GE Transportation

Freight, Fuel, & Emissions

Introduction to Engineering Design
EDGSN 100 Section 002

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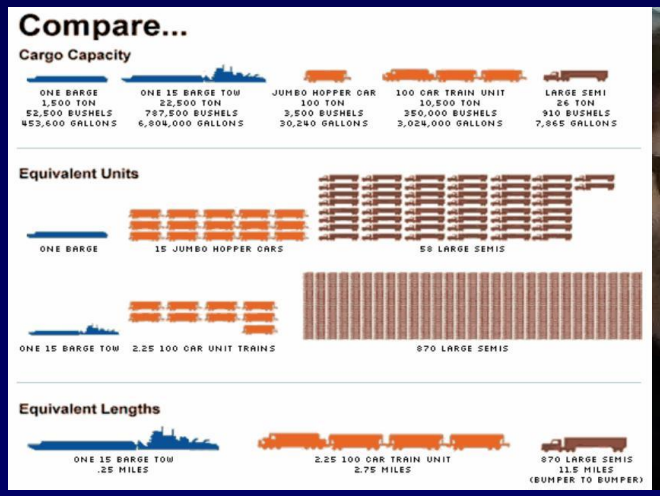

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Introduction

Project Objectives

Design a cost-effective solution for the Pittsdelphia freight that reduces smog, meets EPA requirements, and maintains/increases freight capacity.

Project Background

The shipping system needs to be improved to increase long term economic and environmental efficiency.

Project Sponsor Background

GE Transportation will be the sponsor for this project. Their headquartered in Chicago, IL and has about 13,000 employees worldwide.

Project Description

Teams should research and select alternative shipping methods, prioritizing: emissions, costs, capacity, public opinion, on time delivery.

Transportation Mode Comparisons

Trucks: Fastest, least expensive, very sensitive to delays, lowest capacity

Barges: large capacity, eco-friendly, most expensive, weather sensitive

Railroad: largest capacity, cost effective, time efficient, rail traffic sensitive

Transportation Infrastructure Condition and Capacity

Introduction

Repairs are needed regardless of which mode of transportation is selected.

Pennsylvania Roads and Bridges

Roads and bridges have a rating of D- and D+, respectively

There are many efforts to remedy these issues

The public will be against the congestion and possible shipping delays

Bridges are also susceptible to floods, seismic events, and terrorist attacks

Roads suffer severe congestion and high maintenance costs

Transportation Infrastructure Condition and Capacity

Pennsylvania Inland Waterways

Waterways are 150 yrs old, in disrepair—overall D+ rating
Delays are likely and repair projects are severely underfunded
Port of Pittsburgh supported 35 million tons of cargo.
Dams: 0 are satisfactory, 7 are fair, 7 are poor, and 3 are unsatisfactory
Locks: 3 are satisfactory, 4 fair, 4 poor, and 6 unsatisfactory

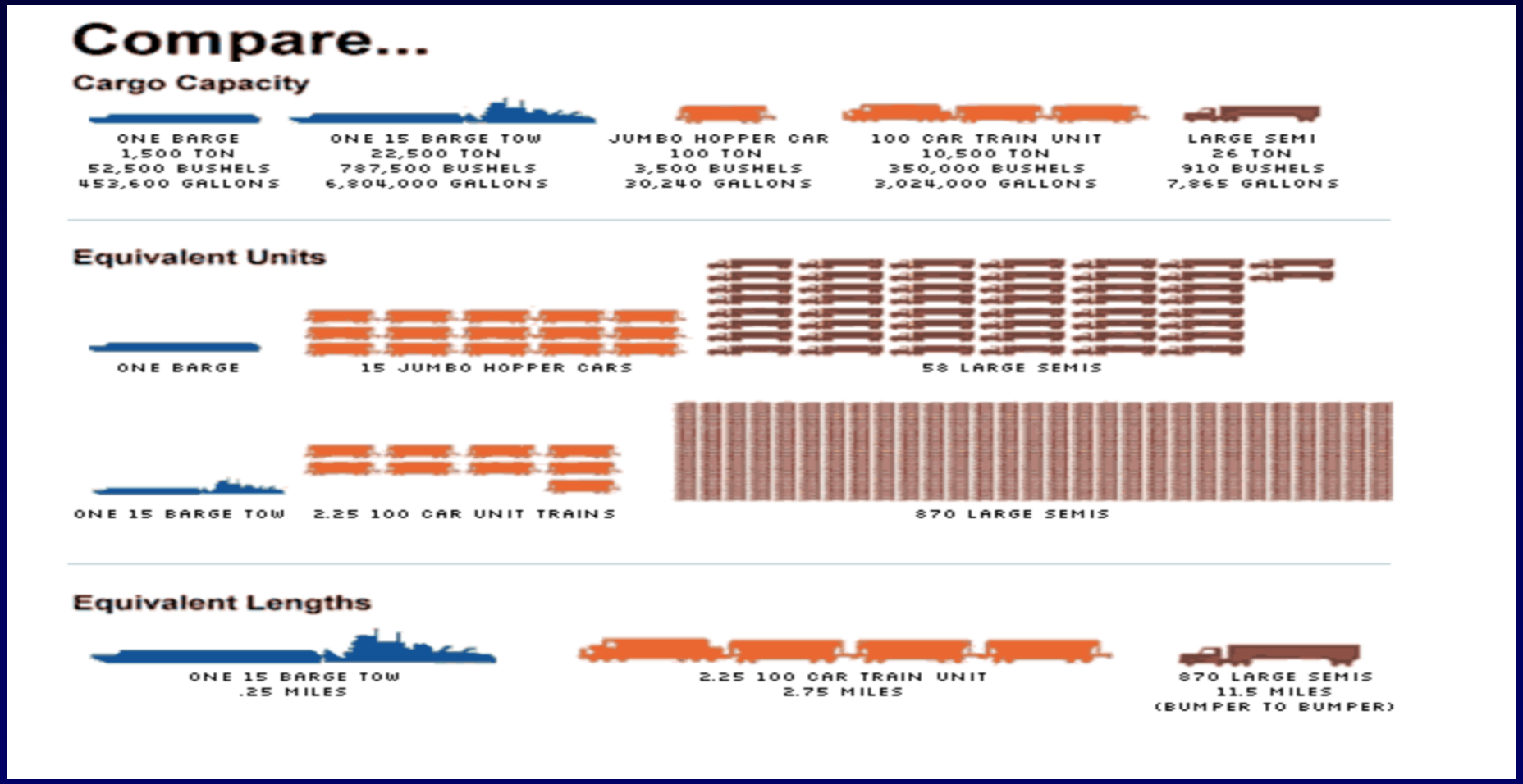
Transportation Infrastructure Condition and Capacity

Pennsylvania Freight Rail System

Overall B rating, supporting 246 million tons of freight demand exceeds capability
Rail system pays for itself, improves congestion, air quality, traffic safety
4 class 1 railways, 2 class 2 rails, 32 class 3 rails, and 27 local rails
60% of infrastructure is in need of rehabilitation, with 45 traffic chokepoints
Short and regional rails are not all fit for heavy loads
There are several projects to update the railway infrastructure.

Standard Capacity for Alternate Transportation Modes

A 100-car train unit can carry the most cargo while a large semi truck carries the least.



Transportation Costs and Concept of Operations (ConOps)

- **Average costs**
  - Truck: $80,000-$150,000 Custom features could cost about $200,000
  - Open Dry Hopper Barge: $225,000
  - Covered Hopper Rail Car: $16,500

- **Staffing**
- **Speed Limit of 49 mph except on curves**
- **FRA and the effect on environment as well as surrounding residents**
- **Alternative routes**

EPA Diesel Emission Standards

	Duty-Cycle[b]	Tier	Year[c]	HC[i] (g/hp-hr)	NOx (g/bhp-hr)	PM (g/bhp-hr)	CO (g/bhp-hr)	Smoke (percentage)[m]	Minimum Useful Life (hours / years / miles)[n]	Warranty Period (hours / years / miles)[n]
Federal[a]	Line-haul	Tier 0	1973-1992[d,e]	1.00	9.5 [ABT]	0.22 [ABT]	5.0	30 / 40 / 50	(7.5 x hp) / 10 / 750,000[o]	1/3 * Useful Life
		Tier 1	1993-2004[d,e]	0.55	7.4 [ABT]	0.22 [ABT]	2.2	25 / 40 / 50	(7.5 x hp) / 10 / 750,000[o]	
									(7.5 x hp) / 10 / -	
		Tier 2	2005-2011[d]	0.30	5.5 [ABT]	0.10[k] [ABT]	1.5	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 3	2012-2014[f]	0.30	5.5 [ABT]	0.10 [ABT]	1.5	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 4	2015+[g]	0.14	1.3 [ABT]	0.03 [ABT]	1.5	-	(7.5 x hp) / 10 / -	
	Switch	Tier 0	1973-2001	2.10	11.8 [ABT]	0.26 [ABT]	8.0	30 / 40 / 50	(7.5 x hp) / 10 / 750,000[o]	
		Tier 1	2002-2004[h]	1.20	11.0 [ABT]	0.26 [ABT]	2.5	25 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 2	2005-2010[h]	0.60	8.1 [ABT]	0.13[l] [ABT]	2.4	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 3	2011-2014	0.60	5.0 [ABT]	0.10 [ABT]	2.4	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 4	2015+	0.14[j]	1.3[j] [ABT]	0.03 [ABT]	2.4	-	(7.5 x hp) / 10 / -	

Diesel Engine Exhaust Emissions (DEEE)

- There are four main types of exhaust from diesel engines, hydrocarbons, NOx, Particulate Matter (PM), and CO2.
- NOx refers to both NO and NO2 due to how the two cycle in the engine similarly.
- Hydrocarbons primarily come from the unburned fuel of cold engines, when the fuel doesn't vaporize completely.
- Particulate Matter is the combination of soot, pollen, and other harmful air contaminates that are emitted from the exhaust of diesel engines. This has been found to be a leading cause of lung cancer and respiratory infection.
- Finally, CO2 is the greenhouse gas that causes global warning, in fact, 31% of all CO2 emissions come from transportation exhaust.

Locomotive Fleet Upgrade

No. of Existing Locomotives	Locomotive Group Designation	Assumed Existing Locomotive Mileage Range	Assumed Existing Diesel Type
10	A	<150,000	Tier 2
10	B	>150,000 and <300,000	Tier 2
10	C	>300,000 and <450,000	Tier 2
10	D	>450,000 and < 600,000	Tier 2
10	E	>600,000 and <750,000	Tier 2

Existing Locomotive Fleet Makeup

GE Tier 4 Locomotive

Over the course of 5 years, all currently existing Tier 2 locomotives will be replaced with Tier 4 locomotives. During the course of the 5 years, each group of trains with the lowest mileage will be upgraded to obtaining after treatment systems in order to abide by the regulations set by the FDA. The fleet will not consist of any Tier 3 locomotives at any time. In the 5 year plan, one alternative locomotive will be added to the fleet to be prepared for absence of fossil fuels for energy in the future.

Summary

Costs:

After treatment locomotives cost the city $1.5 billion in upkeep, so eliminating this upkeep need with Tier 4 locomotives saves the city the most money in the long run. Upgrading to after-treatment systems in the Tier 2 until their mileage is up is the most cost effective way to meet FDA standards before their scheduled replacement. Tier 2's are sold before replacement.

Environmental Impact:

Tier 4 locomotives emitt 70% less emissions compared to other commonly used tiers. After treatment systems also help reduce emissions expelled from the locomotives.

Efficiency:

Railways have the capability of bringing in goods to the city with the most cost effective and efficient process. Barges ship goods at too slow of a rate, and Pennsylvania does not have the infastruture to support it. Trucks can't carry large amounts of goods and cause traffic congestion, polluting the air. Trains are able to transport a large amount of goods at a face pace, as well as allowing room for innovations in environmental friendly transportation options.

Public Opinion:

Being environmentally friendly tested extremely high with citizens, so as to please and impress them we will be added 1 alternative fuel locomotives into the fleet. Although this costs a lot of money right now, it will make up for itself in the future when the world is forced to rely on alternative fuels.

Closing

Our innovative transportation design plan will bring the city of Pittsyldelphia the efficiency and capacity to allow it to be able to fully function as a metropolis.