

# **The Eurostar and The Channel Tunnel**

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Day 36

## 1.0 Background

Britain and France have been in need of an affordable means of transportation since the 1700s. Airlines, ferries, and automobiles dominated the market before 1994. Airlines are considered to expensive, while ferries and automobiles are considered cost efficient but require too much time. In 1984, the Eurostar began to help solve this problem.

### *1.1 The Eurostar*

The Eurostar, found in Europe, is the only high speed rail for that area. Its construction began in 1987 with the digging on the channel tunnel and ended in 1994. The Channel Tunnel was funded by a different group of financiers and cost them approximately \$13 billion. The actual railway and trains cost about \$31 million, not including operations or maintenance. This railway stretches from London to Paris and London to Brussels with stops in between. The railway is approximately 124 miles long, 31 of those miles being underground through the Channel Tunnel [1].

The Eurostar was built to provide an affordable means to get from place to place in a timely fashion. It was not meant to replace airlines or ferries, rather provide a different way to travel. It is cheaper than regular airline travel but arrives slower to its destination and more expensive than ferry travel but arrives quicker at its destination. You can also compare it to automobile transportation as well. It costs roughly \$80 to drive from London to Paris. It is about \$35 for gas and \$45 for tolls. The Eurostar is not cheaper than that, but does arrive much faster than all automobiles.

In 1994, operations for the Eurostar began. It traveled at a max speed of 186 miles per hour, but only traveled at 100 miles per hour through cities and through the Channel Tunnel. This reduction in speed was to reduce noise and to reduce the risk of damaging the tunnel. By 1995, the 1 millionth passenger rode on the Eurostar. By 1996, the Eurostar had their five millionth passenger and by 1997 they had their 10 millionth passenger ride on the Eurostar [3]. This shows an increase in interest towards traveling on the Eurostar. It also shows a significant increase in profit per year. If the trend were to continue, the Eurostar would be making a profit in as few as ten years.

### *1.2 The Chunnel*

The Channel Tunnel, also referred to as the Chunnel and Eurotunnel, was being developed as early as 1802 [2]. It was proposed for carriage travel from the Britain to France as is shown in the picture. In 1833, a famous geologist named Thom da Gamond, researched the geology of the seabed [2]. Then in 1870, companies on the French and British side arose for the Channel Tunnel.

Construction on the Chunnel actually began in 1922 on both sides (at Dover and Calais) but was halted because of government opposition. People began researching marine life and other engineering aspects for this large scale project in 1956 [2]. Finally in 1985, construction on the Chunnel began again.

Throughout these years, the Chunnel design kept changing. It kept changing due to the enormous amount of information that was found during the research periods. In 1985, people felt that the design below would provide the most safety and most efficiency for the Chunnel. This design is also the most economical model. The picture below shows the different levels of the Chunnel. It shows a layer of water, a layer of silt/sand, then a layer of harder rock where the Chunnel would be built.

The Chunnel would be built using a TBM (Tunnel-Boring Machine). The largest TBM ranges from 29ft to 33 ft in diameter, are approximately 45 feet in length, and weight almost 1300 tons [2]. Its head rotates approximately 1.5 – 3 times a minute and moves about 3 inches during this time period [2]. Below is a picture of a TBM that was used during the construction of the Chunnel.

It took approximately 13,000 technicians, engineers, and workers to complete the Chunnel by 1994 [2]. The Chunnel was finished in early 1994 so that the trains could be placed on the rails. This means that service for the Eurostar would begin towards the middle of 1994.

## **2.0 Cost – Benefit Analysis**

The Eurostar and Chunnel are two differently funded projects. The Chunnel has been estimated to be approximately \$13 billion [1]. The Eurostar (without Construction and Maintenance costs) is roughly \$31 million. Each project was financed by different groups. In my analysis, I only took into account the costs of the Eurostar. In my sensitivity analysis I will set up a base case including the Chunnel and a base case not including the Chunnel. For this section, however, I will only display an analysis of the costs for the Eurostar. Operation and maintenance costs more than the actual construction costs because of the unreliability that plagued its service. That created a huge social cost for the Eurostar.

As you can see, during its 18<sup>th</sup> year, the total yearly costs increased drastically and in the 19<sup>th</sup> year revenues dropped. This is due to the Hatfield crash. The Hatfield crash is basically a derailment of the train that injured several people but did not kill or severely injure anyone. It cost approximately \$850 million to fix the rails, the trains, and in social costs as well. People were less inclined to travel on the Eurostar after this happened (that is why revenue dropped during the 19<sup>th</sup> fiscal year) [4].

## **3.0 Risks and Uncertainties**

There are several risks and uncertainties that must be thought of before evaluating this project. General risks and uncertainties for projects include ridership, natural disasters, and accidents/damage to structural integrity.

### *3.1 Ridership Uncertainty*

Before constructing this project, the engineers must realize that ridership is a huge uncertainty. There is no mathematical formula or any concrete answer that can help solve this uncertainty. Economists have troubles identifying concrete evidence about this as well because there are too many variables involved when dealing with projects like these. First of all, the engineers must ask the question, “Why am I constructing this project?” The Eurostar is being constructed to offer an affordable and safer means of transportation between Britain and France. It is not meant to compete with the airline industry even though most people feel that it does. Another question the engineer must ask is, “What causes people to avoid our project?” Most people avoid new projects because it is new and has no history involved with the project. Most people avoid new projects because it might get in a huge accident because it has no safety record. “How can people become attracted to this type of travel?” Offer incentives such as Buy 1 ticket get 1 free. Even though it will be a little costly on the economic side for the business, it will increase ridership in the long run. Another way to increase ridership is stability within the operators and track maintenance. If these two factors become unreliable at one point, then people will choose a different way to travel.

### *3.2 Natural Disaster Risks*

A natural disaster can strike at any moment, anywhere. What were to happen if an earthquake were to strike along the English Channel and severed the Chunnel? Water would seep in little by little until the pressure is too great to withstand in the structure. The structure would then collapse/explode and ruin the underground connection between Britain and France. Another disaster that could ruin the Chunnel is a Tsunami. A huge wave of water pounding directly above the English Channel could completely collapse the Chunnel. Even though these risks may seem a little off the wall, they must still be accounted. People’s lives are at stake when building a project of this magnitude.

### *3.3 Accidents/Damage to Structural Integrity*

There are also several incidents that could damage the structural integrity of the Chunnel as a whole. Someone could drop a bomb in the English Channel which would completely destroy the

Chunnel and any structure within it. Maybe a secret submarine could be too low in the water and crash into the seabed, which could possibly ruin the structural integrity of the system. Again, there is nothing we can do to stop these problems. All we can do is hope that these problems will not be prominent in the region related to the Chunnel.

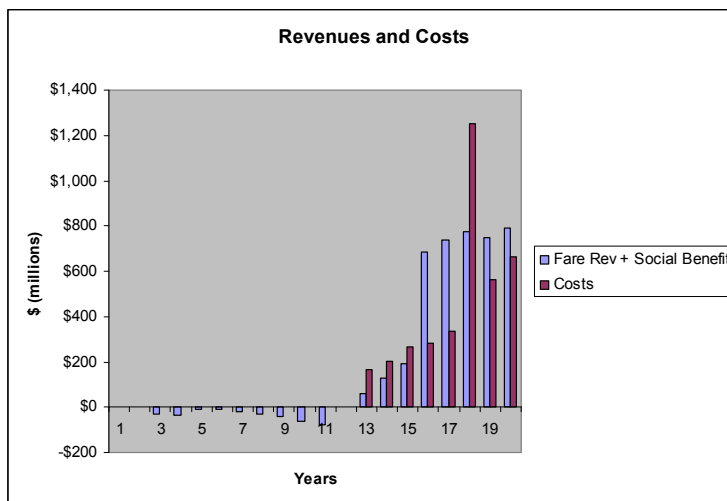
#### 4.0 Sensitivity Analysis

For my sensitivity analysis I will analyze ten possible scenarios for this project and estimate using tables and graphs the outcome of that scenario. I will use the best possible scenario, the worst possible scenario, a few in between scenarios, then some radical scenarios just for comparison.

##### 4.1 Base Case (normal Cost-Benefit Analysis)

The first step to analyzing different variables is setting up the base case. The base case is simply the normal cost-benefit analysis without any changes in its variables. Below is a graph of how the Revenues and Costs compare to each other.

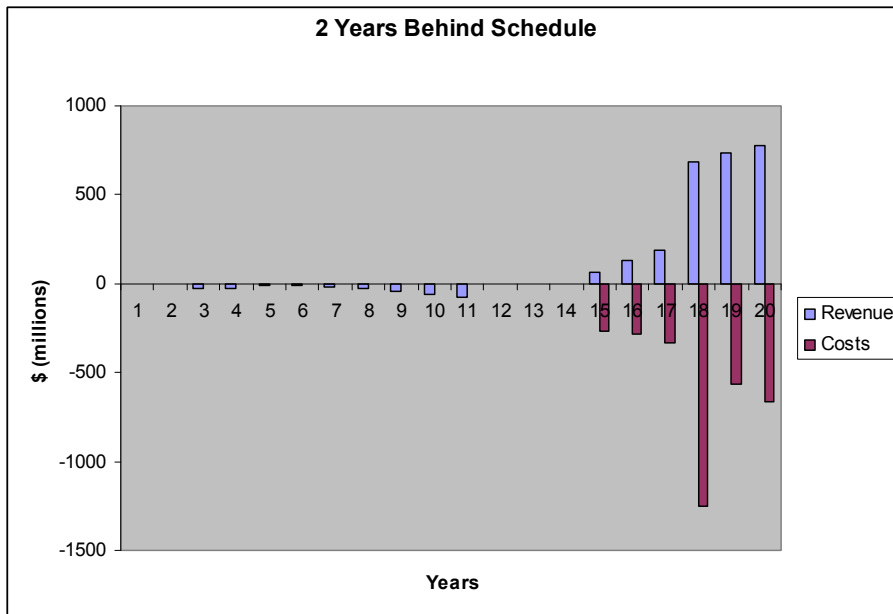
Base Case	
Interest Rate	12%
Costs	\$3,800,000,000
Revenue	\$3,770,000,000
NPV	(\$30,000,000)



##### 4.2 Two Years Behind Schedule

This case will show the Costs and Revenue of having been delayed two years. During these two extra years, construction, land acquisition fees, and engineering fees are added. You also lose two years of revenue and two years of positive social benefit. Here is how this case compares to the base case.

Behind 2 Years	
Interest Rate	12%
Revenue	\$2,270,000,000
Costs	(\$3,400,000,000)
NPV	(\$109,000,000)

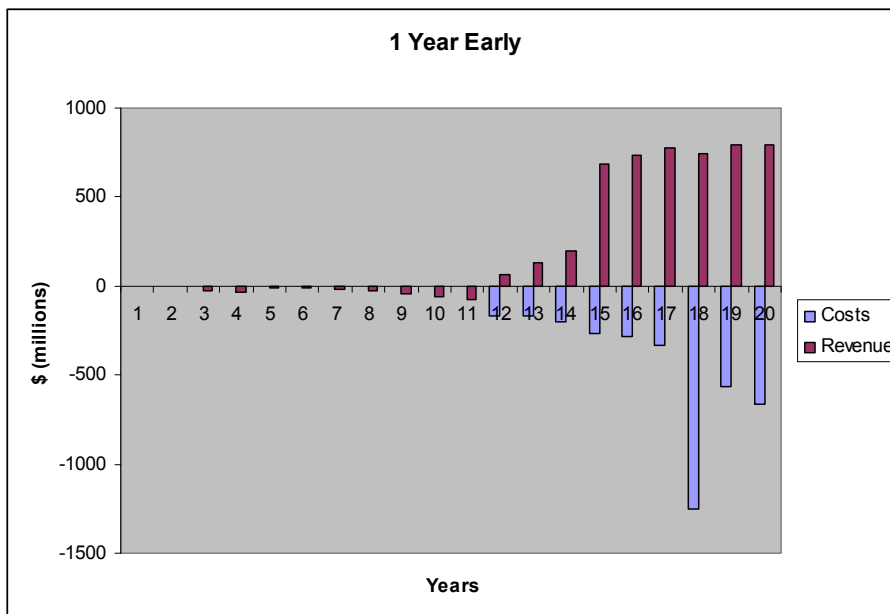


This graph shows that the costs are much greater than the Revenue and social benefit. This makes sense because having a project's construction last a few years longer will create shortages in money and will put the project in more debt than it already is. The base case is preferred over this case because this project is two years behind and because the NPV is greater for the base case than this scenario.

#### 4.3 Finishing the Project 1 Year Early

This is a scenario that will prove to be better than the base case. Less money will be spent on construction and will have one year extra of revenue than the base case. The NPV is expected to be greater and positive because the first year of profit for the base is year 21. If we were to take off a year from the base case (a 20 year long project), there would be one extra year of revenue that will provide just enough to reach a profit.

1 Year Early	
Interest Rate	12%
Revenue	\$4,595,000,000
Costs	(3,933,000,000)
NPV	\$8,350,000



As you can see through the graph and the table, the Revenue outweighs the cost this time around. This means that it would be ideal to finish the project ahead of time. This is better than the base case this time around because it has a positive net present value.

## References

- [1] The Eurostar. <<http://www.o-keating.com/hst/eurostar.htm>>
- [2] The Chunnel.
- [3] Eurostar Services. <<http://www.eurostar.com/dctm/jsp/index.jsp>>
- [4] Eurostar results for 1999 & business update.