Amazon’s operation in the San Francisco area:

- Delivers an estimated **11,000** packages per day [1]
- Currently employs USPS trucks (Grumman LLVs) for package delivery
- Considering transitioning to a drone delivery system for economic and environmental benefits

## Background Information

### Project Objectives

<table>
<thead>
<tr>
<th>Number</th>
<th>Key Objectives</th>
<th>Final FOC Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reliability</td>
<td><strong>Drones</strong></td>
</tr>
<tr>
<td>2</td>
<td>Safety</td>
<td><strong>196/280</strong></td>
</tr>
<tr>
<td>3</td>
<td>Speed</td>
<td><strong>Trucks</strong></td>
</tr>
<tr>
<td>4</td>
<td>Complexity</td>
<td>196/280</td>
</tr>
<tr>
<td>5</td>
<td>Energy Efficiency</td>
<td><strong>216/280</strong></td>
</tr>
<tr>
<td>6</td>
<td>Env. &amp; Econ. Impacts</td>
<td></td>
</tr>
</tbody>
</table>

## Life Cycle Assessment (LCA)

- **Climate Change Emissions** [kg of CO2 eq]
  - Truck: 4791
  - Drone: 4766
- **Eutrophication** (marine) [kg N eq]
  - Truck: 10.5
  - Drone: 4.0
- **Acidification** [EIO-LCA] [kg SO2 eq]
  - Truck: 15.4
  - Drone: 7.0
- **Acidification** (environmental Footprints) [mol H+ eq]
  - Truck: 22.2
  - Drone: 9.5

## Economic Analysis

<table>
<thead>
<tr>
<th>Major Differentiators &amp; Results [1,2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
</tr>
<tr>
<td>Fleet Size</td>
</tr>
<tr>
<td>Manufacturing Cost / Unit</td>
</tr>
<tr>
<td>Maintenance Cost / Unit / Yr</td>
</tr>
<tr>
<td>Lifespan</td>
</tr>
<tr>
<td>NPV</td>
</tr>
</tbody>
</table>

## Recommendation

A **drone delivery system** is recommended:
- Less expensive over 24 yr project life
- Lower environmental impact
- Slightly lower FOC scoring but Amazon prioritizes economic and environmental results
- Drone system aligns with Amazon’s sustainability goals

## DfE Considerations

A **Truck-Drone Hybrid Model** is proposed [5]:

- **Functional Impact**
  - Increased process complexity, less reliability
- **Environmental Impact**
  - Reducing drone travel lengths increases proportion of solar energy
- **Economic Impact**
  - Lower fleet sizes and battery charging costs
- **Societal Impact**
  - Jobs created for drone operators and delivery drivers keep their jobs

## Societal Analysis

**Trucks:**
- Concerns of strike due to recent mistreatment of delivery drivers
- Tight schedules result in skipping lunch and dangerous driving

**Drones:**
- Consumer privacy concerns derived from hacking of drones
- Drone accidents are a hazard to the public
- Public acceptance is high

- **75%** of drivers said that delivery schedules are too tight [3]
- **83%** of people support drone delivery [4]