Autonomous Driving
How Mobility is Evolving and Affecting Us All

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Car technology has dramatically changed in the last decades…
Car technology hasn’t dramatically changed in the last decades…

Road at peak throughput only 5% of the time…
…and then only 10% covered with cars

More than 38,000 road fatalities in US (2015)
260,000 people permanently affected (2015)
$300B annually in cost

95% Caused by human error

1% energy used to move a person
86% of the fuel never reaches the wheels

0.5% sitting in congestion
0.8% looking for parking
2.6% driving

The typical car in US spends 96% of its time parked
Finally! The first steps of improvement…

CONNECTED
Time & Route shift & transit integration

AUTONOMOUS
90% Accident reduction

ELECTRIC
85% efficient drivetrain

SHARED
50% Utilization (70% with delivery of goods at night?)
Five different levels of autonomous driving (NHTSA)

- **Level 0**: Human driver controls it all
- **Level 1**: Driver Assistance
  - Specific functionality can be automated (e.g., steering, accelerating)
- **Level 2**: At least one driver assistance system is automated (e.g., cruise control and lane centering combined)
  - Simultaneously hands of the steering wheel and foot off the pedal
  - Driver must monitor and always ready to take over control
- **Level 3**: Drivers are able to shift "safety-critical functions" to the vehicle under certain traffic/environmental conditions
  - Driver can intervene if necessary, but is not always required to monitor the situation as in previous levels
  - (e.g., adaptive cruise control combined with lane centering)
- **Level 4**: This is considered "fully autonomous"
  - Vehicles are designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip
  - Limited to Operational Design Domain (ODD)
  - Does not cover every driving scenario
- **Level 5**: Fully autonomous
  - Vehicle performance equal to human driver in every driving scenario (but 90+% safer!)
  - Including extreme environments (e.g., dirt roads, very busy city centers)

Source: US Department of Transportation's National Highway Traffic Safety Administration (NHTSA). In October 2016, the NHTSA updated their policy to reflect that they have officially adopted the levels of autonomy outlined in the SAE International's J3016 document (you can download the document [here](#)).
The Aces Model (shared autonomous fleet)

**CONNECTED**
- Time & Route shift & transit integration
- Autonomous maintenance & charging
- Peloton or 8x capacity autonomous HOV lanes

**AUTONOMOUS**
- 90% Accident reduction

**ELECTRIC**
- 85% efficient drivetrain
- No upfront cost for batteries
- Only use size car & battery you need

**SHARED**
- 50% Utilization (70% with delivery of goods at night?)

- Intermodal hub connections
- Match open trips & 2 minute service

- Smart Autoroute
But...outcomes of autonomy depend on how much we share

<table>
<thead>
<tr>
<th></th>
<th>Autonomy as luxury car feature = Driverless Nightmare</th>
<th>ACES (Shared Autonomy Fleet) = Driverless Utopia</th>
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<tbody>
<tr>
<td>Safety</td>
<td>⬆️</td>
<td>⬆️</td>
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<tr>
<td>Vehicle Miles Traveled</td>
<td>⬆️</td>
<td>⬇️</td>
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<td>Greenhouse Gas Emissions</td>
<td>⬇️</td>
<td>⬆️</td>
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<tr>
<td>Urban Sprawl (expansion)</td>
<td>⬆️</td>
<td>⬇️</td>
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<tr>
<td>Parking Requirements</td>
<td>No change</td>
<td>⬇️</td>
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<tr>
<td>Low Income Mobility</td>
<td>⬇️</td>
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(Source: Lauren Isaac)
Autonomous Revolution. Where are we today?

The self-driving vehicle revolution
An illustration of potential growth

<table>
<thead>
<tr>
<th>Era 1: Fully autonomous vehicles (AVs) being developed for consumers</th>
<th>Era 2: Consumers begin to adopt AVs</th>
<th>Era 3: AVs become the primary means of transport</th>
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<tbody>
<tr>
<td>1 AVs are already a reality in industrial fleets</td>
<td>4 The after-sales service landscape is reshaped</td>
<td>7 AVs free up to 50 minutes a day for drivers</td>
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<td>2 Car OEMs begin to assess strategic impact</td>
<td>5 Insurers shift from covering individuals to covering technical failures</td>
<td>8 Parking space is reduced by billions of square meters</td>
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<td>3 New mobility models begin to emerge</td>
<td>6 Supply chain and logistics are redefined</td>
<td>9 Vehicle crashes fall by 90%, saving billions of dollars</td>
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<td>10 AV technology accelerates development of robots for consumer use</td>
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McKinsey&Company
Thank You!