Design Project 2
Design Team 3, Purple Cobras

Ian Hutchinson
Dan Mihalko
Douglas Jorgensen
Azrina Zulkefli
Introduction

• The City of Pittsadelphia is seeking a solution for its freight that reduces smog and meets EPA requirements, while maintaining freight capacity into and out of the city.

• Our design team The Purple Cobras was more than happy to help the great city!

• GE Transportation is our project's sponsor.

• GE helps solve the world’s toughest transportation challenges.

Good Ole Pittsadelphia
Transportation Infrastructure Condition and Capacity

- With access to water and railways. Transportation of Cargo can be done in large quantities without too much difficulty.
- Condition of the railway/locomotives are troublesome and could interfere with traveling logistics.
- Condition of the 15 Tow Barge is the only thing required for transportation over water.
- Transportation by Highway/Interstate/etc, while universal across the nation, can easily be slowed with traffic issues, road maintenance and semi truck maintenance.
- In descending order for capacity, Barges hold more than trains, which hold more than semi trucks.
## Standard Capacity For Alternative Transportation Modes

### Compare...

<table>
<thead>
<tr>
<th>Cargo Capacity</th>
<th>Equivalent Units</th>
<th>Equivalent Lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One Barge</strong> 1,500 Ton</td>
<td><strong>One 15 Barge Tow</strong> 7,500 Bushels 853,600 Gallons</td>
<td><strong>One 15 Barge Tow</strong> .25 Miles</td>
</tr>
<tr>
<td>1,500 TON</td>
<td>1,500 TON</td>
<td>1,500 TON</td>
</tr>
<tr>
<td>5,250 Bushels</td>
<td>7,500 Bushels 6,804,000 Gallons</td>
<td>.25 MILES</td>
</tr>
<tr>
<td>453,600 Gallons</td>
<td></td>
<td>2.25 MILES</td>
</tr>
<tr>
<td><strong>Jumbo Hopper Car</strong> 100 TON</td>
<td><strong>One 100 Car Train Unit</strong> 10,500 TON</td>
<td><strong>870 Large Semis</strong></td>
</tr>
<tr>
<td>100 TON</td>
<td>100 TON</td>
<td>2.25 MILES</td>
</tr>
<tr>
<td>2,500 Bushels</td>
<td>2,500 Bushels 30,240 Gallons</td>
<td>2.75 MILES</td>
</tr>
<tr>
<td>6,804,000 Gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Large Semi</strong> 24 TON</td>
<td><strong>Large Semi</strong> 910 Bushels 7,865 Gallons</td>
<td></td>
</tr>
<tr>
<td>24 TON</td>
<td>910 Bushels</td>
<td></td>
</tr>
<tr>
<td>3,014 Bushels</td>
<td>7,865 Gallons</td>
<td></td>
</tr>
</tbody>
</table>
Transportation Costs and Concept of Operations

- Trucks: $5.35 per ton mile, 155 ton miles per gallon of fuel
- Barges: $0.97 per ton mile, 576 ton miles per gallon of fuel
- Railroad: $2.53 per ton mile, 413 ton miles per gallon of fuel
- As seen, the barge is the most efficient way of travel for transporting freight into and out of Pittsadelphia.
EPA Diesel Emission Standards

- **Tier 0**—The first set of standards applies (effective 2000) to locomotives and locomotive engines originally manufactured from 1973 through 2001, any time they are manufactured or remanufactured.

- **Tier 1**—These standards apply to locomotives and locomotive engines originally manufactured from 2002 through 2004. These locomotives and locomotive engines are required to meet the Tier 1 standards at the time of the manufacture and each subsequent remanufacture.

- **Tier 2**—This set of standards applies to locomotives and locomotive engines originally manufactured in 2005 and later. Tier 2 locomotives and locomotive engines are required to

- **Tier 3 standards**—Near-term engine-out emission standards for newly-built and remanufactured locomotives. Tier 3 standards are to be met using engine technology.

- **Tier 4 standards**—Longer-term standards for newly-built and remanufactured locomotives. Tier 4 standards are expected to require the use of exhaust gas aftertreatment technologies, such as particulate filters for PM control, and urea-SCR for NO\textsubscript{x} emission control.
**Diesel Engine Exhaust Emissions**

- **NOx**
  - NOx (NO + NO2) is formed when air (oxygen and nitrogen) is heated.
  - NOx formation is exponential with temperature (Higher T → much higher NOx).

- **Particulate Matter (PM)**
  - Has the second highest second proportion in the diesel pollutant emission.
  - Can be divided into 3 main components: soot, soluble organic fraction (SOF) and inorganic fraction.

- **CO₂**
  - CO₂ is formed in direct proportional to fuel consumed (Reduce fuel consumption → reduce CO₂).
  - About 12% of the diesel exhaust gas.

- **Hydrocarbons (HC)**
  - Hydrocarbon emissions are composed of unburned fuels as a result of insufficient temperature which occurs near the cylinder wall.
  - Diesel engines normally emit low levels of hydrocarbons.
• Upgrade groups A-C to the NextFuel by GE. Fuel costs are cut by half and locomotives are at Tier 3 standards. It also makes a substitution of up to 80% of fuel with natural gas.
• Groups D and E will be replaced.
• The upgrades will cost around $30 million plus a $1 billion fueling station
• The replacements will cost around $60 million
Barge was chosen as the proposed transportation system as waterborne transportation requires significantly less fuel than rail or trucks, gives off less emissions, and also costs less money.

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**Environmental Quality of Shipping Methods**

Comparison of the emissions of different gases into the atmosphere from different shipping methods

<table>
<thead>
<tr>
<th>Mode of Transportation</th>
<th>Hydrocarbons Emitted (lbs/ton-mile)</th>
<th>Carbon Monoxide Emitted (lbs/ton-mile)</th>
<th>Nitrous Oxide Emitted (lbs/ton-mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trucks</td>
<td>0.0009</td>
<td>0.0020</td>
<td>0.0053</td>
</tr>
<tr>
<td>Barges</td>
<td>0.0046</td>
<td>0.0064</td>
<td>0.0183</td>
</tr>
<tr>
<td>Railroad</td>
<td>0.0063</td>
<td>0.0190</td>
<td>0.1017</td>
</tr>
</tbody>
</table>
References

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