Autonomous Urban Mobility
Key Lessons from the City of Boston

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MassTLC Robotics/IoT Community Meeting
September 18, 2018, Boston
June 2018: The World Economic Forum and Boston Consulting Group complete a 3-year collaboration

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- **2015**
  - Consumer acceptance
  - City perspective
  - Mobility scenarios

- **2016**
  - Go Boston 2030
  - AV impact study
  - AV testing pilot

- **2017**
  - Future modal mix research
  - Conjoint study with 7,000 consumers in three cities
  - AV impact study 2.0
  - Catalyze AV testing

- **2017**
  - Launch of AV testing in Boston
  - Expanded testing area, three partners, active passenger trials
Conducted large-scale conjoint study in three cities

Representative sample

7,000 Consumers

Gender

Geography

Income

Age

Source: World Economic Forum, BCG Analysis
Respondents were given specific situations and use cases ...

Situations along four criteria

1 | Trip reason
2 | Group context
3 | Weather
4 | Time of day

Use case examples

Commute to work alone

Family trip to the zoo

Night out with friends

Source: World Economic Forum, BCG Analysis
... and asked to choose from 8 transport modes

**Mass Transit**
- Bus/subway
- Commuter rail

**Personal car**
- Personal car
- Autonomous personal car

**Mobility on demand**
- Taxi/ride sharing
- Autonomous taxi
- Autonomous shared taxi
- Autonomous minibus

Source: World Economic Forum, BCG Analysis
Top 5 findings from our conjoint study

1. Cities globally move to 30-40% mobility on demand

2. Mass transit ridership drops in urban areas

3. AV adoption varies across city—correlated to income levels

4. The shorter the trip, the higher the AV adoption

5. 20-25% will use a personal car no matter what

Source: World Economic Forum, BCG Analysis
Cities globally move to 30-40% mobility on demand

**Boston**
- **Today:** 35% Mass transit, 58% Personal car, 7% Mobility on demand
  - Mass transit: 87% AV
  - Personal car: 4% AV
  - Mobility on demand: 23% AV

- **Future:** 32% Mass transit, 38% Personal car, 30% Mobility on demand
  - Mass transit: 87% AV
  - Personal car: 4% AV
  - Mobility on demand: 23% AV

**Berlin**
- **Today:** 62% Mass transit, 34% Personal car, 4% Mobility on demand
  - Mass transit: 95% AV
  - Personal car: 9% AV
  - Mobility on demand: 22% AV

- **Future:** 49% Mass transit, 25% Personal car, 26% Mobility on demand
  - Mass transit: 95% AV
  - Personal car: 9% AV
  - Mobility on demand: 22% AV

**Shanghai**
- **Today:** 36% Mass transit, 44% Personal car, 20% Mobility on demand
  - Mass transit: 72% AV
  - Personal car: 5% AV
  - Mobility on demand: 18% AV

- **Future:** 30% Mass transit, 30% Personal car, 40% Mobility on demand
  - Mass transit: 72% AV
  - Personal car: 5% AV
  - Mobility on demand: 18% AV

Source: World Economic Forum, BCG Analysis

- **Mass transit** = Bus / subway + Commuter rail
- **Personal car** = Personal car + Autonomous personal car
- **Mobility on demand** = Taxi / ride sharing + Autonomous taxi + Autonomous shared taxi + Autonomous minibus
Mass transit ridership drops in urban areas

**Urban**
- **Today:**
  - Mass transit: 47%
  - Personal car: 40%
  - Mobility on demand: 13%
- **Future:**
  - Mass transit: 33%
  - Personal car: 26%
  - Mobility on demand: 41%

**Suburban**
- **Today:**
  - Mass transit: 30%
  - Personal car: 65%
  - Mobility on demand: 5%
- **Future:**
  - Mass transit: 32%
  - Personal car: 42%
  - Mobility on demand: 26%

Source: World Economic Forum, BCG Analysis
AV adoption varies across city — correlated to income

Source: World Economic Forum, BCG Analysis
The shorter the trip, the higher the AV adoption

- **Boston**:
  - >40 min: 29%, 9% increase
  - 20-40 min: 34%
  - <20 min: 38%

- **Berlin**:
  - >40 min: 23%
  - 20-40 min: 31%
  - <20 min: 36%, 13% increase

- **Shanghai**:
  - >40 min: 41%
  - 20-40 min: 39%
  - <20 min: 37%, 3% decrease

Source: World Economic Forum, BCG Analysis
AV testing in Boston—an example for fast scaling

Source: World Economic Forum, City of Boston, BCG Analysis
Testing initially allowed in small area; June 2018 expanded to entire city

Testing Started in “Seaport”

Expanded to Entire City

Source: World Economic Forum, City of Boston, BCG Analysis
Identified best practices for launching an AV pilot

- Develop clear mobility vision and KPIs
- Balance stakeholder interests in approval process
- Create a tiered testing plan with achievement milestones
- Build public awareness early, e.g. AV petting zoo/robot block party
- Publish regular updates on testing progress to residents

Source: World Economic Forum, City of Boston, BCG Analysis
Last year: Agent-based model for downtown Boston

We took a real world environment ...

... and simulated traffic flows in its streets

Traffic participants, autonomous and traditional

Cars
Taxis
Pedestrians
Buses
Minibuses

Environment and infrastructure

Traffic lights
Streets

Dynamic behaviors

Following distance
Speed
Traffic rules
Capacity

Source: World Economic Forum; BCG analysis in cooperation with MIT Media Lab
Expanded impact study across four key dimensions

1. Expanded study to cover entire City of Boston
   - 316x larger area (142 km²)

2. Added enriched trip data and commercial vehicles
   - 11x more trips (2M/day)

3. Determined future modal mix through conjoint study with 2,400 consumers
   - 72 modal mixes, by area & use case

4. Quantified traffic efficiency gains from AV technology
   - 6.3% gain in throughput with 37.5% AV share

Source: World Economic Forum, BCG Analysis
## Key outputs from the city-wide impact study

<table>
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<tr>
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<th>Today</th>
<th>Future (Conjoint Scenario)</th>
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<tbody>
<tr>
<td>Traffic volume on the road</td>
<td>1.75M</td>
<td>-15%</td>
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<tr>
<td>Vehicle distance travelled (km)</td>
<td>8.8M</td>
<td>+16%</td>
</tr>
<tr>
<td>Parking space needed (km²)</td>
<td>10.0</td>
<td>-48%</td>
</tr>
<tr>
<td>Average travel time (min)</td>
<td>12.0</td>
<td>-4%</td>
</tr>
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Source: World Economic Forum, BCG Analysis
Congestion increases in Downtown Boston

Average Travel Time

Modal Mix

Mass transit = Bus / subway + Commuter rail
Personal car = Personal car + Autonomous personal car
Mobility on demand = Taxi / ride sharing + Autonomous taxi + Autonomous shared taxi + Autonomous minibus

Source: World Economic Forum, BCG Analysis
Cities can influence outcome through policy levers

City-wide travel time improvement vs. today

- Occupancy-based pricing scheme: -15.5%
- Converting street parking: -10.0%
- Dedicated AV lanes: -8.3%

Source: World Economic Forum, BCG Analysis
Thank you