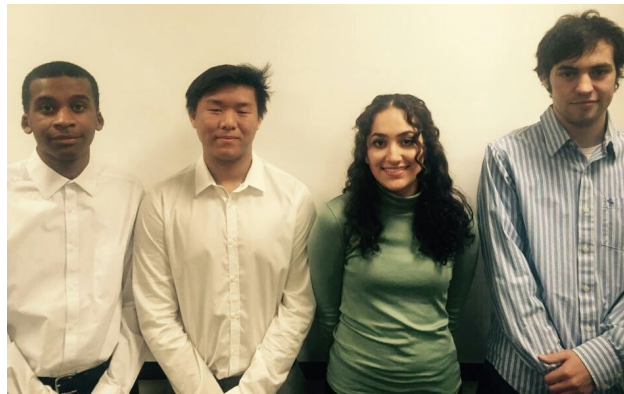




The Renovation and Improvement of the Pittsedelphia Freight Shipping Infrastructure



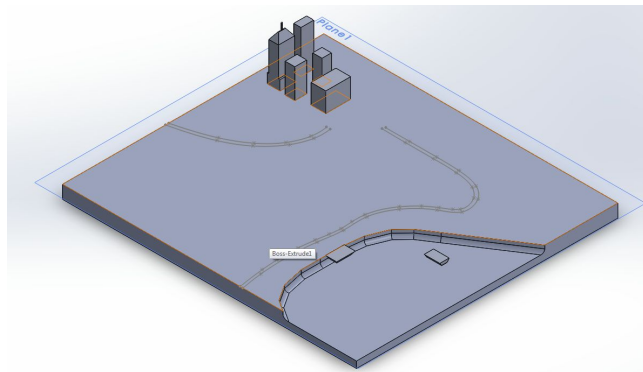
EDSGN 100 Section 010

Team #7

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Abstract

The best shipping system design for Pittsedelphia is in which half of the existing locomotive fleet is sold, while the remaining fleet is upgraded to tier 3 standard and given aftertreatment. The missing half of the fleet is replaced by ships working out of the already extant Pittsedelphia shipyard. This system, while having a high initial cost, decreases emissions significantly and decreases daily fuel costs over the existing system.

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Introduction

Transportation plays an important role in shipment of goods to Pittsedelphia. The current system that provides goods to the city is flawed. The system is currently at tier 2 EPA emissions levels. G.E. has challenged the class come up with an idea to improve this system. The goal of the new system is to have it reach at least tier 3 EPA. This report shows the process that leads to the final proposed solution. Therefore, Group 7 has decided to sell half the fleet of trains(25), and the remaining half will be upgraded to Tier 3 with after treatment given afterwards. Freight will be transported by ships while some part of coal and freight will be transported by locomotives. The number of ships will vary according to the amount of freight in tons at each given period of time.

Description of the Design task

Problem statement:

Pittsdelphia, with its current system of freight locomotives, has an abundance of smog caused by buildup of emissions from said locomotives.

Mission statement:

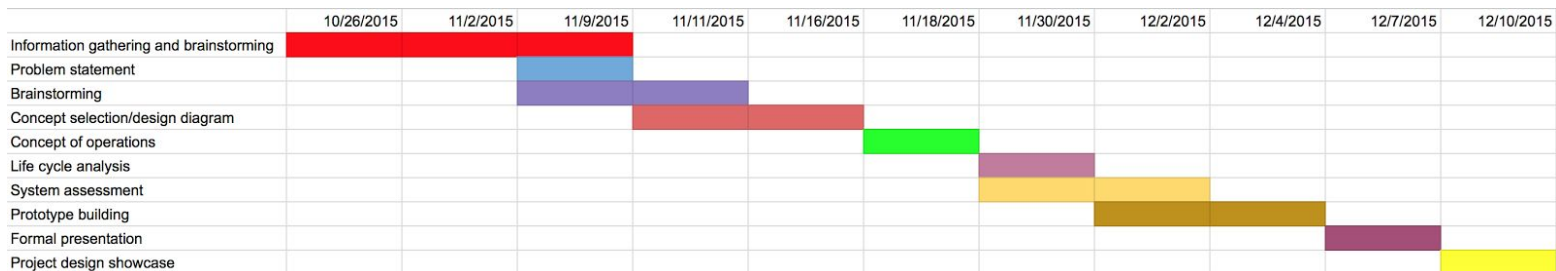
To reduce the levels of smog in Pittsdelphia by upgrading the existing locomotives to at least tier 3 levels, or integrating an entirely new system of freight transportation.

Design Specifications:

1. must transport 165,000 tons of freight
2. to reach at least level tier 3 EPA
3. reduces smog, while maintaining or increasing freight capacity

Design process/approach-design matrix

Gantt Chart-



Concept generation-

1. Ships and trains

25 of the 50 existing locomotives are sold. The remaining 25 are upgraded to tier 3 standards and given aftertreatment. The trains carry the coal and some freight, while most of the freight is carried by cargo ships, which are purchased.

2. Upgrade trains to tier III with after treatment

Upgrading 50 of the existing tier II locomotives will cost the group \$42.5 million. Upgrading all locomotives to tier III will emit 450 kg of particulate matter a day, and 1,237,500 of NO_x

3. Sell all tier II old trains and buy tier 4 trains

Selling all old trains will cash in \$75 million as each train can be sold for an estimate of \$1.5 million. However, buying all tier 4 will cost \$200 million as each tier 4 train is sold for \$4 million each. The total cost of this solution is \$125 million. From calculations, this solution will emit NO_x of 292500 kg and 135 kg of particulate matter per day.

4. Magnetic trains

All of the existing locomotives and tracks are sold and replaced with maglev trains. These hover above the track using electromagnets, reducing friction and drag.

5. Electric trains

The existing locomotives are upgraded by removing the diesel engine and installing a converter that receives electrical energy through a boon from a rail buried underground. This energy is then used to power the existing electrical engines of the locomotives.

Design matrix

Table.1

		Concepts	
		Ship and Train	Upgrade Train
Selection Criteria	Weight Percentage		
Environmental	40%	5/2	3/1.2
Cost	30%	2/.6	4/1.2
Time	15%	3/.45	4/.6
Capacity	15%	5/.75	2/.3
Total Score		3.8	3.3
Rank		1	2
Continue		yes	No

Table.2

	Electrical	Sea & Train	Updating System
Cost	-	+	+
Capacity	+	0	+
Time	+	-	+
Environmental	+	+	-
Overall	2	1	2
Continue?	No	Yes	Yes

Detailed Description of the Chosen Design:

The best design, which was chosen, is the ships and trains system. This system involves selling half, 25, of the existing 50 locomotive fleet. The remaining are upgraded to tier 3 and given after-treatment. The 25 upgraded locomotives carry all 60,000 tons of the coal and 28000 tons of the freight. The remaining 77000 tons of freight are carried by cargo ships loaded and unloaded at the already extant Pittsedelphia shipyard.

In this system, the number and size of the cargo ship is variable, and is taken as such in the cost and emission calculations done for these ships.

System Supporting Numbers:

Daily NO_x emissions by ship-843 kg

Daily NO_x tier 4 emissions for 77000 tons carried-1287 kg

Daily fuel cost of ship-\$17000

Total daily fuel cost of new system-\$298000

Daily fuel cost of 45 locomotives-\$611000

System features:

- Ships have very long lives and low maintenance costs
- Ships emit much less NO_x and PM than locomotives when carrying the same cargo
- Buying cargo ships and upgrading half of the locomotives cost significantly less than simply purchasing tier 4 locomotives
- This system puts to better use the shipyard of Pittsedelphia, which was evidently not extensively used before
- The money saved by decreased fuel costs can be used to buy new tier 4 locomotives to replace the upgraded tier 3 locomotives, decreasing emissions even further
- Because some freight is still carried by train, the slow delivery time of the ships can be mitigated by having time sensitive cargo shipped by train
- The freight taken into the city can be increased by using saved money to expand the shipyard and buy more ships

Prototype / Model
Fig.1

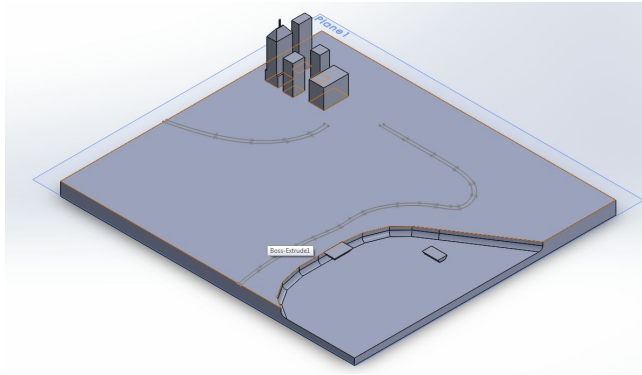
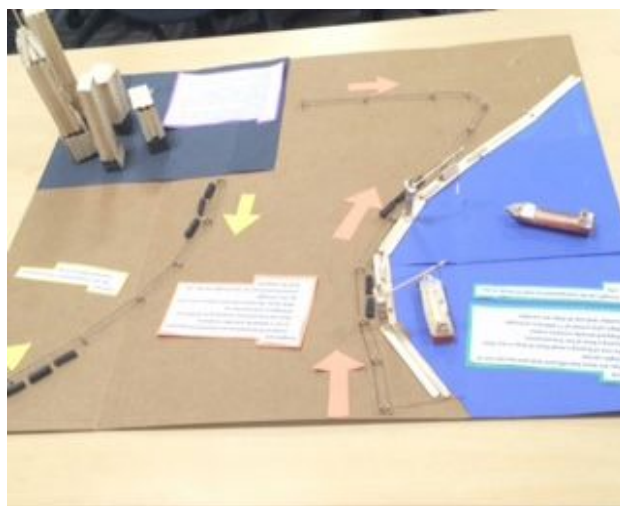


Fig.2



Fig.3



Analysis

Concept of Operations-

The goal of this system is to reduce the amount of pollution in Pittsedelphia, in a cost effective way. Like any solution to a problem, there are some obstacles that group 7 faced. One challenged faced with this system is the time it takes to use cargo ships. Group 7's solution to this problem was to use the remaining trains as speedy delivery. The ships will be loaded up from different ports around the surrounding area, and sent towards Pittsedelphia's port. Once the cargo ships arrive, crane operators will take the supplies off of the ship and load them onto the trains. Once fully loaded, the remaining fleet of trains will take them to Pittsedelphia, where they will be unloaded and used by the population.

Life Cycle Analysis-

The Life Cycle Analysis is used to determine the environmental impacts of this solution. This solution is looking into a long term development. Ships last for a longer period of time than trains, with lower maintenance cost as well. This shows the advantages that ships have over trains. Furthermore, since ships require less amount of fuel to move the same amount of cargo as trains do, this proves that ships are more superior according to Life Cycle Analysis. The fuel efficiency of the ship cuts the cost down. In fact, the money saved from the fuel efficiency could be used to purchase modern tier 4 locomotives to replace the old trains. There are many reasons why this solution provides a sustain environment.

Assessment of important aspects of your system-

The existing port near Pittsedelphia ensures that the system is viable and concrete. The port in Pittsedelphia has cranes running that transport freight from ships into freight trains running into the city. There are two main railways running into the city, coal and freight. This aspect creates the perfect atmosphere for the system to thrive. Once these goods have been transported from the ship, they will be send to a freight train to carry into the city.

Economic viability of the system-

This proposed solution is economically design, due to the fact that ships last for very long periods of time, making cost of upgrades almost nonexistent. Furthermore, the cost of maintenance will be very low in both short run and long run. Fuel efficiency is another aspect that ships have advantage of. The money saved from the fuel efficiency can be used to purchase extra tier 4 locomotives in the long run. The cost of maintaining the upgraded trains, will be about the same as the ones in the previous system, so there is no real change in pricing. The money made from turning old train tracks into passenger trains gives an additional amount of money for fuel and after-treatment.

Conclusion

The design specifications laid out for the system are met and exceeded using the combination Ships and Trains system. These specifications included meeting at least tier 3 epa emission standards, shipping 165000 tons of cargo into the city daily, and to reduce smog in the city while maintaining or exceeding the current level of freight.

The emission standard is easily met due to the extremely efficient design of the marine diesel engines used in the cargo ships. These engines emit much less for their size than the engines used in the locomotives. In addition, it takes less horsepower to carry one ton of freight at sea than on the rails, necessitating a smaller engine. These combine to reduce emissions of the system to significantly better than tier 3 epa standards.

The 165000 tons shipped daily is met with this system by having the freight divided to be carried by both the ships and the trains. The ships carry 77000 tons of the freight while the trains carry 28000 tons of freight and all 60000 tons of coal. These numbers can even be exceeded with relative ease by upgrading and expanding the existing shipyard using money saved by the decreased fuel costs of the ships.

Smog is reduced significantly by two factors: the decreased PM emissions by the cargo ships, and the distance between the city itself and the shipyard. The shipyards of most cities are adjacent, but not in the city itself. This means that much of the smog created by the ships would not linger in the city, but be blown away or out to sea. In addition, because the smog is mostly created out to sea, it affects other cities and the land ecosystem less than the smog created by locomotives.

The additions of ships to the shipping infrastructure, even though they carry less than half of the total tonnage, easily allows the design specifications to be met while maintaining relatively low costs. This makes it the ideal solution for the city in both the short and the long term. The lower initial cost will not discourage the city from making the switch, while the decreased daily costs will allow the city to reduce emissions even further in the future, or put the funds to other use.

Powerpoint

The Renovation and Improvement of the Pittsedelphia Freight Shipping Infrastructure

— By: Amanda Perez, Brandyn Bard, —
Liam Geleskie
and Piyadej Wongsirikul

Background

- 165,000 tons of freight transported daily
 - reach at least tier 3 EPA requirements
 - Fleet size = 50 locomotives
 - 15 freight, 5 mineral (coal)
-

Assumptions

- Pittsedelphia is a mixture of the properties of the real Pittsburgh and Philadelphia
- **Pittsedelphia has an extant shipyard with loading cranes**
- **Most of the freight carried to the city has no need for speedy delivery**
- **The city pays for fuel to run the locomotive fleet for ten hours each day, and the ship fleet for ten hours a day**
- **the amount of horsepower required to move 1 ton of freight is roughly the same no matter the size or number of the ships carrying it**
- **the variable amount of variable sized ships can be modeled by the statistics for a single ship carrying the total cargo capacity needed by ship**
- the consumption of fuel oil in multi-fuel marine engines is roughly equivalent to the consumption of diesel fuel
- the ratio particulate matter to nitrous oxide emitted from the ships is similar to the ratio of particulate matter to nitrous oxide emitted from the locomotives

Proposed Solution

- Sell 25 of current Tier 2 locomotives
- Remaining 25 are upgraded to Tier 3 and given aftertreatment
- Ships are used to transport 77,000 tons of freight
- 60,000 tons of coal and 28,000 tons of freight are transported via locomotives

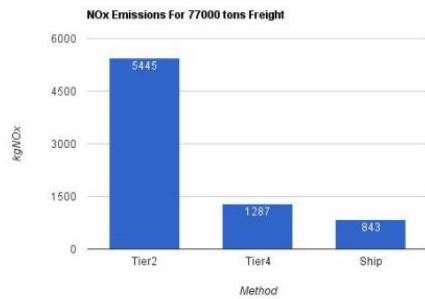


Costs

- Average cost of Cargo ship: \$500 per ton
- Sold 25 Tier 2 locomotives: \$37.5 million
- 25 upgrade to Tier 3 with aftertreatment: \$21.25 million
- To carry 77,000 tons: \$40 million
- Total cost compared to upgrade to Tier 4: \$23.75 million vs \$125 million



Why this solution?



- Using ships reduces amount of Nitrous Oxide emitted
- more cost effective than upgrading all locomotives to tier 4 or tier 3
- Because not all, but most, of the freight is carried by ship, the cargo requiring express shipping can simply be shipped by train
- ships are more fuel efficient per ton of cargo
- Daily NO_x emissions by all ships: 843kg (10 hrs)
- Daily emissions from single tier 3 locomotive: 4.5kg kg PM, 247.5kg NO_x (10 hrs)

Supporting Numbers

- Daily fuel consumption by ship: 45000kg
- Daily NO_x emissions by ship: 843kg (10 hrs)
- Price for ship purchase-\$500 per ton of freight
- Ship horsepower needed: 0.75hp per ton of freight
- Daily emissions from single tier 3 locomotive: 4.5kg kg PM, 247.5kg NO_x (10 hrs)
- Daily fuel costs

Life Cycle Assessment

- ships last forever
- modern cargo ships have low maintenance costs
- ships require less fuel to move the same cargo
- the locomotives that were simply upgraded could be sold and replaced with modern tier 4 versions in several years using the money saved by the fuel efficiency of the ships
- much of the train tracks that are no longer in use could be repurposed for passenger trains or scrapped

Brochure

Why?

This proposed system is the cheapest and most effective alternative. The new innovative system:

- cheaper than upgrading to tier 4
- cargo ships emit less NO_x than tier 4
- fuel cost for ships are less
- does not require any new infrastructures

Cost and Emissions

	Cost	Daily Fuel Cost
Tier 4	\$125 million	\$32,000
Cargo Ships	\$23.75 million	\$17,500

Emissions



NOx Emissions For 77000 tons Freight

Method	Approx
Tier2	5445
Tier4	1287
Ship	843

How will it work?

Non perishable items will be transported via the cargo ships to the shipyard. The goods will then either be driven by trucks or by extra or unused locomotives into the city. Perishable or time dependent cargo will be transported from its origin directly to the city, taking much less time than the cargo carried by ship.

Pittsedelphia

Pittsedelphia is a mixture of the properties of the real cities of Pittsburgh and Philadelphia. These properties included, keyly, a close proximity to a major body of water, an extant shipyard on that body of water, and an extensive road and train track system extending far outside the city itself.





The Renovation and Improvement of the Pittsedelphia Freight Shipping Infrastructure

Amanda Perez, Liam Geleskie, Brandyn Bard, Piyadej Wongsirikul




What's the problem?

The city of Pittsedelphia currently railway system that both transports coal and freight in and out of the city. These trains carry 165,000 ton of both freight and coal via Tier 2 locomotive trains. Residents have been complaining about the excess amount of smog caused by the emission of the trains.


What needs to be done?

- All upgraded systems need to meet Tier 3 EPA standards.
- Most effective in terms of both cost and efficiency
- Goal is to lower both particulate matter and NO_x emissions from locomotives



Life cycle Analysis:

Cargo ships have a very long useful life span and very low maintenance costs. This means that the system proposed will be a long term solution that decreases upkeep costs. In addition, ships use much less fuel per ton of cargo carried than locomotives, reducing annual fuel costs drastically. The money saved in fuel costs over a relatively short time can then be put towards the purchase of new tier 4 locomotives to replace the upgraded tier 3s. In a relatively short time, this system will reduce the emissions by transport of the city to a marginal fraction of the previous system.



Proposed Solution

The best solution to lower the amount of smog while being conservative with costs, is to replace half of the locomotive fleet with cargo ships. Selling 25 of the 50 locomotive fleet allows both the purchase of cargo ships and upgrading the remaining 25 locomotives to Tier 3 with after treatment. 77,000 tons of freight will be delivered to the shipyard via the cargo ships, while the remaining 28,000 tons will be transported by 8 locomotives. The entire 60,000 tons of coal will solely be transported by 15 locomotives. This allows 2 locomotives free and available for backup.