>ChargePoint</td>
<td>261</td>
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<td>2011</td>
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<tr>
<td>1 Functional</td>
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<td>ChargePoint</td>
<td>261</td>
<td>Level 2 (240 V 30 A)</td>
<td>2011</td>
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<tr>
<td>1 Functional</td>
<td>San Diego</td>
<td>EV Project</td>
<td>261</td>
<td>Level 2 (240 V)</td>
<td>2012</td>
</tr>
<tr>
<td>1 Functional</td>
<td>Seattle</td>
<td>EV Project</td>
<td>407</td>
<td>Level 2 (240 V)</td>
<td>2012</td>
</tr>
<tr>
<td>1 Functional</td>
<td>Phoenix</td>
<td>EV Project</td>
<td>285</td>
<td>Level 2 (240 V)</td>
<td>2012</td>
</tr>
<tr>
<td>1 Functional</td>
<td>Houston</td>
<td>EV Project</td>
<td>177</td>
<td>Level 2 (240 V)</td>
<td>2012</td>
</tr>
<tr>
<td>1 Functional</td>
<td>Tennessee</td>
<td>EV Project</td>
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<td>Level 2 (240 V)</td>
<td>2012</td>
</tr>
<tr>
<td>1 Functional</td>
<td>South Carolina</td>
<td>Eaton</td>
<td>100</td>
<td>(some of them)</td>
<td>2010</td>
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<tr>
<td>1 Functional</td>
<td>Dallas/Houston</td>
<td>BetterPlace</td>
<td>140/200</td>
<td></td>
<td>2011</td>
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<tr>
<td>2 Construction</td>
<td>SF Bay Area</td>
<td>California ARB</td>
<td>109</td>
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<td>2010</td>
</tr>
<tr>
<td>2 Construction</td>
<td>San Diego</td>
<td>EV Project</td>
<td>1500</td>
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<td>2012</td>
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<tr>
<td>2 Construction</td>
<td>Texas</td>
<td>NRG Energy</td>
<td>50</td>
<td></td>
<td>2010</td>
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<tr>
<td>2 Construction</td>
<td>California</td>
<td>NRG Energy</td>
<td>200</td>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>2 Construction</td>
<td>CA, DC, MI, NY, TX, WA</td>
<td>ChargePoint</td>
<td>4600*</td>
<td>(optional)</td>
<td>2011</td>
</tr>
<tr>
<td>3 Out of serv.</td>
<td>California, Arizona</td>
<td>GM EV1</td>
<td>500</td>
<td>MagneCharge (220 V, 30 A)</td>
<td>1996</td>
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<tr>
<td>3 Planned</td>
<td>AZ, CA, OR, TN, TX, WA</td>
<td>EV Project</td>
<td>6350</td>
<td>310x Level-3 DC</td>
<td>2012Q4</td>
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<tr>
<td>4 Proposed</td>
<td>California</td>
<td>BetterPlace</td>
<td></td>
<td></td>
<td>2012</td>
</tr>
</tbody>
</table>

Comparison – Number of Gas Stations (2007): 118,756

How Smart is Your Car?

Smart Phone

Dumb Car?
Network of Systems in an Automobile

Up to 80 controllers¹
- Powertrain: ignition, injection, transmission, 4WD...
- Safety: airbag, seatbelts, pre-tensioners...
- Chassis: steering, brakes, dampers...
- Driving Aid: parking aid, night vision...
- Entertainment: MP3, CD, radio...

Up to 20 Communications Networks²
- CAN: Powertrain, safety, chassis, driving aid
- MOST: Entertainment and information
- LIN: Body, vision, HVAC
- HVAC: air conditioning...
- Body: seats, doors, roof...
- Vision: lights, wipers, mirrors...
- Information: displays, navigation...

Sources:
1. “Driving Cars Toward Complexity”, I. Krueger (UC San Diego), NPR Interview, April 30, 2010
More than 4200 signals, 10M lines of code, 35% system cost

Source: “Driving Cars Toward Complexity”, I. Krueger (UC San Diego), NPR Interview, April 30, 2010
The Internet of Cars – Everything Connected

Safety, Efficiency
Entertainment, Service
Vehicle Safety Communication - DSRC
ME302 (spring): The Future of the Automobile
+++ Vehicle Safety Communication +++

There is a lot of talk about "smart vehicles" or "intelligent transportation" in public, research, industry, and government. These terms generally refer to systems and solutions that are supposed to make traffic safer, more efficient, and more convenient while assisting the driver in navigating the vehicle. "Vehicle Safety Communication" aims to provide additional information to the driver and to have vehicles communicate with one another or the roadside infrastructure.

Terms: Spr | Units: 1 | Grading: Satisfactory/No Credit
Instructors: Delgrossi
U.S. Government Agencies Pertaining to Automobiles

- Department of Transportation
- Department of Energy
- Environmental Protection Agency
- National Transportation Safety Board
U.S. Government Agencies Pertaining to Automobiles

- Office of the Secretary of Transportation (OST)
- National Highway Traffic Safety Administration (NHTSA)
- Federal Aviation Administration (FAA)
- Office of Inspector General (OIG)
- Federal Highway Administration (FHWA)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Federal Motor Carrier Safety Administration (FMCSA)

- Research and Innovative Technology Administration (RITA)
- Federal Railroad Administration (FRA)
- Saint Lawrence Seaway Development Corporation (SLSDC)
- Federal Transit Administration (FTA)
- Surface Transportation Board (STB)
- Maritime Administration (MARAD)

Source: http://www.dot.gov/DOTAgencies.htm
NHTSA “Save lives, prevent injuries, reduce vehicle-related crashes.”

- Corporate Average Fuel Economy (CAFE)
- New Car Assessment Program (NCAP)
- Federal Motor Vehicle Safety Standards (FMVSS)
- Fatality Analysis Reporting System (FARS)
Situation for Autonomous Driving Regulation by State

Source: http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action
Regulation in 3 States: What it Means

What it means:
• Nevada, Florida, and California are currently the only states to expressly regulate “autonomous vehicles”
• Legislators or regulators in many states are aware of and interested in this topic
• Lobbying determines the fate of these bills

What it does not mean
• These three states have “legalized” autonomous vehicles
• These vehicles are illegal elsewhere
• The legal status of autonomous vehicles is entirely clear in any state