Autonomous Urban Mobility
Key Lessons from the City of Boston

John Moavenzadeh
Member of the Executive Committee, World Economic Forum
Automated Vehicles Symposium
July 11, 2018, San Francisco
The World Economic Forum and Boston Consulting Group have completed a three-year collaboration

<table>
<thead>
<tr>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer acceptance</td>
<td>Go Boston 2030</td>
<td>Future modal mix research</td>
</tr>
<tr>
<td>Customer research</td>
<td>AV strategy development</td>
<td>Conjoint study with 7,000 consumers in three cities</td>
</tr>
<tr>
<td>City perspective</td>
<td>AV impact study</td>
<td>AV impact study 2.0</td>
</tr>
<tr>
<td>City policy maker interviews</td>
<td>Agent-based simulation of downtown traffic</td>
<td>Holistic city-wide traffic simulation with enriched trip data</td>
</tr>
<tr>
<td>Mobility scenarios</td>
<td>AV testing pilot</td>
<td>Catalyze AV testing</td>
</tr>
<tr>
<td>Scenarios for urban mobility</td>
<td>Launch of AV testing in Boston</td>
<td>Expanded testing area, three partners, active passenger trials</td>
</tr>
</tbody>
</table>

**2015**
- Consumer acceptance
  - Customer research

**2016**
- Go Boston 2030
  - AV strategy development

**2017**
- Future modal mix research
  - Conjoint study with 7,000 consumers in three cities
- AV impact study 2.0
  - Holistic city-wide traffic simulation with enriched trip data
- Catalyze AV testing
  - Expanded testing area, three partners, active passenger trials
Conducted large-scale conjoint study in three cities

Representative sample

7,000 Consumers

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

Source: World Economic Forum, BCG Analysis
**Mass transit ridership drops in urban areas**

**Urban**
- **Today**: 47% (Mass transit) + 40% (Personal car) - 13% (Mobility on demand) = 84% Total
- **Future**: 33% (Mass transit) + 26% (Personal car) + 41% (Mobility on demand) = 98% Total

**Suburban**
- **Today**: 30% (Mass transit) + 65% (Personal car) + 5% (Mobility on demand) = 96% Total
- **Future**: 32% (Mass transit) + 42% (Personal car) + 26% (Mobility on demand) = 99% Total

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

% AV adoption

Seaport and South Boston: 53
Dorchester: 26
Friedrichshain-Kreuzberg: 36
Marzahn-Hellersdorf: 26
Jiading: 46
Songjiang: 37

Median income

Seaport and South Boston: $100-$149K
Dorchester: $50-$74K
Friedrichshain-Kreuzberg: €100-€149K
Marzahn-Hellersdorf: €25-€49K
Jiading: ¥200-¥299K
Songjiang: ¥100-¥199K

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

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

1. Develop clear mobility vision and KPIs
2. Balance stakeholder interests in approval process
3. Create a tiered testing plan with achievement milestones
4. Build public awareness early, e.g., AV petting zoo/robot block party
5. 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

2. Added enriched trip data and commercial vehicles

3. Determined future modal mix through conjoint study with 2,400 consumers

4. Quantified traffic efficiency gains from AV technology

- 316x larger area (142 km²)
- 11x more trips (2M/day)
- 72 modal mixes, by area & use case
- 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>
<thead>
<tr>
<th>Metric</th>
<th>Today</th>
<th>Future (Conjoint Scenario)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic volume on the road</td>
<td>1.75M</td>
<td>-15%</td>
</tr>
<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>
</tbody>
</table>

Source: World Economic Forum, BCG Analysis
Congestion increases in Downtown Boston

**Average Travel Time**

<table>
<thead>
<tr>
<th>Boston City Average</th>
<th>Downtown Boston</th>
<th>Allston Neighborhood</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modest improvement</strong></td>
<td>+5.5%</td>
<td>-12.1%</td>
</tr>
<tr>
<td><strong>Average Travel Time</strong></td>
<td>-4.3%</td>
<td>Large improvement</td>
</tr>
</tbody>
</table>

**Modal Mix**

<table>
<thead>
<tr>
<th>Today</th>
<th>Future</th>
<th>Today</th>
<th>Future</th>
<th>Today</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass transit</td>
<td>Personal car</td>
<td>Mobility on demand</td>
<td>Mass transit</td>
<td>Personal car</td>
<td>Mobility on demand</td>
</tr>
<tr>
<td>35%</td>
<td>-3</td>
<td>58%</td>
<td>38%</td>
<td>7%</td>
<td>-20</td>
</tr>
<tr>
<td>46%</td>
<td>-16</td>
<td>34%</td>
<td>-9</td>
<td>25%</td>
<td>-24</td>
</tr>
</tbody>
</table>

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