Safe Testing of Automated Trucks
Trucks transport 70% of all goods.
4,000 people die in truck accidents each year

The only way to zero fatalities is self-driving
Advantages of Self-Driving Trucks

53% lower cost per mile

<table>
<thead>
<tr>
<th>Cost per Mile*</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Wage</td>
<td>33%</td>
</tr>
<tr>
<td>Driver Benefits</td>
<td>10%</td>
</tr>
<tr>
<td>Insurance</td>
<td>5%</td>
</tr>
<tr>
<td>Fuel</td>
<td>21%</td>
</tr>
<tr>
<td>Maintenance</td>
<td>10%</td>
</tr>
<tr>
<td>Lease</td>
<td>16%</td>
</tr>
<tr>
<td>Other (Permits, etc.)</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

*American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2017

24/7 operation

A self-driving truck can cross the country in 2 days instead of 5.

Truck drivers are limited to 11 hours/day by law.
Embark’s freight route with Electrolux:
Embark’s system is highway-only

Transfers the load to a local driver for city streets
Embark’s Milestones

- First to drive through a major city
- First cross-country trip with an automated truck
- First to ship freight for a Fortune 500 customer
How do we do test safely?
You need an attentive driver

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No automation</td>
<td>Driver Assistance</td>
<td>Partial Automation</td>
<td>Conditional Automation</td>
<td>High Automation</td>
<td>Full Automation</td>
</tr>
</tbody>
</table>

- **Attentive Driver**
  - System not responsible
- **Inattentive Driver**
  - System responsible for safety
Safety at Embark

Engineering
Drivers
  Selection
  Training
  Operating
Engineered for Safety

• No single point of failure
• Run safety checks on all outputs
• Guarantee Driver’s ability to disengage
Engineered for Safety

Fail Safe Embedded System

Autonomy Stack

Redundant ECUs

Independent Code bases

Vehicle CAN

Hardware E-Stop
Safety at Embark

Engineering

> Drivers

  Selection

  Training

  Operating
Driver Selection

1. Professional – Specially licensed and trained

2. Experienced
   i. Our drivers average of over a million miles of experience as a professional driver

3. Good driving record
   i. We match the standard of the most selective fleets in America
Driver Training

Multi-week Training Program:
• Classroom:
  • Theory
  • Demonstrations
• Test Track:
  • Self-driving practice
  • Fault injection training
• On-road
• Final Exam (DMV Style)
Operations – Safety Policies

• Stricter driving limits than the federal Hours of Service
• All drivers submit to random drug testing
• No phones allowed while the truck is in motion
Operations – Real-time Monitoring

We continuously monitor key safety metrics and provide feedback to drivers in real time:

• Hands on wheel detection
• Driver gaze monitoring

If driver appears distracted, audio and visual warnings go off for 5 seconds. Following which, the system returns control to the driver.
Operations – Audits

Embark records inward and outward facing camera views at all times:

These videos are audited on a weekly basis to continuously improve our processes.

Audits include both random sampling and specific safety events we’ve identified.
Top 3 safety processes we’d like to see adopted across the industry:

- Fault injection training
- Real-time gaze tracking and feedback
- Video audits
Thank You.