GE Transportation
Freight, Fuel, & Emissions

Introduction to Engineering Design
EDGSN 100 Section 001

Team Flying Wombat / Team #4
Cody Heaton, personal.psu.edu/csh5267, csh5267@psu.edu
Connor Hoover, personal.psu.edu/cjh5764, cjh5764@psu.edu
Denis Pasic, personal.psu.edu/djp5536, djp5536@psu.edu
Laura Cook, personal.psu.edu/lkc5121, lkc5121@psu.edu

Presented to:  Prof. Bereziak
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Introduction

• General Electric (GE) Transportation tasked EDSGN 100 to strategize on efficient ways to upgrade a fleet of 50 locomotives
• Each of the locomotives is currently at Tier 2 standards
• Wide variety of options based on transportation method, fuels/fuel stations, after-treatment systems, and selling locomotives
• Main goal is to determine the best combination of solutions that maximizes economic and environmental efficiency
Transportation Infrastructure Condition and Capacity

- **Bridges:** D+
  - 22.6% PA bridges structurally deficient

- **Roads:** D-
  - 32% US roads in poor condition

- **Inland Waterways:** D+
  - delays and structural deficiencies
  - 12,000 miles of inland waterways, 51M truckloads’ worth of cargo/year

- **Freight Rail:** B
  - freight traffic may increase by 22% by 2035
  - 57 freight railroads over 5127 miles, 246 million tons of cargo/year
Standard Capacity for Alternate Transportation Modes

**Compare...**

**Cargo Capacity**

- **ONE BARGE**
  - 1,500 TON
  - 52,500 BUSHELS
  - 453,600 GALLONS

- **ONE 15 BARGE TOW**
  - 22,500 TON
  - 787,500 BUSHELS
  - 6,804,000 GALLONS

- **JUMBO HOPPER CAR**
  - 100 TON
  - 2,500 BUSHELS
  - 30,240 GALLONS

- **100 CAR TRAIN UNIT**
  - 10,500 TON
  - 350,000 BUSHELS
  - 3,024,000 GALLONS

- **LARGE SEMI**
  - 26 TON
  - 910 BUSHELS
  - 7,865 GALLONS

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**Equivalent Units**

- **ONE BARGE**
- **15 JUMBO HOPPER CARS**
- **58 LARGE SEMIS**

- **ONE 15 BARGE TOW**
- **2.25 100 CAR UNIT TRAINS**
- **870 LARGE SEMIS**

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**Equivalent Lengths**

- **ONE 15 BARGE TOW**
  - .25 MILES

- **2.25 100 CAR TRAIN UNIT**
  - 2.75 MILES

- **870 LARGE SEMIS**
  - 115 MILES (BUMPER TO BUMPER)
Transportation Costs and Concept of Operations (ConOps)
**Transportation Costs and Concept of Operations (ConOps)**

- **Barges:**
  - Most economical
  - High capacity for cargo
  - Fuel efficient
  - But...SLOW
  - And prone to delays (weather, locks, seasons)

**SOURCE** (mine, quarry, factory, etc.)

**TRANSFER TO EXPORT PORT** (often by train)

**TRANSFER TO IMPORT PORT** (using inland waterways)

**EXPORT PORT** (loaded onto barges)

**IMPORT PORT** (loaded onto train or truck)

**TRANSFER TO FINAL DESTINATION** (often by train)

**FINAL DESTINATION** (company, factory, client, etc.)
EPA Diesel Emission Standards
Diesel Engine Exhaust Emissions (DEEE)

Types of emissions
Pollutants include:
- NO\textsubscript{x}
- Particulate matter
- Hydrocarbons
- CO

Diesel retrofit device
## Locomotive Fleet Upgrade

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Cost per locomotive</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade all</td>
<td>$750k x 50 trains</td>
<td>$37.5M</td>
</tr>
<tr>
<td>Sell/replace all</td>
<td>$1.5M x 50 trains</td>
<td>$75M</td>
</tr>
<tr>
<td>Alternate fuel upgrade all</td>
<td>$1M x 50 trains (+ two $1B fueling stations)</td>
<td>$2.05B</td>
</tr>
<tr>
<td>Our Solution</td>
<td>$750k x 20 trains + $100k x 20 trains + $1.5M x 10 trains</td>
<td>$32M</td>
</tr>
</tbody>
</table>

- Upgrade new trains (Groups A and B)
- Exhaust after-treatments on middle trains (Groups C and D)
- Sell and replace old trains (Group E)
Summary

• Of rail, road, and river, barges are the cheapest option, but they have the tradeoff of speed
• Alternate fuels like biofuel or compressed natural gas are also possibilities, but are expensive
• Replacing all of the locomotives or upgrading all of the locomotives are pricy solutions
• Ultimately, use a combination of upgrading, exhaust after-treatment, and replacing
• Maybe consider barges and alternate fuels in the future
Closing

questions?