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The CHUNNEL

Historical Purpose

- The Chunnel runs beneath the English Channel and connects Great Britain with France.

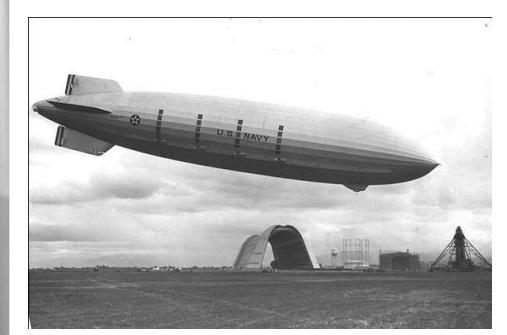
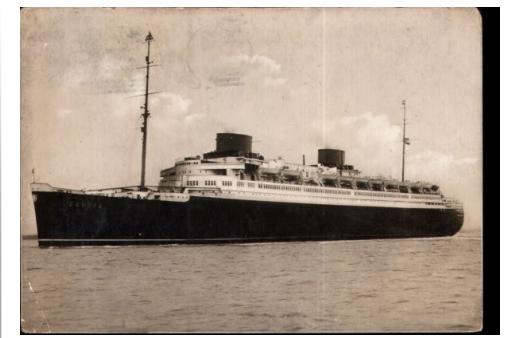
- Giving British citizens train access to the European continent and vice-versa

- Transport passengers and freight cargo with greater convenience and efficiency



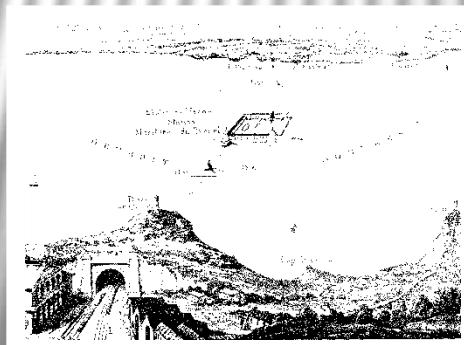
Before the Tunnel

- Travel was very limited before the Chunnel was built
- Blimps – Unsafe and slow, could not sustain large demand of travelers
- Boats – Time consuming
- Ferries – Inconvenient, uncomfortable
- Airlines – Costly



Early Beginning

- The desire to link Britain and France dates back more than 200 years.
- 1880's : 1st attempts were made to channel through the earth, however due to technological inadequacies British government was forced to halt construction.
- It took 100 years for the idea to become a reality and in late 1984 the British and French governments reached an agreement to build the tunnel.

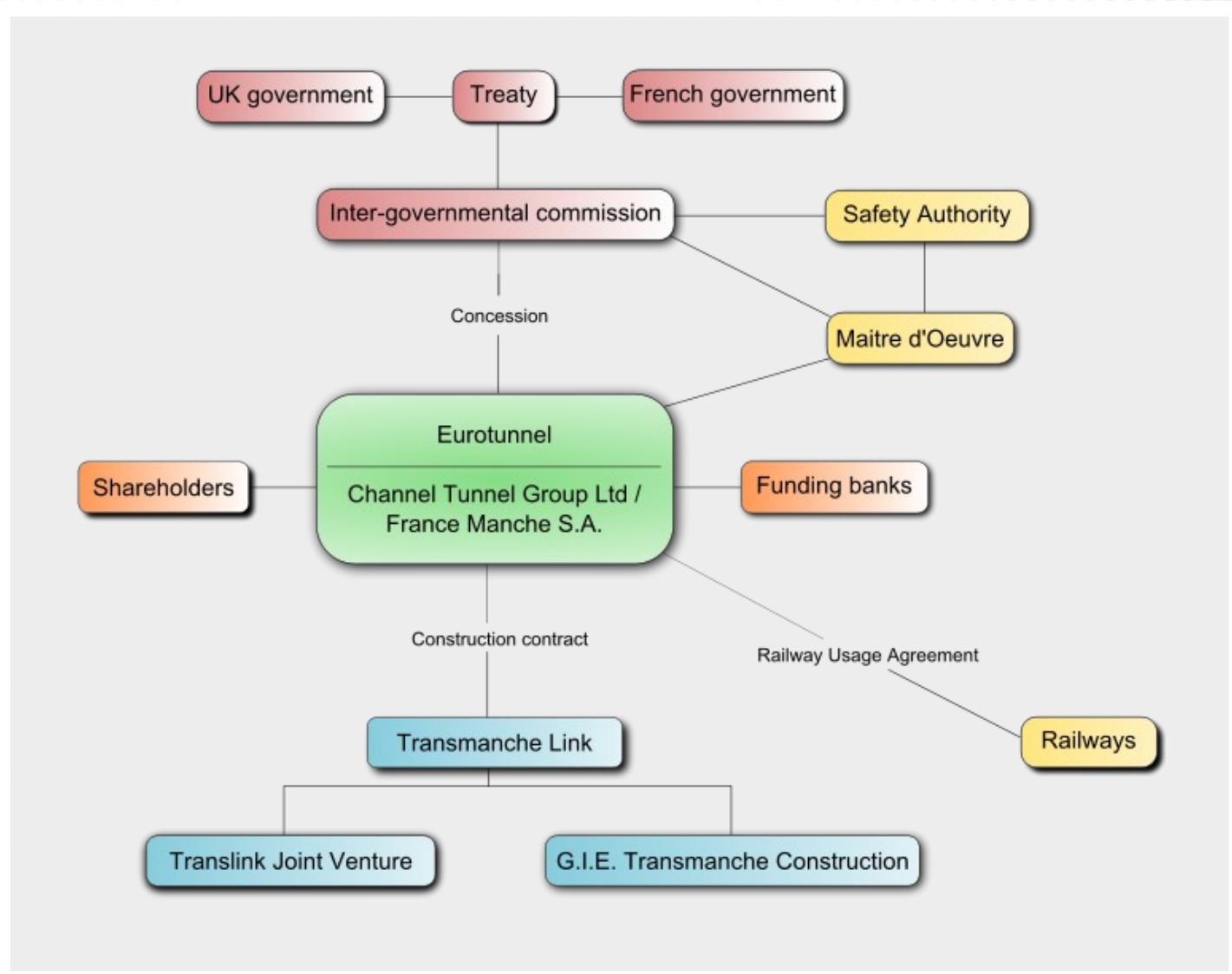


Construction period



- Tunneling commenced in 1988 and
- Began operating in 1994

Construction commencement



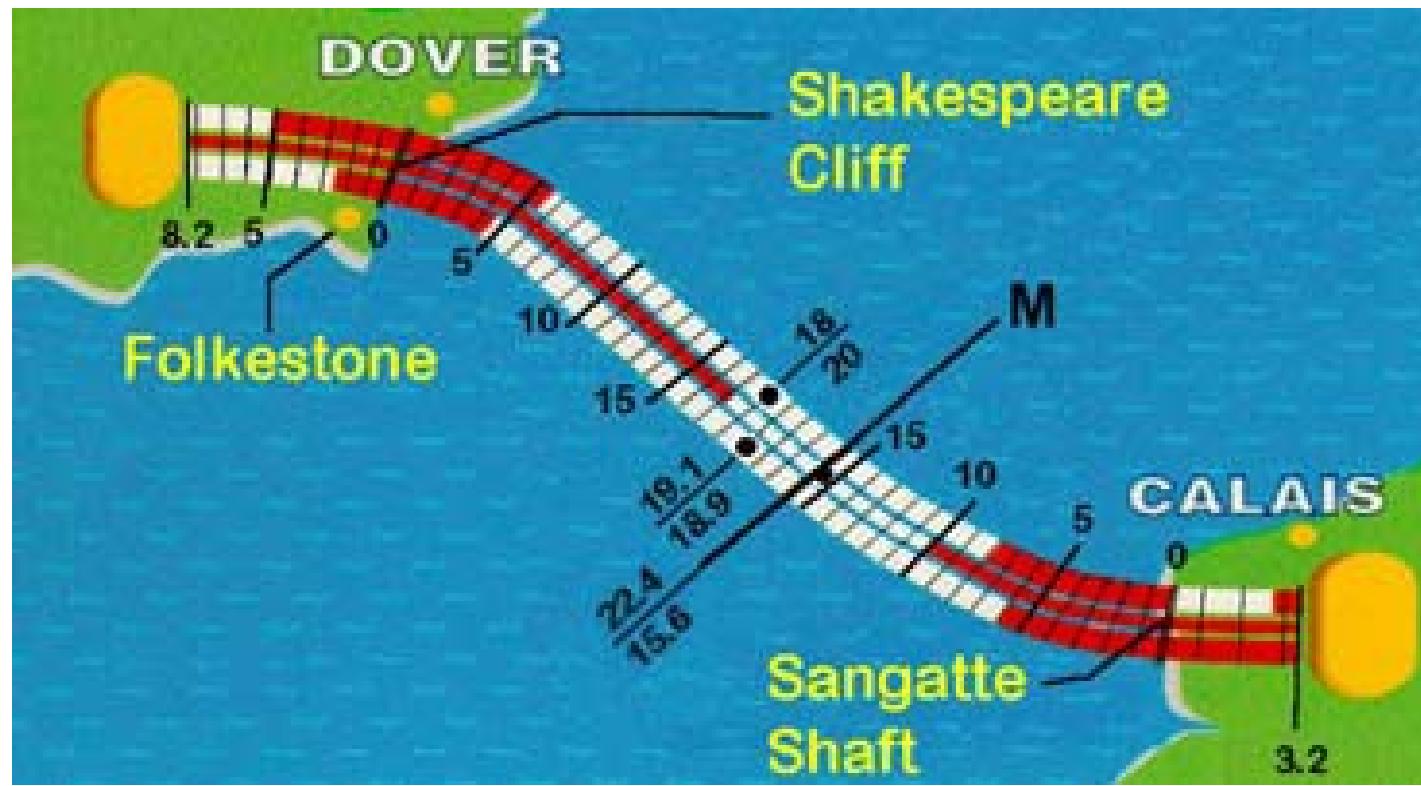
The Tunnels

- 3 parallel tunnels (50.5 km each)
- 38 km undersea
- 3.2 underland (France)
- 9.3 underland (UK)
- One of the Seven Wonders of the Modern World

Popular Mechanics,

Construction

- Eleven tunnel boring machines
- Two rail tunnels
 - Diameter 7.6 m
- Service tunnel
 - Diameter 4.8 m
- Tunneling Sites
 - Shakespeare Cliff (UK)
 - Sangatte (France)



Tunneling Sites

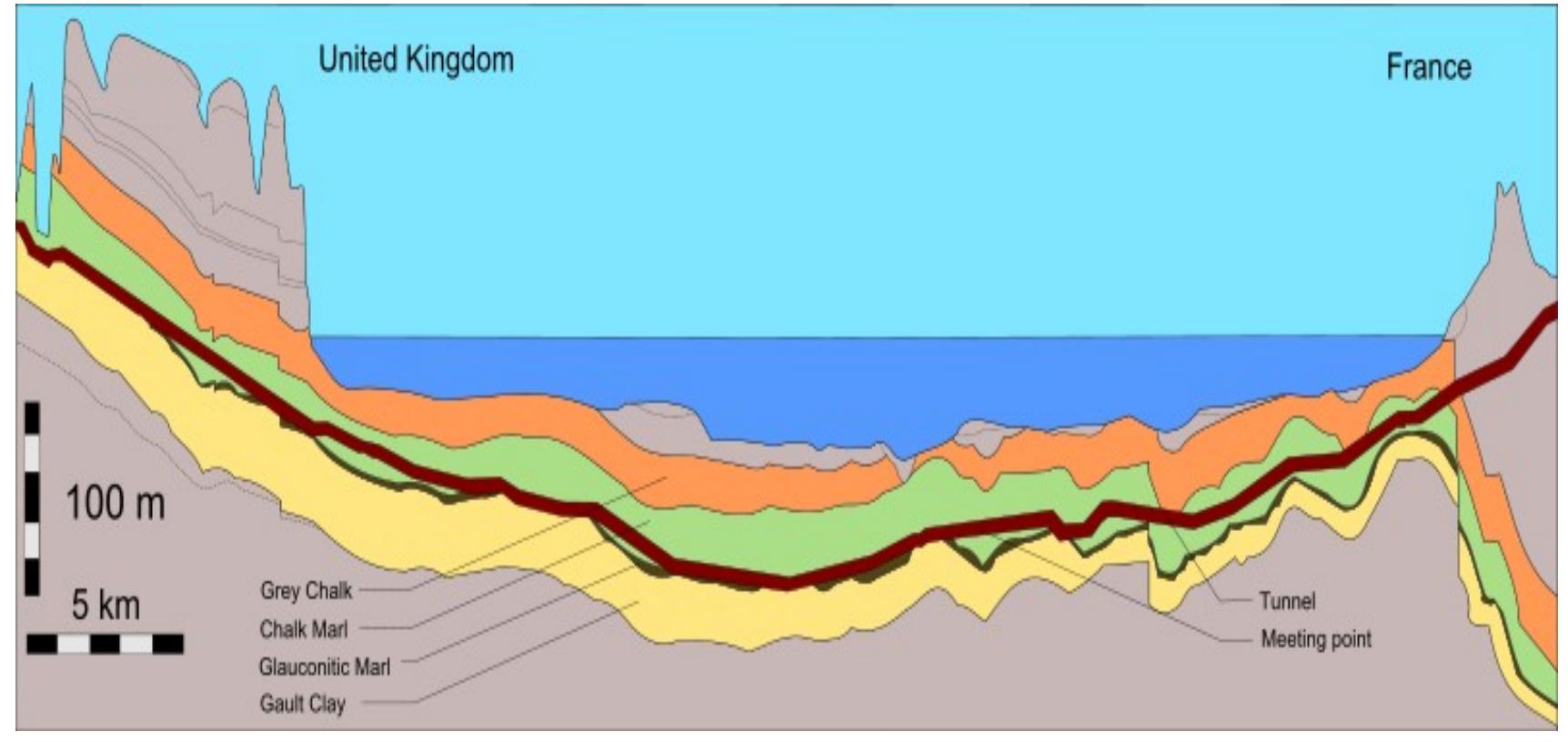
- Shakespeare Cliff (England), Sangatte (France)
- As close to the ocean as possible

Economic Construction Challenges

- Time
 - Private investment
 - Importance of financial return
- Cost of \$5 million a day
 - Far over budget
- Total \$7 – \$21 billion
 - £11 billion
- 80% cost overrun

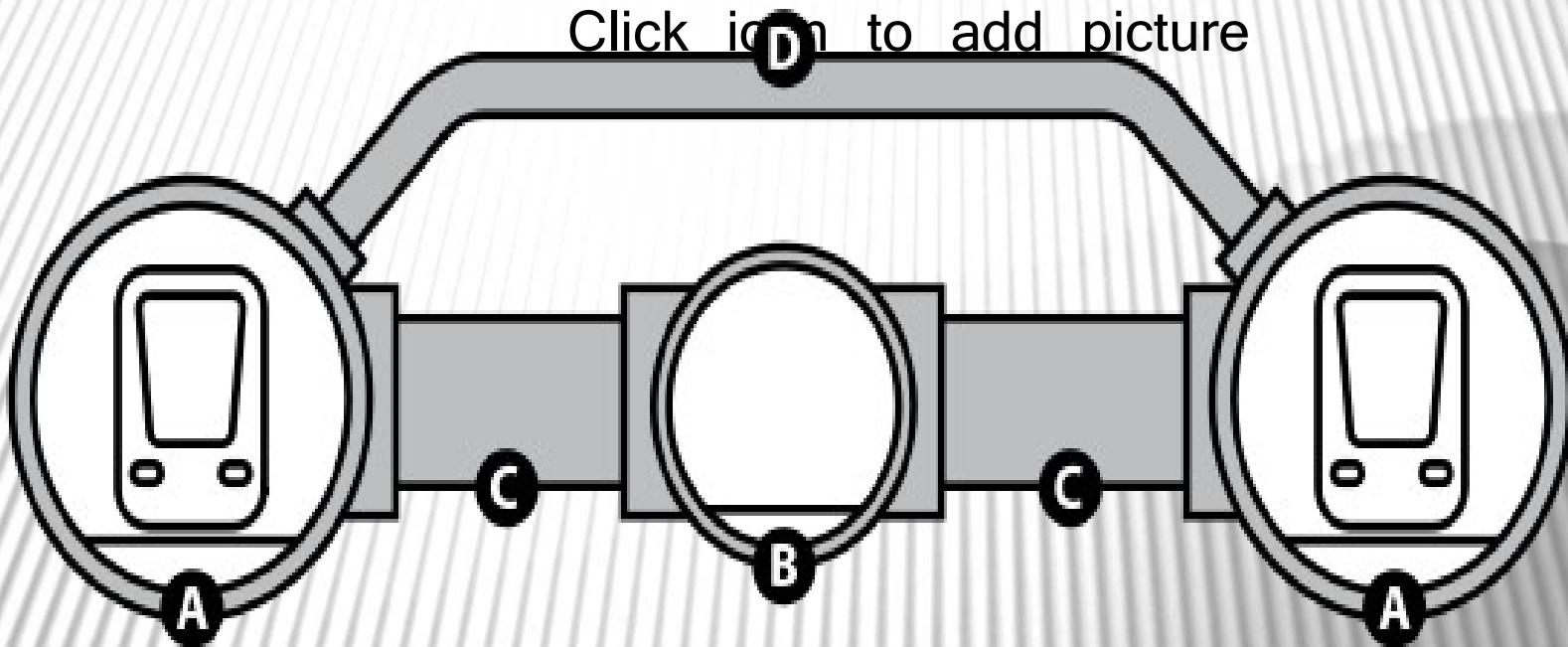
Construction Challenges

- Water Inflow
 - Pressure
 - Leaks (weak ground conditions)
- Fires and equipment failure.
- Ten workers killed
 - 8 UK, 2 French
 - Tunneling accidents
- 60,000 jobs created
 - Added cost
 - Economic consequence



Geology

- Average: 45 Meters below seabed (150 feet)
- Majority Chalk marl stratum (layer).
- Chalk marl Properties
 - Impermeability
 - ease of excavation



Tunnel cross section

- A: Rail tunnels
- B: Service tunnel
- C: Linking Service tunnel from rail tunnels

The Need For Further Expansion?

- First Profit of £1m (£890,000) Occurred in 2007

London Eurostar 2504 August 2003 2004 August 2004

Eurostar 67.99% 64.91%

- First Dividend Paid in 2008

Air France 11.13% 12.06%
British Airways 11.78% 13.59%

- Eurotunnel In Large Amounts of Debt

Easyjet 4.38% 4.60%

- No Need For Another Link, But A Need For More Users

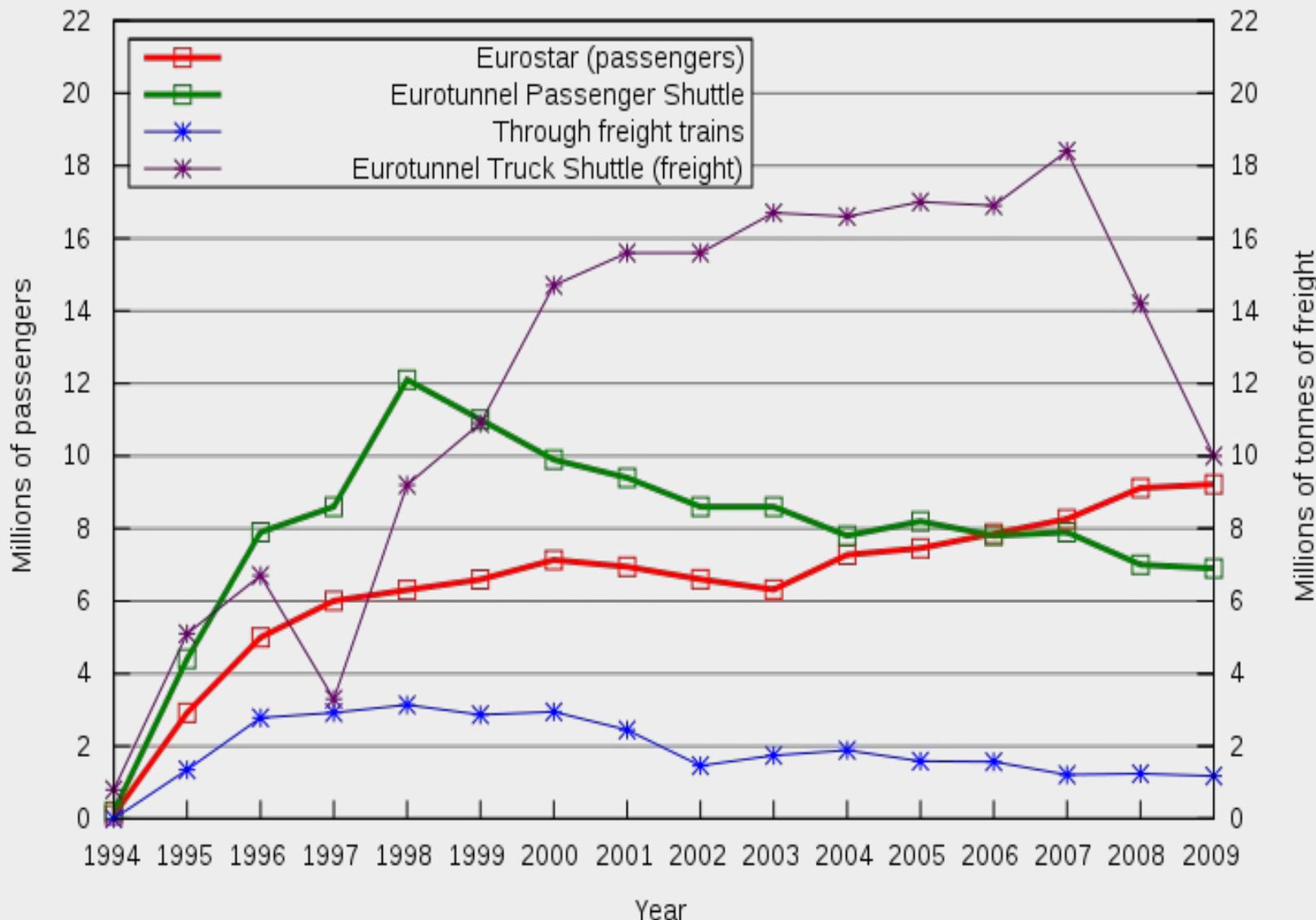
Other 0.23%
0.28%

Total 100%

100%

Year	Passengers transported...		
	by Eurostar (<i>actual ticket sales</i>)	by Eurotunnel Passenger Shuttles (<i>estimated, millions</i>)	Total (<i>estimated, millions</i>)
1994	~100,000	0.2	0.3
1995	2,920,309	4.4	7.3
1996	4,995,010	7.9	12.9
1997	6,004,268	8.6	14.6
1998	6,307,849	12.1	18.4
1999	6,593,247	11.0	17.6
2000	7,130,417	9.9	17.0
2001	6,947,135	9.4	16.3
2002	6,602,817	8.6	15.2
2003	6,314,795	8.6	14.9
2004	7,276,675	7.8	15.1
2005	7,454,497	8.2	15.7
2006	7,858,337	7.8	15.7
2007	8,260,980	7.9	16.2
2008	9,113,371	7.0	16.1
2009	9,220,233	6.9	16.1

Channel Tunnel traffic



Tunnel Problems

- Electrical Failures
- Natural Disasters
- Immigration
- Fires



Electrical Failures

- Four Major Electrical Failures
- No Major Injuries Were Caused
- Two Of The Four Failures W



© Ady Kerry

February 19, 1996



engers Were Trapped Inside The
de The Circuit Boards

August 3, 2007



Passengers Inside The Tunnel
by 6 Hours



December 18, 2009



overnight

The Winterization Shield

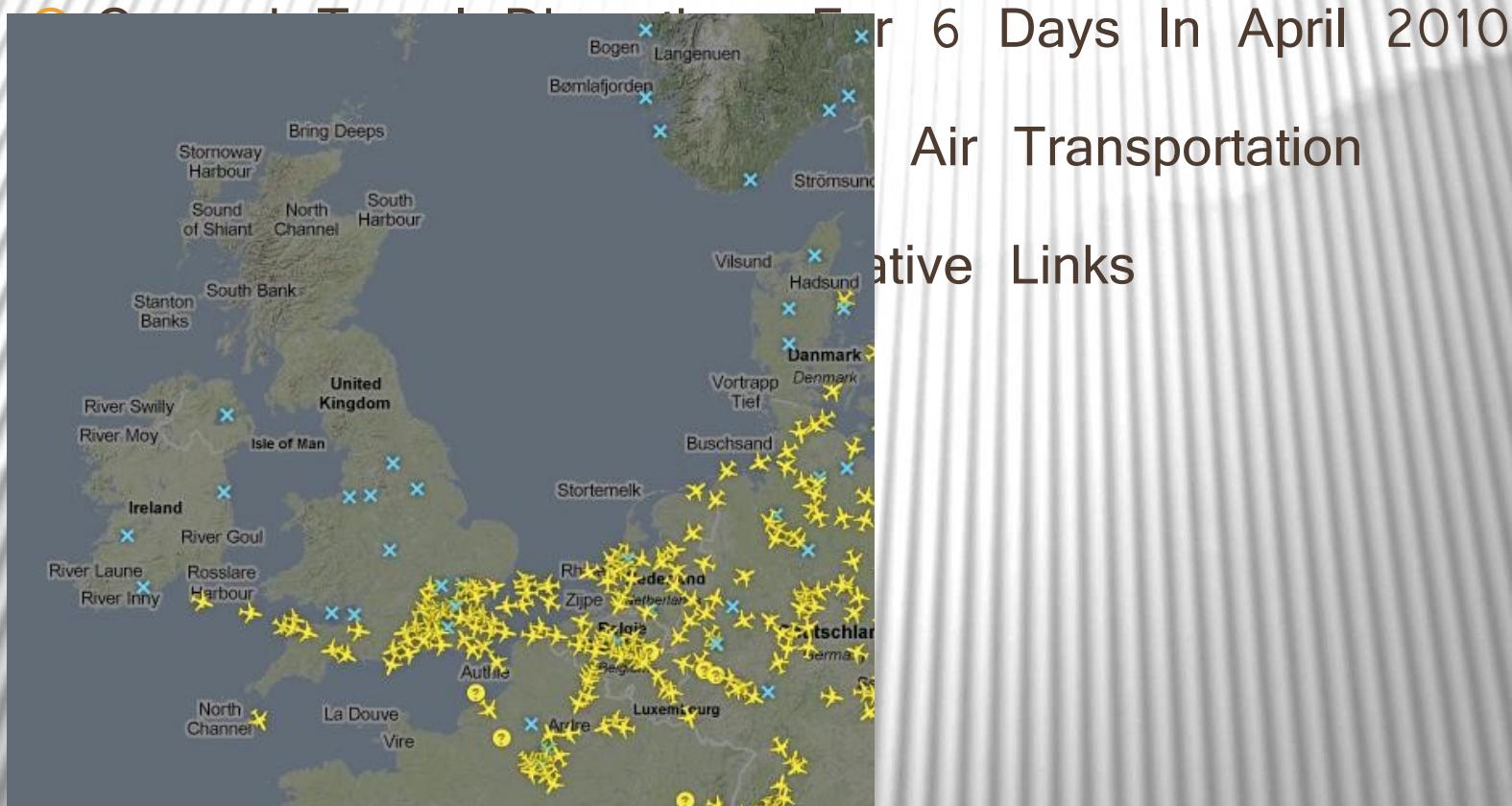
atched Pull Train Out

engers Were Evacuated From

Inside The tunnel



Eyjafjallajokull Eruption



Flight Paths After 6 Days In April 2010

Air Transportation

Flight Paths

Immigrants and Asylum Seekers



Utilize The Chunnel To Enter Britain

Increased

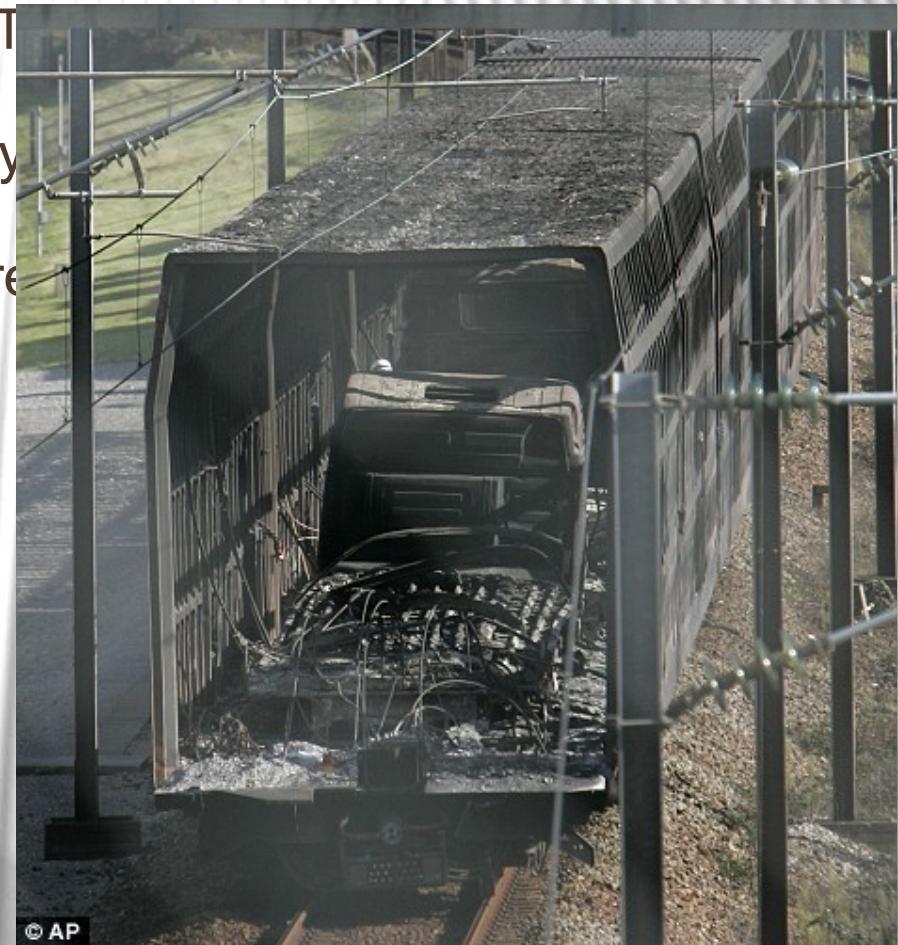
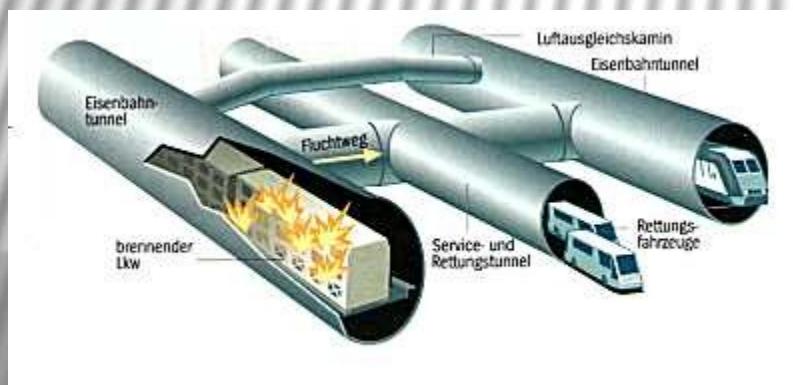
Have Died

Million Euro Per Month



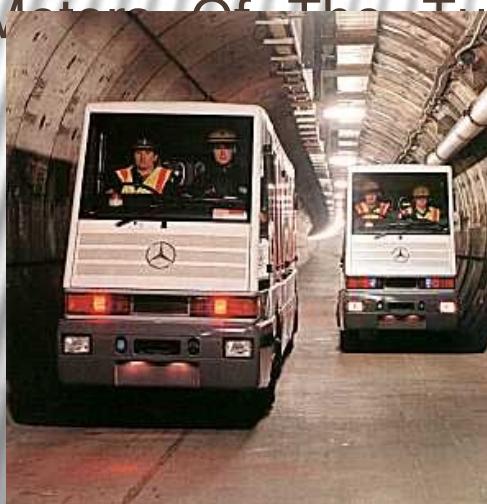
Eurostar/Channel Tunnel Fires

- 3 Major Fires Occurred On The Eurostar
- All Took Place On the Heavy Rail Section
- Two Of the Three Fires Were Caused by



November 18, 1996

- Hurricane Andrew Hit
- 7 Bridges Collapsed
- Between 100 and 150 homes were destroyed
- Total Cost of Repair Was More Than \$300 million to repair
- 46 Motors Of The Tunnel Was Damaged



Alternate modes of Transportation



Air Transportation

- London, Heathrow to Paris, Orly
- Companies: British Air, Air France, Lufthansa
- Flight Cost
 - Weekday: \$81 to \$120
 - Weekend: \$95 to \$150
- Car Rental: \$50 per day
- Time: 1:15 minutes



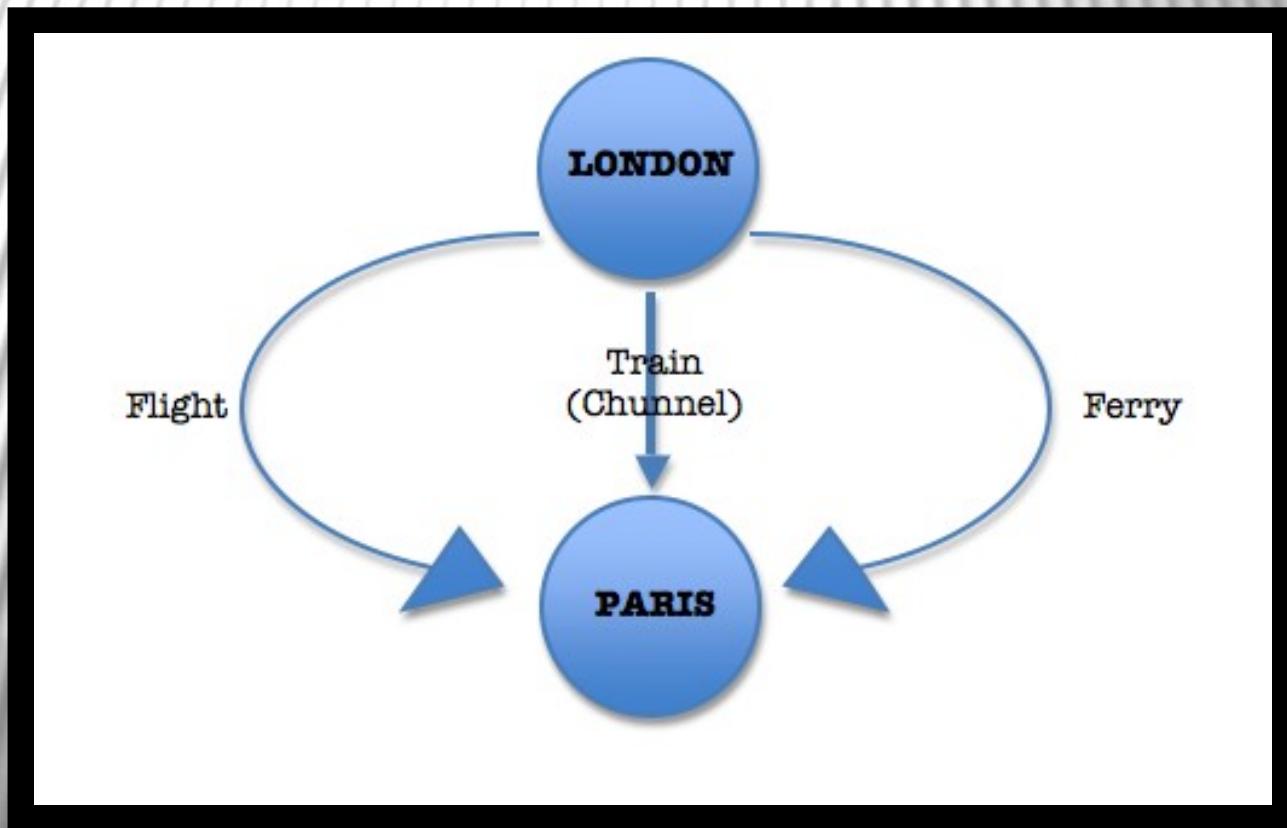
Passenger & Car Ferry

- Dover to Calais
- Companies: Sea France, P&O Ferry
- Cost:
 - W/ Car: 35€ to 75€
 - W/O Car: 6€
- Time: 1:25 minutes



The Model

- Simple three path, three link O/D network
 - Where each path = link



Estimated Costs/ Demands

O/D (London-Paris)					
Plane Cost		Train Cost		Ferry Cost	
Plane Ticket	\$120	Train Ticket	\$180	Ferry Ticket	90
To and From Airport	\$70	To and From Station	\$30	To and From Dock	75
Total Cost	\$190	Total Cost	\$210	Total Cost	165
Time to airport	30	Time to Station	15	Time to Dock	80
Airport Wait time	90	Station wait time	20	Station wait time	40
Flight time	75	Movement time	145	Movement time	85
Leave Airport	45	Leave time	15	Leave time	170
Total Time	240	Total time	195	Total time	375
Stress Factor (1-10)	9	Stress Factor (1-10)	4	Stress Factor (1-10)	6
Demand	19721	Demand	12000	Demand	13640
Airbus 321 seats	185	Train seats	1600	Ferry seats	550
Average flights per day	164	Average trains per day	15	Average ferries per day	31
Fill percent	65%	Fill percent	50%	Fill percent	80%