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REVIEW OF HS1 DEMAND FORECASTS

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.

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0. INTRODUCTION AND EXECUTIVE SUMMARY

0.1 PURPOSE OF REPORT AND CONTENTS

High Speed 2 Ltd (HS2) wish to understand the reasons behind the over-forecasting of cross Channel rail passenger demand carried by Eurostar on High Speed 1 (HS1) and the implications of these over-forecasts for HS2.

This summary section of the report provides a précis of a range of demand forecasts undertaken since the mid-1980s, compares them with actual traffic carried by Eurostar and then draws out conclusions and implications for HS2.

The remainder of this report examines these issues in more detail. Chapter 1 focuses on the forecasts prepared before the opening of the Channel Tunnel, and those used to bid for the concession to build the Channel Tunnel Rail Link to operator Eurostar (UK) Ltd. Chapter 2 looks at more recent forecasts (post 1997), outlining market trends over the period to 2010. Chapters 3 to 5 analyze in detail three sets of forecasts prepared by Booz & Company for Government from 1997 to 2004/5.

0.2 HS1 FORECAST PHASES

The forecasts fall into three main phases:
- Phase 1, covering HS1 pre-opening/bid phase, initially as part of feasibility studies into the tunnel and subsequently by consortia bidding for the rights to the HS1 concession;
- Phase 2, following the opening of the tunnel but before the opening of the first stage of HS1; and,
- Phase 3 following the opening of the first stage of HS1 but before the opening of the link from Ebbsfleet to St. Pancras (HS1 Stage 2).

The Phase 2 forecasts, made at various times between 1996 and 2003, were prepared for Eurostar or for the Department for Transport and predecessor departments. These were required to support re-financing initiatives and to prepare for Stage 1 of HS1.

The final forecasts were made post-2003 and centred on estimating the impact of Stage 2 of HS1, examining terminal options and building on the experiences of the earlier forecasts.

0.3 EVOLUTION OF HS1 TRAFFIC

Since 1997 a wide number of external issues have impacted on HS1/Eurostar relating to: competition from airlines; the impacts of global events (such as the terrorist attacks of September, 2001); the Hatfield railway incident (and consequent impacts on rail reliability); and, of course management and infrastructure initiatives, such as pricing policies, construction of HS1 (in two stages) and the move to a new terminal at St. Pancras.

Figure 0.1
Eurostar Traffic 1995 - 2010

Pax (Mn)

- Belgian High Speed Line 1997/98
- Section 2 Late 2007
- Reliability & 9/11 security issues
- Section 1 Late 2003
- Major fire late 1996

— Passengers (Mn)

95 96 97 98 99 0 01 02 03 04 05 06 07 08 09 10
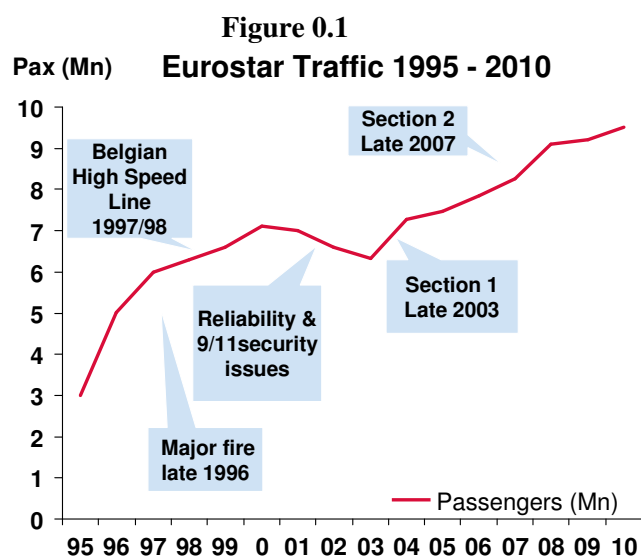
0.4   RESULTS OF FORECASTS

The Pre-Opening / Pre bid (Phase 1) forecasts (in black) were summarized and compared with actual demand (in red) over the period 1997 – 2010. The pre-bid forecasts ranged from 20-28m passengers by 2010. Although actual loadings were well below forecasts, the two final bidders conformed to earlier projections and produced similar forecasts (at around 28 million passengers by 2010). All forecasts relied heavily on estimates of diversion from other modes, typically undertaken with modal split models of some type, supported by generation and general market growth.

Figure 0.2

Phase 1 Forecasts v Actual 1997 - 2010
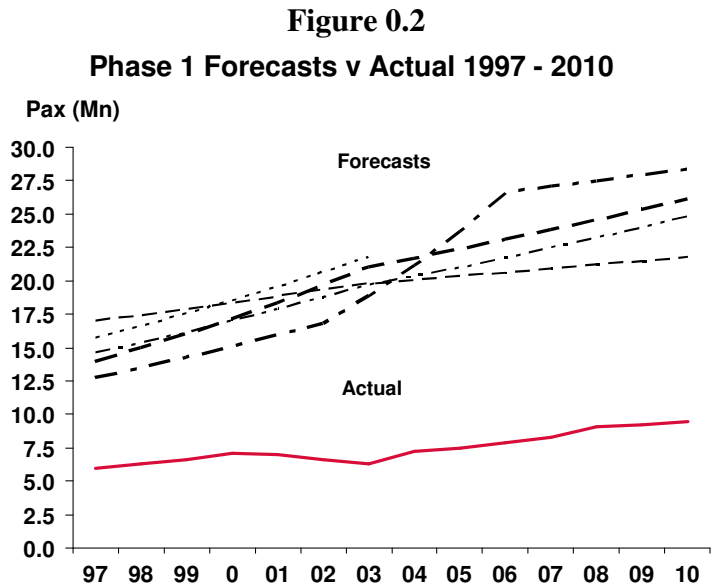
Figure 0.3

Phase 2 Traffic Forecasts & Actual 1997 - 2010
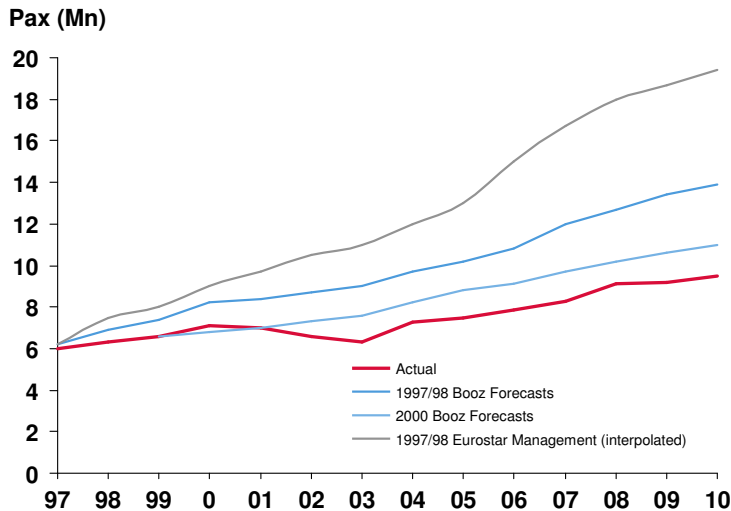
Phase 2 forecasts (post opening but pre-HS1 Stage1) made for Eurostar management and for Government (the Booz & Co forecasts) ranged between 11 and 20 million passengers (in 2010). These forecasts pivoted projections on the number of passengers already carried, but continued to overlay aggressive market growth assumptions. All forecasts were high, with the management numbers being the most aggressive.

Finally, the Booz Phase 3 forecast undertaken in 2004/5, mirrored actual demand very well. However, even here the market growth was over estimated, with the error being offset by more conservative assumptions elsewhere such as impact of service improvements and declines in airlines quality of service (caused by increased security delays at major airports).

Figure 0.4

Phase 3 Booz Forecast & Actual
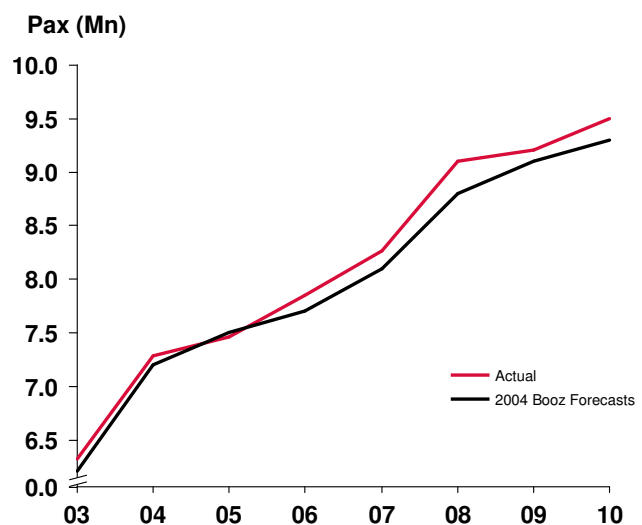
0.5   CONCLUSIONS FROM REVIEW OF FORECASTS

We concluded that not too much time should be spent on the pre opening / pre bid forecasts, as the models, reports and data were difficult to access. However, what information was available was scrutinized. It is likely that these 'pre-tunnel' over forecasts related to:

-    over estimation of market share (particularly from sea traffic);
-    underestimation of competitor strategies and reactions;
-    over estimation of demand from areas beyond London, Paris, Brussels;
-    over estimation in market growth.

We then focused on a review of:
-    Booz models for 1997/98 (which gave a 30% over forecast);
-    Booz models for 2000/2001 Pre HS1 Stage 1 improvements (13% over forecast); and
-    Booz models for 2004/5 Pre HS1 Stage 2 improvements (a 2% under forecast).

We found that the key reason underlying the 'over forecasts' of demand related to that fact that total 'market growth' in the corridor was near zero. This was set against model projections of rapidly rising demand to near European destinations (France, Belgium, Holland and Germany).

The fact that the last (2004/5) Booz set of forecasts were very close (within 2%) to actual demand was not so much a result of improving market growth modeling, but because over forecasts in this area were offset by overly conservative aspects elsewhere.

0.6   IMPLICATIONS FOR HS2

There seem to be limited methodological lessons to be learnt for HS2. The adjustments made for changes in the level of service of both Eurostar and competing modes seem to have performed reasonably well (or under forecast) once allowance has been made for the difference in forecast and actual causal variables (time savings, fare changes and so on).

This suggests that the elasticity and attribute valuation components of the Booz & Co models were not responsible for the HS1 over forecasts, and so we concluded that HS1 experience, does not show that PDFH based service quality (elasticity and attribute) methodologies are inappropriate for HS2.

By far the largest problem has been the stagnation of the travel market between UK and 'near Europe'. It is difficult to see how this could have been foreseen; this market had grown strongly and consistently for many years and most independent forecasts were united at that time in projecting it forward almost ad infinitum. But whether this risk also applies to HS2 to the same degree is a moot point, unless there is a belief that the market for long distance domestic travel is subject to the same uncertainties and fluctuations as the international leisure market. In this context it is worth noting that in the same period as the base Eurostar market has stagnated, passenger trips on long distance rail franchises in Great Britain increased on average by nearly 5% per annum suggesting that the nature of the HS1 and HS2 markets would be very different.

Eurostar forecasts did not predict the impact of the deregulation of European passenger aviation. This has had a particular impact in terms of the relative loss of the overall travel market share to 'near Europe' countries such as France and Belgium (which Eurostar directly serves), as people switched to other destinations in Europe (such as Spain, Portugal, Greece, Central Europe etc), as well as the losses to destinations well beyond Europe. However, the analogy with High Speed 2 would be a

decline in the core London travel markets and it is unlikely that domestic travelers are going to switch destinations (e.g. substituting Manchester-London trips with Manchester to Yeovil) with the same alacrity that air passengers have switched from London to Paris to say London to Prague or indeed the West Indies (as costs have declined to more exotic destinations).

Understanding competitive response will continue to be a key issue for HS2 demand forecasts. However, HS2's main competitor will be other rail services, not aviation, and government policies on franchising and rail fare regulation would greatly influence the competitive environment in which HS2 would operate. This contrasts with Eurostar, where government has less influence over market competition.

Eurostar's early pre-opening forecasts faced severe difficulties as the 'base' rail market had declined significantly by the time the project opened. HS2 has the advantage of a long time series of data and much research into the causes of demand growth and the impacts of rail improvements.

Since 1997 a number of different one-off events (e.g. Channel tunnel fires, Hatfield, BSE and international issues such as; terrorist incidents, and SARS) have further distorted Eurostar demand. At the time, with a limited real experience of Eurostar demand, it was difficult to determine the long-term impacts of these events. HS2 is possibly in a better position given that it can draw on a wide breadth of data and research into domestic rail demand which has been subject to many different one-off events over the years.

The HS1 experience illustrates that demand forecasting is subject to uncertainty, but these uncertainties were magnified for HS1 by the need to understand international travel choices, uncertainties in exchange rates, overseas economic growth and the competitive environment. Major uncertainties for HS2 remain but they should be significantly less than those faced by HS1.

Probably the biggest single lesson is to focus on the key variables that influence demand and not be diverted into the numerous possible sophistications and complexities, many of which, over a decade or so, simply either disappear or else cancel out.

1   PHASE 1 FORECASTS (PRE-OPENING / BID FORECASTS)

1.1   OVERVIEW

At least a dozen forecasts were made in the ten years prior to the construction of the Tunnel. They were undertaken for a range of interested parties. These included Eurotunnel, the French and British Governments and their national railways as well as the bidders for the concession to build the Channel Tunnel Rail Link (known now as High Speed 1) and operate Eurostar (UK) Ltd. Table 1.1 (overleaf), shows that Eurostar was predicted to carry between 11 and 17 million passengers in its first year of operation (generally assumed to be 1993; services actually commenced in late 1994).

Figure 1.1 shows that, by 2010 demand was projected to have grown to between 21 and 27 million passengers. In 1995 fewer than 5 million passengers were carried, and in 2010 only 9.5 million were carried, indicating that the initial forecasts were a factor of 2 to 3 times too high.

Early forecasts were based on the SNCF experience with the domestic Paris – Lyons TGV service, with apparently little allowance for the different characteristics of an international route.

Over-forecasts continued, whether for French or British Government/Railway clients or for the shortlisted bidders. The technical reasons for the over-estimates were:

Figure 1.1 Phase 1 Forecasts Against Actual
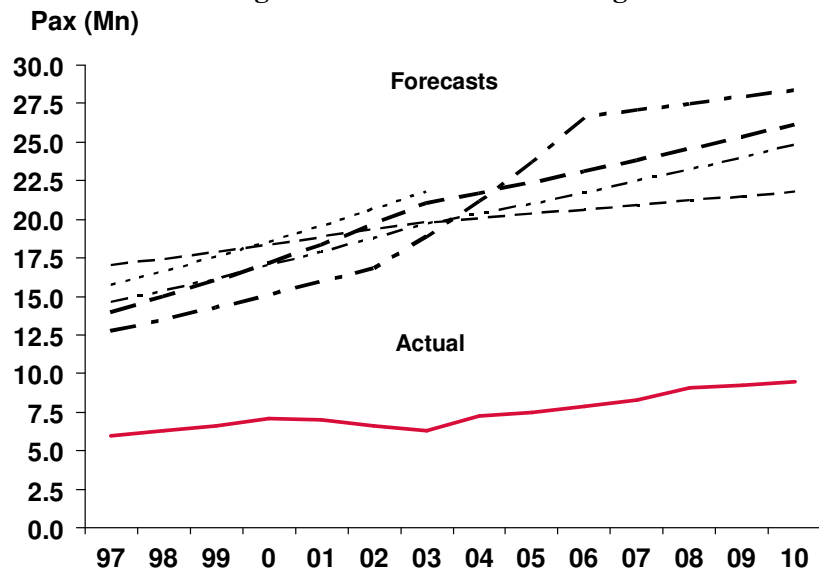
- Overestimating Eurostar's geographic penetration in Europe. Many forecasts indicated that Eurostar would attract significant numbers of passengers for destinations in Germany, Spain and even Eastern Europe; in fact, 1996 on-board passenger surveys indicated that only 3% of passengers actually travelled outside France or Belgium.
- Overestimating Eurostar penetration in the UK, where demand was in practice subsequently restricted to South East England. 1996 surveys indicated only 12% of demand at that time was to/from the 'rest of England', a function of the relative inaccessibility of the services (at least prior to the opening of St. Pancras) for those living North of London.
- Overestimating demand on the London-Brussels market, which has never become a primary leisure destination. London-Paris projections (city centre to city centre), however, have been reasonably accurate, with over 70% of the air traffic transferring to Eurostar relatively quickly and with Eurostar now probably taking some 90% of the inter capital air market (excluding interlining).
- Misunderstanding the market in terms of diverting passengers from individual modes. This was particularly significant for ferry traffic transfer. Passengers from ferry made up around half of the SETEC and Eurotunnel rights issue forecasts. Subsequent surveys indicated that most of Eurostar's demand has been abstracted from air and little from ferry. At the time of the original forecasts, there was still a large 'classic' rail market, but this steadily declined through the 1980s and early 1990s as services were steadily downgraded, and by the time the Eurostar services began, the market had reduced to a fraction of its former size.

Table 1.1 Eurostar Passenger Forecasts 1985 – 2004/5 and Actual (passenger millions)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Planned Introduction	Eurostar								CTRL1		CTRL2										
Actual Introduction		Eurostar									CTRL1				CTRL2						
Pre Opening studies																					
SNCF 85	15.9																				
SETEC 85	17.4																				
MVA 87	12.6																				
SETEC 88	15.4										19.8							21.6			22.4
C&L88	12.7										21.8										
C&L 90	13.8																				
TME 90	12.0										19.7							24.2			26.5
BRBB/SNCF 1993					17.6																
Rights issue 94	10.6										21.0							25.5			27.7
Bids																					
LCR bid March 95					12.7					16.8				26.6				28.0		28.8	
Eurorail bid March 95			8.3	10.7	13.7	16.0	17.2	18.1	19.2	20.6	22.3	23.7	24.8	25.6	26.3			27.6		29.7	
Pre HS1 Stage 1																					
LEK / Management Feb 1997										14.9				22.6				26.0		27.9	
LEK / Management Sept 1997										10.5				15.1				17.9		19.4	
BAH 1997/98								8.0	8.4	8.7	9.1	9.7	10.2	10.7	11.9	12.6	13.3	13.8			
EUKL Management 98								7.5	8.2	8.9	9.4			12.5							
BAH June 2000								7.0	7.3	7.6	8.2	8.8	9.1	9.7	10.2	10.6	11.0				
Pre HS1 Stage 2																					
BAH 2004/2005												7.2	7.5	7.7	8.1	8.8	9.1	9.3			
Actual			2.9	4.9	6.0	6.3	6.6	7.1	7.0	6.6	6.3	7.3	7.5	7.8	8.3	9.1	9.2	9.5			

3rd party data from secondary sources, Booz & Co are not aware of major inaccuracies but they may exist & Booz & Co have not been able to verify (also see disclaimer)
2010 figures for early studies SETEC 88, TME 1990 and Rights Issue 1994 interpolated from 2013 figures (no 2010 figures readily available to us).
2010 figures for LCR Bid, and the February and September 1997 Management forecasts interpolated from 2012 figures (no 2010 figures readily available to us).
Notes: Transport consultants: BAH, C&L, TME, LEK, MVA, SETEC, Hague Consult (1994 Rights issue)
*   Bid consortia: LCR, Eurorail,*
*   Railway companies: BRB, British Railways Board, SNCF, French Railways, EUKL/Management, Eurostar UK Limited.*
Note   LEK work undertaken for Eurostar/LCR management in 1997/98 and quoted in earlier salvaged documentation, source material not available.
Note   BAH figures salvaged from surviving Booz & Co records, note BAH 1997/98 salvaged model gives forecast for 2010 of 13.8m but supporting report not found.

- Misunderstanding of competitive responses (ferries reduced fares and marketed new duty-free services aggressively). The introduction of low-cost airlines, and general de-regulation in the aviation sector may not have had an impact at the early stages of the process, but has been a significant competitor on and off-route since 1996/7.

The forecasts produced by SNCF had major methodological differences to those produced by other parties, which used more conventional multi-modal techniques. However, even these conventional models all had large variations in assumptions on diversion rates and generation, many of which arise from differing assumptions on service variables such as fare levels. In addition, much of the earlier work was based on incomplete and differing base data. Many of the forecasts were produced by a process of incremental adjustment from earlier work and weaknesses thus persisted for several years.

1.2 EUROTUNNEL FORECASTS - MID 1980s – 1993

These forecasts were prepared jointly by Wilbur Smith Associates and SETEC on a regular basis from the mid-1980s. As such they used a consistent methodology, with changes in forecasts due to steadily improving base data and revisions to diversion rates as more research and analysis of passenger behaviour was undertaken. The major revision in December 1993 formed the basis of the forecasts included in the May 1994 Eurotunnel Rights Issue prospectus.

1.3 INITIAL GOVERNMENT AND RAILWAY FORECASTS - MID TO LATE 1980s

Forecasts have been undertaken at varying intervals by the British and French railways (BRB and SNCF), both individually and in conjunction with their governments. In 1985, forecasts were prepared by Martin and Voorhees Associates (MVA) for BRB (which were substantially revised in 1986-87) and internally by SNCF, so as to enable initial planning and scheme selection to be undertaken. These forecasts differed (MVA forecast over 12 million passengers in 1993 and SNCF forecast over 16 million) and in 1988 a joint study was undertaken in which Coopers and Lybrand (C&L) examined the forecasts and came to an independent view.

The methodologies adopted by the two railways differed significantly:-

- The BRB approach was a conventional model in which each pair of origin and destinations was examined and diversions to a tunnel rail service estimated on the basis of service characteristics.
- The SNCF approach was based on their experience of the TGV Sud-Est, where there was significant 'new' traffic which had not previously travelled by either conventional rail or by air. Much of this traffic had previously travelled by car and a major point of debate was as to whether this transfer would be repeated for cross-Channel traffic.

C&L recommended that the MVA approach be adopted, with some technical modifications, revised the base parameters (which had also been different between BRB and SNCF) and estimated a demand intermediate between the two previous railway estimates.

1.4   GOVERNMENT AND RAILWAY FORECASTS 1990 - 1995

After 1990, a series of studies were undertaken in the UK, either internally or by external consultants. The most comprehensive of these was undoubtedly the model developed for Union Railways by Hague Consultants. This had a similar structure to that previously used by MVA/C&L, except that it was applied to disaggregate data, with diversion rates based on the results of Stated Preference surveys (which ask passengers what they would do under a series of hypothetical travel scenarios). Under the terms of the Usage Contract, the railways were required to submit annual forecasts to Eurotunnel for use in their forward planning. The December 1993 forecasts were clearly based on the SNCF approach but were rejected by Eurotunnel as being insufficiently documented and supported.

1.5   EURORAIL FORECASTS – 1988-1990

A series of forecasts were produced between 1988 and 1990 by Travers Morgan Economics (TME) for Eurorail as part of their assessment of the Southern Route into London. The approach adopted was to use a base forecast, prepared by C&L in updating their 1988 forecast. The C&L approach did not easily lend itself to the analysis of the impact of different fare levels and service options, which were of prime importance to Eurorail, and TME estimated these impacts by using a series of elasticities to adjust the C&L base forecast.

1.6   LCR FORECASTS – 1994-1995

London and Continental Railways (LCR) adopted a different approach to forecasting than the others. Their consultants split the market into a wide number of market segments (30 or more), based on data from IPS and CAA surveys. This was argued to make the model more responsive to a wider range of policy variables and allow the impact of 'airline' style yield management techniques to be brought to bear. The model lacked a formal/conventional mathematical or 'statistical' basis and was largely assumption-driven. The model was later used as the basis for Eurostar/LCR management work in negotiations with Government.

1.7   HAGUE CONSULT FORECASTS 1994 FOR UNION RAILWAYS RIGHTS ISSUE

A complex and detailed set of forecasts were made, based on:

- a series of disaggregate revealed/stated preference based hierarchical logit models (for mode choice modelling);
- market research survey based estimates of new/generated traffic; and,
- market growth models based on research undertaken by the Henley Centre.

The model had a number of surprising results. These included very low fare sensitivities (implying very high values of time and that high prices could be charged for the services). Some other outputs also appeared counter-intuitive. For example on the key UK-France business market, Eurostar achieved a share of 54% for non UK residents, but only 28% for those from the UK, while non-UK leisure had a higher share from the Netherlands than Paris.

1.8   SUMMARY OF FORECASTS

Table 1.2 summarizes 'early' forecasts produced prior to Eurostar operation. They were produced on a variety of fares policies; as fare is a key determining variable, comparisons of the figures need care.

The forecasts could be said to be trending downwards as more detailed information became available, with early (1985) forecasts coming in at 18 million and later (1994) for the rights issue coming in at just under 11 million (however, if 'build-up rates' were ignored the rights issue forecast was for 11.8 million). It should also be noted that LCR bid projections were for some 13 million passengers (however, these were given for a later forecast year 1997). Hague Consult work undertaken for Union Railways at the same time as the bids (and provided to the bidders) projected over 20 million passengers in 2001 (though these forecasts also included opening of the Channel Tunnel Rail Link).

The major change over the years was the large reduction in the assumed diversion from 'foot' passengers, i.e. those travelling by ferry without a vehicle. Indeed later surveys showed over 25% of these were 'excursionists' on day-trips (probably to take advantage of duty free shopping). Initial forecasts, in the absence of this information, assumed they would all transfer to through rail services.

It is clear, however, that all projections were considerably at variance with the actual demand carried, with the closest projections more than double the 4.9 million passengers actually carried in 1995. Most forecasts were out by a factor of three.

Analysis of observed travel patterns indicates that air has supplied the majority of Eurostar passengers, with Ferry only being the source of between 17% and 30% of Eurostar trips.

Table 1.2 Comparison of Sources of Actual Traffic and Rail Forecasts (millions passengers p.a.*)

Current mode	Actual Traffic Carried in 1996(1) (2) & (5)		Eurotunnel Forecasts			Government / National Railway Forecasts				Bidders' Forecasts: Initial Eurorail/TME and 'Final' LCR		
	EUKL - ITS		SETEC 1985	SETEC 1988	Rights Issue	SNCF 1985	MVA 1987	C&L-Hague (4) 1988 & 1995		C&L 1990	TME 1990	- LCR 1995
Forecast year			1993	1993	1994	1993	1993	1993	2001	1993	1993	1997
Build-up %			*100*	*100*	*90*	*100*	*100*	*100*		*100*	*100*	
Source												
Air	2.34	2.96	13.3	5.7	4.0							
Ferry												
• Coach	0.16			1.4	0.1							
• Car	0.29			0.6	1.2							
• Foot	1.00			6.3	3.4							
Subtotal	1.45	0.83	3.6	8.3	4.7							
Generated	1.07 (3)		0.5	1.4	1.9							
TOTAL	**4.86**		**17.5**	**15.4**	**10.6** 11.8 (6)	**15.9**	**12.6**	**12.7**	**20.3**	**13.8**	**12.0**	**12.7**

Notes (Data taken from secondary sources and not verified)

(1) EUKL sales database, breakdown by air, ferry etc. based on surveys of Eurostar passengers, asking if Eurostar, not available. Later data might indicate higher share from air due to presence of low cost airlines.

(2) Generated assumed to be 22% of market based on EUKL analysis of 1997 origin destination surveys.

(3) Broken down on basis of responses to 1996 Terminal survey, asking Eurostar passengers choice of mode.

(4) Hague Results 2001 include Rail Link.

(5) ITS 98 surveys, indicate higher proportion switching from air, 63-78%, depends on interpretation, but most likely the higher proportion.

(6) Total if 100% build up.

2. CORRIDOR CHARACTERISTICS, MARKET AND FARES GROWTH

2.1 MARKET GROWTH

Figure 2.1 shows that since 1995, although the total UK travel market has averaged 2% per annum. growth, travel between UK and near Europe (the main countries served by Eurostar) stagnated. Effectively near Europe lost share as low cost airlines expanded choices into other parts of Europe, while rising incomes and competitive prices have increased the share of travel to the rest of the world.

Figure 2.1 Evolution of UK Travel Market
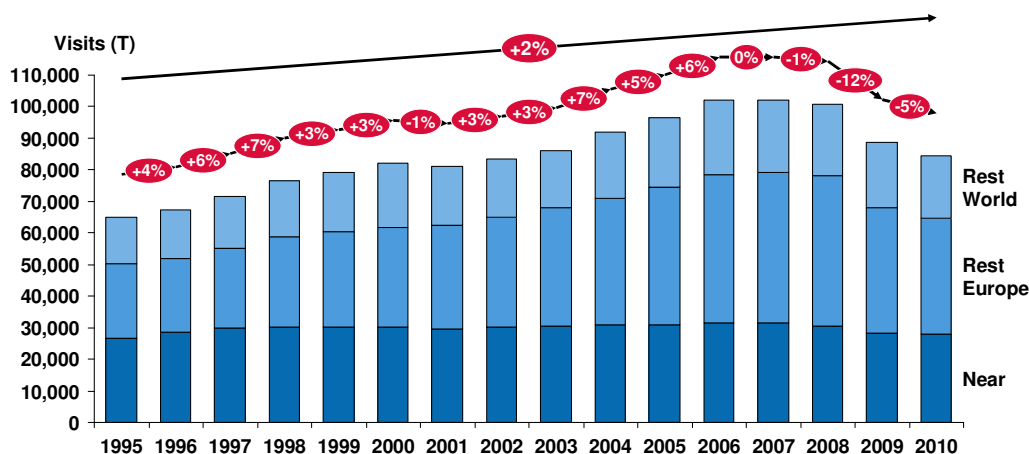
Source: IPS Travel Data all Traffic UK Rest of World

A key reason for this stagnation has been the loss of market share of near Europe in the UK travel market (Figure 2.1, Tables 2.1 and 2.2.) and, presumably, UK in the travel markets of near Europe.

Table 2.1 shows that between 1997 and 2008, total visits overseas by UK residents increased at 4.3% p.a., although the drop in overseas trips since then has reduced this growth to 1.9% p.a. for the 1997-2010 period.

Focusing on the 1997-2010 period, we see visits by UK residents to the near four grew by only 0.1% per annum., the remainder of the EU15 grew by 1.2% p.a. and visits to other countries grew by 4.3% p.a.

The share of trips to the 'near four' (excluding one day) reduced from 30% of total overseas visits in 1997 to 23% in 2008 before recovering slightly to 24% in 2010. In retrospect, the loss of share began in the 1980s but appears to have reversed in the early 1990s, at least according to the data available at the time.

Table 2.1 UK Overseas Travel Market Growth (% p.a.)

	1997- 2008	2008 – 2010	1997-2010
Near four[1]	1.9	-9.3	0.1
Rest of EU 15	4.2	-13.9	1.2
Other	6.5	-7.0	4.3
Total[1]	4.3	-10.3	1.9
	1997	2008	2010
Near four share of total (%)	30	23	24

2.2   AIR FARES GROWTH

Air fare indices were constructed for the various routes considered in the model based on raw data from the Sabre airline database. Although this database gives the average fare by route and carrier at monthly intervals, the fare quoted excludes airport charges and taxes such as the Air Passenger Duty and these have been estimated to derive air fare as paid by the passenger. The Sabre database only includes data from 2002 onwards. The only readily available source of data for the period from 1997 is the International Passenger Survey. Unfortunately, the sample sizes for many of the years are small and the fare estimates clearly have a large sample error. Nevertheless, it has been used to construct an index prior to 2002 which has been spliced with the Sabre series. The various fare indices are given in Table 2.3. It is clear that the monetary cost of air travel has fallen in line with low cost carriers and accelerated efficiency measures. However, what the fares do not demonstrate is a reduction in air travel's quality of service, brought about by enhanced security measures, which has significantly increased time spent at airports waiting to board.

2.3   EUROSTAR FARES GROWTH

Unfortunately, Eurostar were unable to provide us with any information for our analysis, either on fares, market growth, or demand segments. Eurostar, were concerned about commercial information entering into the public domain. The only information available to us is the average yield and aggregate demand available from press releases. This yield is presented over all routes and ticket types. This is also given in Table 2.3 and demonstrates growth in real terms, reflecting both its market dominance (over aviation) in the corridor and the improvement in quality of service brought about by the various infrastructure investments.

Table 2.2 Visits to and from near Europe 1997-2010 (two way - 000's)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Growth 2010:1997
UK residents															
Belgium	1,419	1,699	1,602	1,657	1,738	1,784	1,964	1,799	1,733	1,815	1,870	1,787	1,392	1,370	-0.3%
France	11,149	11,518	11,946	11,903	11,959	12,112	11,957	11,602	11,094	10,854	11,201	10,855	9,764	9,058	-1.6%
Neth/Germany	3,779	4,014	4,044	4,455	4,337	4,424	4,285	4,501	4,667	5,108	4,925	4,711	3,967	3,840	0.1%
Total	16,347	17,231	17,592	18,015	18,034	18,320	18,206	17,902	17,494	17,777	17,996	17,353	15,123	14,268	-1.0%
Total excl 1-day	12,847	13,731	13,712	14,110	14,239	14,843	14,942	15,100	15,316	15,832	16,111	15,847	13,788	13,030	0.1%
Foreign residents															
Belgium	1,345	1,183	1,077	997	916	966	936	1,104	1,112	997	995	970	903	1,136	-1.3%
France	3,586	3,274	3,223	3,087	2,852	3,077	3,073	3,254	3,324	3,693	3,404	3,636	3,784	3,618	0.1%
Neth/Germany	4,564	4,548	4,411	4,198	3,720	3,975	4,160	4,588	5,014	5,202	5,199	4,718	4,495	4,762	0.3%
Total	9,495	9,005	8,711	8,282	7,488	8,018	8,169	8,946	9,450	9,892	9,598	9,324	9,182	9,516	0.0%
Total															
Belgium	2,764	2,882	2,679	2,654	2,654	2,750	2,900	2,903	2,845	2,812	2,865	2,757	2,295	2,506	-0.8%
France	14,735	14,792	15,169	14,990	14,811	15,189	15,030	14,856	14,418	14,547	14,605	14,491	13,548	12,676	-1.2%
Neth/Germany	8,343	8,562	8,455	8,653	8,057	8,399	8,445	9,089	9,681	10,310	10,124	9,429	8,462	8,602	0.2%
Total	25,842	26,236	26,303	26,297	25,522	26,338	26,375	26,848	26,944	27,669	27,594	26,677	24,305	23,784	-0.6%
Growth rates (% p.a.)															
Belgium		4.3%	-7.0%	-0.9%	0.0%	3.6%	5.5%	0.1%	-2.0%	-1.2%	1.9%	-3.8%	-16.8%	9.2%	
France		0.4%	2.5%	-1.2%	-1.2%	2.6%	-1.0%	-1.2%	-2.9%	0.9%	0.4%	-0.8%	-6.5%	-6.4%	
Neth/Germany		2.6%	-1.2%	2.3%	-6.9%	4.2%	0.5%	7.6%	6.5%	6.5%	-1.8%	-6.9%	-10.3%	1.7%	
Total		1.5%	0.3%	0.0%	-2.9%	3.2%	0.1%	1.8%	0.4%	2.7%	-0.3%	-3.3%	-8.9%	-2.1%	

Source: International Passenger Survey, Booz & Company Calculations

Table 2.3 Air and Eurostar Fare Indices 1997-2010 (Index: 2010 = 100)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Growth 2010:1997
Paris total	136	128	122	115	109	118	107	95	96	95	97	104	102	100	-2.3%
Paris economy	116	110	104	98	93	101	97	88	92	89	86	88	99	100	-1.1%
Paris business	138	130	124	117	111	120	121	102	103	106	104	110	110	100	-2.4%
Brussels total	108	81	80	84	92	95	97	102	111	109	90	102	106	100	-0.6%
Brussels economy	85	64	63	66	72	75	77	85	95	91	70	88	99	100	1.3%
Brussels business	125	94	93	97	106	110	119	113	112	113	107	105	95	100	-1.7%
London-Europe								87	87	85	87	94	97	100	
France - Europe								115	113	114	111	107	98	100	
Eurostar	77		87				86	87	89	92	99	96	95	100	2.0%

Source Sabre data sets, Eurostar press releases and consultant's estimates

3. THE 1997/98 MODELS

3.1 CONTEXT

After the formal opening of the Channel tunnel in May 1994 and the award of the operation and construction concessions to London and Continental Railways (LCR) in February 1996, preparations were made to offer the business to equity participants. New forecasts were provided by LCR and Eurostar UK Limited (EUKL) management supported by LEK consultants. Analysis was based on the ULTRA model, a development of LCR's bid model.

Following the introduction of Eurostar services in November 1994, a tunnel fire occurred in November 1996, causing a two-month suspension and then continuing disruption to Eurostar services until May 1997. By the end of 1997 the poor performance of the Eurostar business revealed the LCR forecasts were optimistic and weakened LCR's ability to raise private capital to fund HS1. In January 1998 LCR approached Government with a view to re-financing the scheme to construct the high speed line. Booz & Co were commissioned by Government to provide forecasts for Eurostar services to support the negotiations with LCR.

The Booz & Co and EUKL/LCR management forecasts are shown below; although lower than the management projections, Booz projections were still significantly higher than out turn. We examine the Booz model in more detail below.

Figure 3.1 Management and Booz 1997/98 forecasts for 2010 against Actual (Pass. Millions)
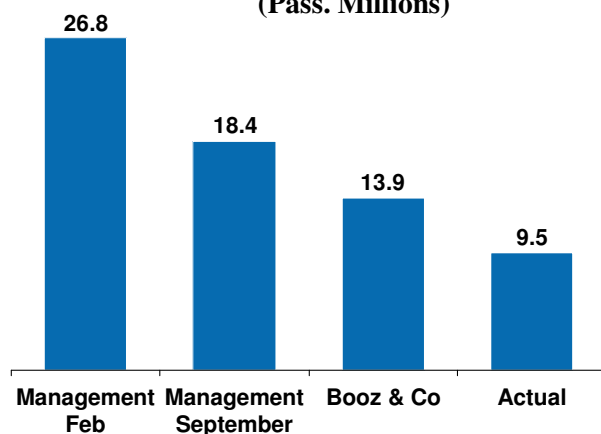
Note: Management figures based on Booz & Co interpolation of LEK February & September 1997 outputs from Table 1.1. Note an additional set of management forecasts were closer to Booz, but fares were much higher (rising 40% to 2006) & as we only have data to 2006, these are not shown.

3.2 1997/98 BOOZ MODEL

The Booz model[1] was relatively simple. It was constructed using the 24 market segments used at that time by LCR (Table 3.1). The model forecast each of the segments independently, applying annual market growth factors following one of three standard profiles and a series of adjustments to reflect the impact of network and pricing changes.

Figure 3.2 Booz Model Structure

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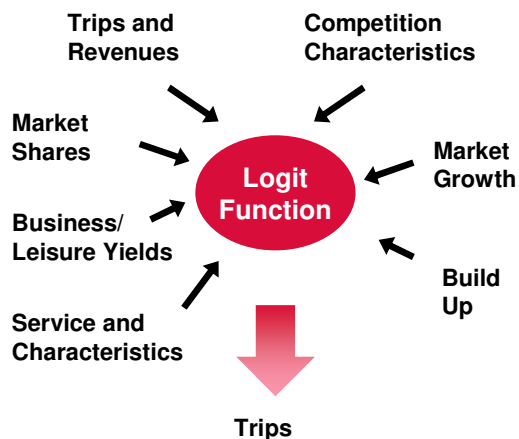
[1] Note the Booz model analysed in this current report is a slightly different version to the one actually used (which has been lost) but gives similar outputs

Table 3.1 Structure of 1997 model

Segment		Market growth	
		Profile	Growth index 1997 - 2010
1	Business LSE-Paris-Day	1	1.78
2	Business LSE-Paris-Non Day	1	1.78
3	Business LSE-Belgium-Day	1	1.78
4	Business LSE-Belgium-Non Day	1	1.78
5	Leisure LSE-Paris-Day	2	1.81
6	Leisure LSE-Paris-Day	3	1.81
7	Leisure LSE-Paris-Non Day-Hols	2	1.81
8	Leisure LSE-Paris-Non Day-Hols	2	1.81
9	Leisure LSE-Paris-Non Day-Hols	3	1.81
10	Leisure LSE-Paris-Non Day-VFR	2	1.81
11	Leisure LSE-Belgium-Day	2	1.81
12	Leisure LSE-Belgium-Non Day	2	1.81
13	Business LSE-NE France	1	1.78
14	Leisure LSE-NE France	2	1.81
15	Leisure LSE-NL/Lux	2	1.81
16	Leisure LSE-Inner Germany	2	1.81
17	Leisure LSE-Rof/Swiss	2	1.81
18	Leisure RoUK-Paris/NE France	2	1.81
19	Leisure RoUK-Belgium	2	1.81
20	Business RoUK-Paris/NE France	1	1.78
21	Business RoUK-RoF/Swiss	1	1.78
22	Business RoUK-Belgium & LSE-NL/Lux/D	1	1.78
23	Business Leisure to Near 6	2	1.81
24	Business Leisure beyond Near 6	2	1.81

Source: Booz and Co analysis

3.2.1   MARKET GROWTH PROJECTIONS

Market growth rates for each segment were input directly. These were sourced from a range of third-party projections (CAA, BAA, Economist Intelligence Unit, etc) with no relationship to any independent variables such as GDP/head[2].   Three growth profiles were used: one for business segments, one for leisure and a third for two of the London – Paris leisure segments. However, although there were small fluctuations from year to year, total forecast growth over the period to 2010 was almost the same for all segments, at around an 80% increase or 4.6% p.a. However, as discussed in Chapter 2, travel between UK and near Europe (France, Belgium, Netherlands and Germany, the primary countries served by Eurostar) has stagnated over the period.

3.2.2   ADDITIONAL ADJUSTMENTS

The model also included other adjustments, covering:
- the remaining ramp-up of initial demand;
- the impact of the Brussels high-speed line;
- other network changes (principally for traffic to/from Germany and Netherlands);
- HS1 Stage 1 a fast link through Kent, (also called CTRL 1);
- HS1 Stage 2 (CTRL 2) the link to St. Pancras;
- fare restructuring; and,
- real changes in fares.

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[2] Efforts at constructing elasticity based models were made at the time but were not successful.

3.2.2.1 Remaining ramp-up

This was a hotly debated issue at the time, with many claiming that the faltering start to the services was caused by issues surrounding the Channel Tunnel fire in 1996. The forecast assumed residual ramp-ups by segment, typically 10% for the business segments and 20% for the leisure segments, spread over the following 2-3 years. The reasoning for the higher leisure ramp-up included the slow development of associated travel packages (such as weekend breaks) and, for the beyond Brussels-traffic, the poor arrangements at the time for through ticketing and the like. The overall impact was to add 12% of traffic in 1998, 4% in 1999, with a cumulative increase of 18% by 2001, equivalent to about 1.1 million passengers in 2010. Whether this actually occurred is difficult to judge; certainly some of the pre-conditions, especially those associated with beyond-Brussels traffic, seem to have taken far longer to come about in practice. It is likely that the impact was only about half of that assumed.

3.2.2.2 Brussels high-speed line

The model assumed time-savings when the line opened in 1998 and a further gain because of the improved frequencies. The overall effect was an increase in patronage of about 0.4 million trips in 2010.

3.2.2.3 Other network improvements

The model assumed time-savings of 20-30 minutes for leisure traffic to Germany and the Netherlands, presumably based on the HSL2 and HSL3 in Belgium. These lines actually opened quite late, in 2002 to Liege and 2009 to the Dutch/German borders. The model also assumed other improvements in access times, i.e. from construction of the Jubilee line extension etc. The forecast impact on demand was an increase of some 0.3 million in 2010.

3.2.2.4 CTRL 1 (HS1 stage 1)

The model assumed a time-saving of 15 minutes. The forecast increase in demand was 10% for business traffic and 4-6% for leisure traffic, with a ramp-up period of three years, increasing patronage by 0.7 million in 2010.

3.2.2.5 CTRL 2 (HS1 stage 2)

The model assumed further time-savings for CTRL1 and frequency improvements. It also assumed a set of access and transfer benefits as the result of the move to St. Pancras. At the time not all services were assumed to transfer to St. Pancras and it was assumed that a split operation using Waterloo and St. Pancras would be run. The overall forecast increase was about 13%, increasing overall patronage by nearly 2 million in 2010.

3.2.2.6 Fares restructuring

The model assumed a set of segment-specific fare increases in 1998 and 1999, of between 15-30%. The model assumed a set of elasticities, varying by segment and ticket type, which ranged from -0.4 for full-fare business trips to -1.6 for leisure passengers travelling in groups. The forecast impact of the combined changes was to reduce demand by 10%, with individual segments decreasing by 5-18%, or by just over 1.7 million in 2010.

3.2.2.7 Fare increases

The model assumed progressive increases in fares relative to air. Air fares were assumed to be constant for business passengers but to decrease for leisure trips by 0.5% p.a. until 2005. Eurostar fares were assumed to increase by 1% p.a. relative to air fares until 2007, with additional increases of 3% in 2004 (CTRL 1) and 8% in 2007 (CTRL 2). The combined impact was an increase between 1997 and 2010 of 18% in business and 8% in leisure fares. As for fare restructuring, elasticities were assumed for each segment to derive the impact on demand. The forecast impact by 2010 was a reduction in demand of 1.1 million (7%) with a small change in revenue, reflecting an average elasticity over all segments of -1.

3.3 EX POST ASSESSMENT (S)

In this section we re-run the models with observed fare and network changes (as far as we can, given model and data limitations[3]). We identify what we think actually happened under each of the variables and speculate what may be the major reason behind any residual gap.

3.3.1 Summary of Base Results

Firstly, the Booz & Co 1997/98 model results are summarized in Table 3.2 below. Actual traffic in 2010 was 9.5m (some 30% below the projection of nearly 14m).

The key drivers of the forecasts related to market growth and build up. Analysis shows these were significant over-estimates. The network impacts of Stage 1 & Stage 2 of CTRL appear reasonable, while impact of fares should be larger as they did not take account of the fall in air fares that has happened over the period).

Table 3.2 Components of 2010 demand in 1997 model

		Passengers (000)	%	Comment
1	Base	6265		
2	Residual build-up	1130	18	Probably too large by 50%
3	Market growth	5939	80	No market growth in practice
4	Brussels HSL	421	3	Probably reasonable
5	Other network changes	266	2	Reasonable but other network changes have also occurred
6	CTRL 1	699	5	Reasonable
7	CTRL 2	1858	13	Reasonable
8	1998/9 fare restructure	-1704	-10	Forecast Eurostar yield close to actual but most air fares have declined rather than increased. So impact potentially much greater in practice.
9	General fare changes	-1094	-7	
	Total	13780		

Source Booz and Co Analysis

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[3] Eurostar have been unable to provide us with a breakdown of fare information by market segment, or indeed any other information, so we had to rely only on aggregated data contained in various press releases.

3.3.2 Correcting for Growth and Actual Change

Correcting for lack of growth and then entering into the model[4] actual fare and service changes, demonstrates that the model would then significantly under-estimate. This is significantly influenced by the decrease in real terms of most air fares. At this stage we retained the assumption that residual build up was achieved.

Table 3.3 Components of 2010 demand in 1997 model actual independent variables

		Passengers (000)	%	Comment
1	Base	6265		
2	Residual build-up	1130	18	Assumed same as model with 82% build up achieved end 1997, leaving another 18% to go.
3	Market growth	0	0	No market growth in practice.
4	Brussels HSL	343	5	As modeled with revised inputs, absolute number lower in the base as base demand lower without market growth..
5	Other network changes	156	2	As modeled but with some other network changes which also occurred.
6	CTRL 1	363	5	As modeled with revised inputs similar % impact.
7	CTRL 2	830	10	As modeled but revised inputs, impact falls as the base ran to St Pancras & Waterloo, now only St. Pancras is served, so accessibility lost.
8	1998/9 fare restructure		0	Now included in the general fare changes below.
9	General fare changes	-2600	-29	Modelled with actual inputs including large reduction in air fares, so big negative % impact.
	Total	6487		

Source Booz & Co. analysis

3.3.3 What We Believe Actually Happened

We finally discuss what we believe actually happened for each segment. Firstly, we reduced the build up assumption by half. Looking back over the data it is clear that build up was mostly exhausted by 1997, so we revised the impact down to 9%.

Major changes then included entering a figure for CTRL2 which again reflects our view of what occurred in practice, based on the high level data that is available. Between 2007 and 2009 Eurostar demand increased by about 11% at a time when overall travel between UK and France/Belgium fell by nearly 10%. At the same time, the real yield on Eurostar tickets reduced by some 4%. Assuming a fare elasticity of -1, and also that Eurostar demand broadly follows general trends in travel between

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[4] Eurostar have not provided breakdown of fare changes by sector. Impact of switching all services to St. Pancras broadly estimated.

UK and near Europe, there is a gap of 19%. This probably reflects the impact of CTRL2. Given a pre-CTRL2 demand of some 8 million, this suggests that the impact of CTRL2, net of market growth and fare changes, was about 1.5 million passengers and this has been adopted in this analysis.

The CTRL1 estimates of some 0.6m have been taken from the 2004 model as the service had been introduced by then and the model was calibrated to fit the available data. Jhe impact of other network changes has been increased to reflect management service initiatives such as the ski-trains, direct services to Avignon, etc.

Table 3.4 Components of 2010 demand in 1997 model assessment of what occurred in practice

		Passengers (000)	%	Comment
1	Base	6265		
2	Residual build-up	565	9	Half the impact of the original model.
3	Market growth	0	0	No market growth in practice
4	Brussels HSL	317	5	As modeled above, impact appears reasonable in % terms perhaps conservative.
5	Other network changes	284	4	As modelled but with extra impacts of hard to model initiatives such as ski trains
6	CTRL 1	605	8	Increased impact to replicate 2004 assumed actuals.
7	CTRL 2	1495	19	Broadly replicating our view of actuals
8	1998/9 fare restructure and general fares	-2727	-29	Modelled with actual fares, including large cut in air fares, so a larger negative % impact.
	Total	6804		Against actual of 9.5m
	Unexplained	2696		

Source Booz & Co. analysis

In total, trips rise and the gap between forecast and actual reduces to 2.7m, still a significant under-forecast against 9.5m actual. We believe the key reason for the gap was the increases in travel time and inconvenience of air travel since 1997. This was not foreseen at the time and was thus not captured at all in the model and Eurostar's mode share, far from reducing, which it should have done on the basis of air and Eurostar fares alone, has been steadily increasing from about 70% in 1997 to nearly 90% in 2010. The increase in Eurostar fares has thus probably not diverted many passengers to air (but will nevertheless have suppressed demand, given the significant proportion of Eurostar traffic that is generated). Reliability has also improved since 1997 (but in 1997 it was not regarded as a particular problem; it was at its worst following the Hatfield accident which led to restrictions on operating speeds across the network).

3.4   SUMMARY

Actual demand out turn was around a third below forecast, primarily because the key component of the forecasts (market growth) failed to materialize. Traffic build up was also lower than anticipated, while the model failed to predict the significant reduction in airline fares.

Once, these issues are taken into account, along side the actual changes in fares, impacts of CTRL 1 and 2 etc, the model actually under forecasts. This is because the significant relative decline in air's level of service (reliability, security issues etc) was not predicted.

Figure 3.3

1997 Model for Forecasts by Growth Component & Comparison With Actual

| | Base | Market growth | 1997 network changes | CTRL 2 | Fare level |
| | BUP | BHSL | CTRL 1 | Fare structure | Unexplained |

0
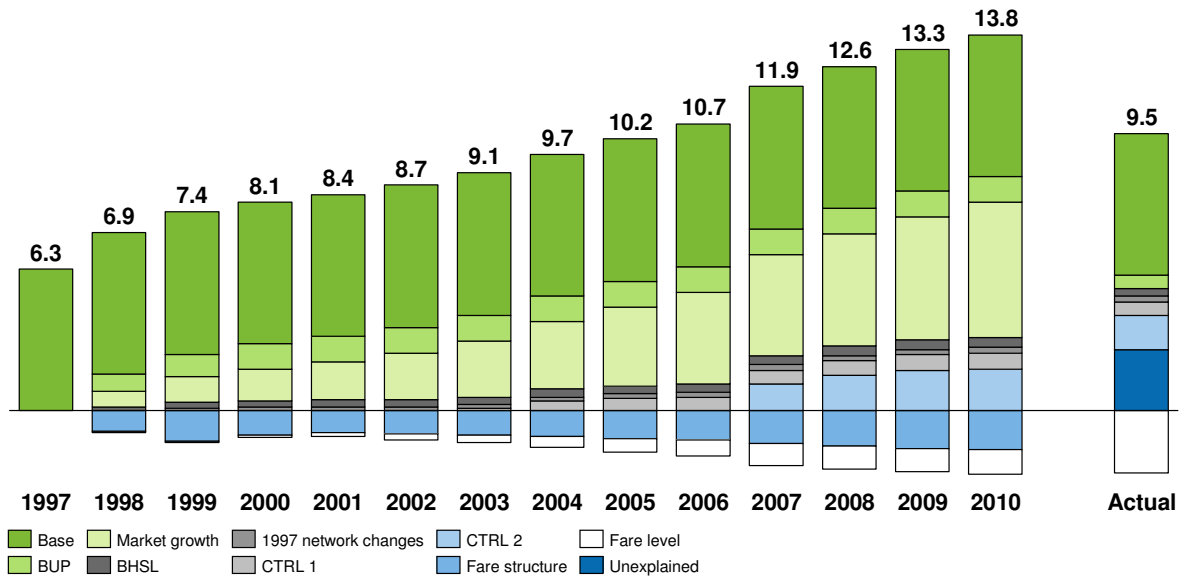
4.   THE BOOZ 2000/2001 MODEL

4.1   CONTEXT

A further set of Eurostar forecasts was prepared in 2000 when actual demand was seen to be falling behind the 1997 model projections.

4.2   MODEL STRUCTURE AND MARKET GROWTH

This model collapsed the 24 market segments used in 1997 to 10 categories, eliminating the distinction between day trips and non-day trips as well as between the different types of leisure trips. It also combined the beyond-Brussels and Brussels segments. However, it did distinguish between trips by UK residents, those by European residents and those by 'Overseas' residents (Table 4.1 below). As in 1997, the model separately considered the effect of market growth and pricing changes, but did not include any network changes other than the effect of CTRL 1 and CTRL 2. Finally, it allowed for the effect of capacity constraints which, even then, were beginning to appear on services such as Friday and Sunday evenings between London and Paris.

Table 4.1 Revised model structure and growth rates (with forecast and actual GDP),

	Segment	Model forecast of market growth index 1999:2010	
		With forecast GDP	With actual GDP
1	UK-France Business	2.05	1.81
2	France-UK Business	2.08	1.68
3	UK-France Leisure	1.50	1.23
4	France-UK Leisure	1.50	1.21
5	Overseas France	1.66	1.66
6	UK-Belgium Business	2.05	1.81
7	Belgium-UK Business	2.03	1.70
8	UK-Belgium Leisure	1.50	1.23
9	Belgium-UK Leisure	1.47	1.23
10	Overseas Brussels	1.66	1.66
	Total	1.60	1.33

Source Booz & Co. analysis

The market growth rates for each segment were based on a set of econometric equations, relating growth to GDP in the current and previous years and, in the case of leisure travel, to the exchange rates in these two years as well. However, a dampening mechanism was also included, so that the sensitivity to these variables progressively reduced; by the end of the forecast period, growth rates had reduced by half compared to 2002 for the same changes in GDP and exchange rate.

The model assumed GDP growth rates between 2000 and 2010 averaging some 2.5% p.a. for UK, France and Belgium. In the event, growth has been much slower at 1.5-1.8% p.a.. The exchange rate estimates also proved difficult with sterling now being significantly weaker than projected at the time. The market is dominated by leisure travel and average growth is thus controlled by the leisure growth rate. Although the model structure included the option of reducing this growth, by allowing some diversion due to UK low-cost airlines, this only addressed modal diversion on the Eurostar corridors and the model thus failed to allow for any diversion away from near-Europe to other destinations.

As with the earlier model, market growth was estimated to have a very significant impact (an increase in base demand of over 60%). In practice it was negligible.

4.3   ADDITIONAL ADJUSTMENTS

As in the 1997 model, the 2000 model also included a series of adjustments covering a range of additional variables:
- 'commercial initiatives';
- the impact of low-cost airlines on the London-Paris route;
- CTRL 1;
- CTRL 2;
- real changes in air and Eurostar fares; and,
- capacity constraints as demand increases.

The impact of all these changes was estimated using a common framework. This was a pivot-point model with a generation component. The change in utility was estimated using parameters broadly similar to those in PDFH, and the sensitivity of demand derived from assumed elasticities of -0.6 for business travel and -1 for leisure (rather lower than previously).

4.3.1   Commercial initiatives
This adjustment covered two areas:
- faster business-class check-ins, saving ten minutes per passenger, introduced in 2000 and 2001. This benefited 45% of business travellers and 3% of leisure travellers. The impact on demand was estimated at 3% increase in business travel and 0.3% increase in leisure travel; and,
- an anticipated reduction of £2.50 in Air Passenger Duty for economy flights. The impact on Eurostar demand was estimated as a 4% decrease in leisure travel and 1% decrease in business travel.

These impacts were combined and spread over 2001 and 2002. Producing a minor negative impact.

4.3.2   Low-Fare Airlines
The model assumed the introduction of low-cost air services to Paris in 2001 (in practice, this was Ryanair flying to Beauvais). The model assumed this would reduce the average air fare by £10 for business passengers and £5 for leisure passengers, to which Eurostar would respond by reducing their fares by an average of £5 for business and £2.50 for leisure. The forecast impact of the changes was to reduce Eurostar demand by about 1%, with the loss of market share being offset by generated traffic.

4.3.3   CTRL 1
The 2000 model assumed a time-saving of 19 minutes for CTRL1 and a frequency benefit equivalent to 14 minutes. The forecast increase in demand was 10% for business traffic and 5-6% for leisure traffic, with a ramp-up period of two years.

4.3.4   CTRL 2
For CTRL2, the 2000 model assumed a time-saving of 9 minutes for Paris business passengers and 12 minutes for Paris leisure passengers. This included both in-vehicle time and the difference in access time between Waterloo and St. Pancras (a split operation was still assumed), based on a detailed analysis of surface origins and destinations. The Brussels services were not analysed in such detail and savings of 15 minutes were assumed based on the in-vehicle times alone. No frequency benefits were considered nor were any transfer benefits for north of London passengers. The forecast impact on demand was an increase of 3-4% for both business and leisure passengers, almost certainly a significant under-estimate of what occurred in practice.

4.3.5 Real Changes in Air and Eurostar fares

Air fares were assumed to be constant in real terms for both business and leisure passengers. Eurostar fares were also assumed to be constant except for a 4% increase in Paris business fares spread over 2000 and 2001, with a very small impact on demand. In practice air fares reduced significantly, while Eurostar rose more than anticipated.

4.3.6 Capacity constraints

The 2000 model included an adjustment to allow for capacity constraints suppressing demand, which were already having an impact on Friday and Sunday afternoon services.

4.4 EX POST ASSESSMENTS

Table 4.2 summarizes the contribution of the various components to the overall forecast.

Table 4.2 Components of 2010 demand in 2000 model[5]

		Passengers (000)	% impact	Comment
1	Base	6594		
2	Market growth	4093	62	Negligible in practice
3	Commercial initiatives	-216	-2	Wrapped in overall fare changes
4	Low-cost airlines	-109	-1	Ceased operation by 2010
5	CTRL 1	641	6	Reasonable
6	CTRL 2	360	3	Significantly under-forecast
7	Fare changes	-54	-	Much greater impact in practice but countered by decline in airline level of service.
8	Constrained demand	-335	-3	Probably occurs in practice
	Total	10974		

Source Booz & Co. analysis

The 2000 model over-forecasts (1.5m above the actual 9.5m passengers carried), and again market growth is heavily over-estimated. However, the impact of CTRL2 is now under-estimated. The impact of fare changes on both the airlines and Eurostar is also heavily underestimated but again the model did not take account of the counterbalancing deterioration of the airline level-of-service.

The following estimated variables were replaced by actual values:
- GDP;
- exchange rates;
- commercial initiatives - has been used as a line to reflect the deterioration in the air level of service[6], assessed as penalties of 20 minutes air in-vehicle time and 30 minutes additional airport wait time;
- low-cost airlines omitted as services began and then ceased;
- CTRL 1 inputs unchanged; and,

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[5] One of a number of models compiled over the period, giving broadly similar results
[6] Difficult to measure precisely but order-of-magnitude estimate derived using 2000 model framework & taking the change in airline level-of-service as an increase in in-vehicle time of 20 minutes (to reflect congestion delays) and an increased wait time of 30 minutes (to reflect security and boarding procedures).

- CTRL 2 inputs originally assumed split services. In practice, services were consolidated at St. Pancras, providing frequency benefits compared with previous assumption, operating 4 minutes faster then assumed, but receiving some accessibility losses.

Actual fare changes have seen Eurostar fares increase in real terms over forecast period while air fares have reduced in real terms by 1-2% p.a. Such an adjustment has been included for comparison purposes and the combined impact of the changes in the Eurostar and air fares is a reduction in demand of 12%, or 1.3 million passengers in 2010.

Table 4.3 summarizes the possible components of actual 2010 demand on this basis using the 2000 model framework.

Table 4.3 Components of 2010 demand with revised inputs in 2000 model

		Passengers (000)	Impact %	Source of estimate
1	Base	6,594		1999 actual
2	Market growth	2,383	36	Revised inputs
3	Commercial initiatives	1,206	13	Revised inputs for aviation whose quality of service suffered
4	Low-cost airlines	-	0	Excluded, it ceased to operate.
5	CTRL 1	639	6	As modeled
6	CTRL 2	523	5	Revised inputs and rerun in model
7	Fare changes	-1,310	-12	Revised inputs and re run in model
8	Constrained demand	-227	- 2	As modeled
	Total	9,808		

Source Booz & Co. analysis

Although the recalculated model gives a reasonable result in aggregate (an over-forecast of only 0.3m), individual components are clearly in error. Market growth is too high and the impact of CTRL2 too low (against our estimate of what occurred in practice). The impact of fares is, correctly, much lower in this model than the 1997 model, as about half of the change in relative fares occurs between 1997 and 1999.

Table 4.4 presents possible components of actual demand based on adjusted estimates for the main components.

Table 4.4 Components of actual 2010 demand in 2000 model assessment of what occurred in practice

|		Passengers (000)	% impact	Comment
1	Base	6594		
2	Market growth	0		Negligible in practice
3	Commercial initiatives	886	13	As the 2000 model
4	Low-cost airlines	0	0	Ceased operation
5	CTRL 1	605	8	Absolute number as 2004 model
6	CTRL 2	1500	19	As derived (see Section 3.2)
7	Fare changes	-1107	-12	Much greater impact in practice. As 2000 model proportion.
8	Constrained demand	-110	-1	Probably occurs in practice take from the 2004 model
	Total	8368		
	Unexplained	1132		

Source Booz & Co. analysis

The gap is 1.1 million passengers. Reasons for closure of this gap could include a range of issues not explicitly modeled such as improved Eurostar reliability, and the impact of the Icelandic volcano eruption in early 2010, which may also have led to a few hundred thousand additional trips.

4.5   SUMMARY

The 2000 model, was again an over forecast, with actual passengers numbers being some 13% below the projected level in 2010. Again, the key reason for error related to the failure to predict that demand in the corridor would fail to grow.

We analyzed the impact of each independent variable and allocated passengers to that heading. At the end of the process the model resulted in an under-forecast with a gap or 'unexplained' component of some 1.1 million passengers. Reasons for closure of this gap could include a range of issues not explicitly modeled such as improved Eurostar reliability, and the impact of the Volcano in early 2010, which may also have led to a few hundred thousand additional trips.

Figure 4.1
2000 Model Forecasts by Growth Component V Actual
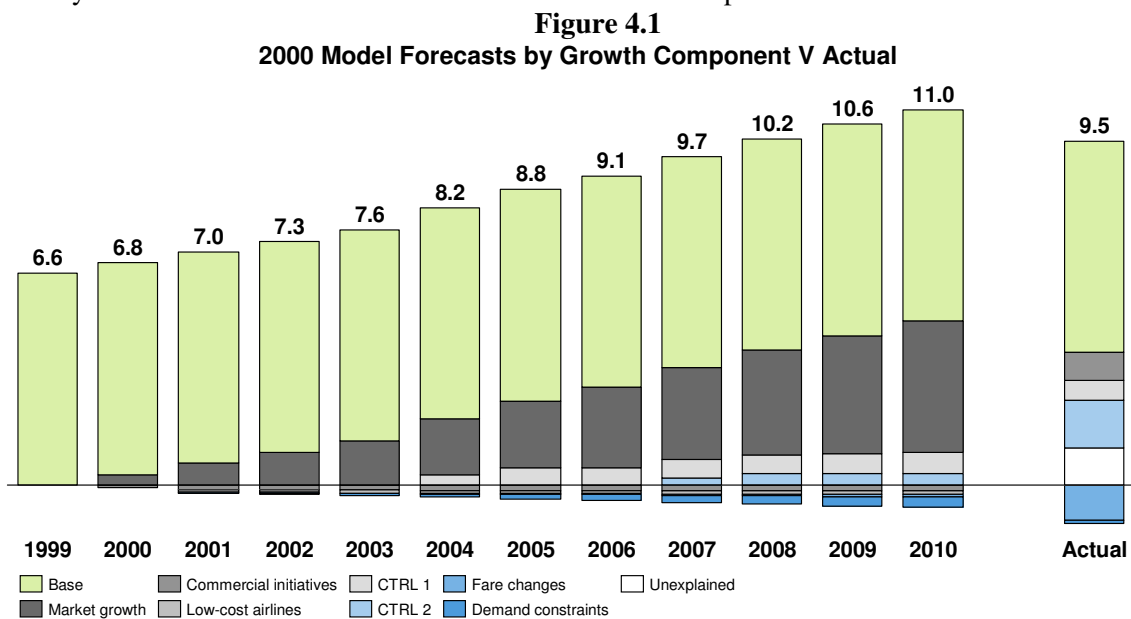
5. THE BOOZ 2004/2005 MODEL

5.1 CONTEXT

A further set of Eurostar forecasts was prepared in 2004/5. This followed reductions in demand after the slowing of train speeds in the wake of the Hatfield incident and the associated problems with reliability, which impacted the entire GB rail network including Eurostar routes. This model was a combination of the two previous models in that it adopted the 10 categories used in 2000 to establish market growth rates but then applied these to 37 market segments which were then subject to adjustment for the impact of changes in service levels and fares. The model made an attempt to allow for 'off-corridor' growth, but this only considered diversion from near-Europe to other European destinations and thus failed to allow adequately for diversion to non-traditional destinations such as Asia, North Africa and the Caribbean. On the face of it, this model was remarkably accurate, being able to replicate patronage between 2000 and 2004, but also forecasting demand between 2004 and 2010 to within 2% (Table 5.1). However, this was achieved by combining an over-forecast of growth with an under-forecast of mode switching.

Table 5.1 Comparison of 2004 model forecast and actual demand[7]

Year	Eurostar patronage (million)	
	Actual	Forecast
2000	7.1	7.1
2001	7.0	6.9
2002	6.6	6.5
2003	6.3	6.3
2004	7.3	7.3
2005	7.5	7.5
2006	7.8	7.7
2007	8.3	8.1
2008	9.1	8.8
2009	9.2	9.1
2010	9.5	9.3

Source Booz & Co. analysis

5.2 MODEL STRUCTURE & MARKET GROWTH

The model assumed GDP growth rates between 2004 and 2010 averaging 2.1- 2.7% p.a. for each of UK, France and Belgium. In the event, growth has been much slower at 1.0-1.5%. The exchange rate estimates proved reasonably accurate until the sterling devaluations of 2008 (Table 5.2).

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[7] One of series of models giving broadly similar outputs

Table 5.2 Assumed and actual GDP growth and exchange rates

	2004	2005	2006	2007	2008	2009	2010
GDP forecast, cumulative							
Forecast							
UK	1.04	1.07	1.10	1.13	1.15	1.18	1.21
France	1.01	1.04	1.07	1.09	1.11	1.14	1.16
Belgium	1.02	1.04	1.07	1.09	1.12	1.15	1.17
GDP actual, cumulative							
UK	1.03	1.05	1.08	1.11	1.11	1.06	1.07
France	1.02	1.04	1.07	1.09	1.09	1.06	1.08
Belgium	1.03	1.05	1.08	1.11	1.12	1.09	1.11
Exchange rate £:Euro							
Forecast	1.52	1.47	1.45	1.45	1.45	1.45	1.45
Actual	1.47	1.46	1.47	1.46	1.26	1.12	1.17

Source Booz & Co. analysis

The growth factors for the individual segments in the model, using both the assumed and actual GDP growth and exchange rates, are given in Table 5.3. The market is dominated by leisure travel and the average is thus controlled by the leisure growth rate. The market growth rates for each segment were based, as in 2000, on a set of equations relating growth to GDP in the current and previous years and, in the case of leisure travel, to the exchange rates in these two years as well. As in 2000, a dampening mechanism was also included, so that the sensitivity to these variables progressively reduced. Compared to previous models, the forecast growth was more conservative, although still considerably greater than the actual change, i.e some 34% against negligible in practice, actual GDP reduced this to 14%.

Table 5.3 2004 model market growth forecasts

	Segment	Model forecast of market growth 2003:2010	
		With forecast GDP	With actual GDP
1	UK-France Business	1.41	1.16
2	France-UK Business	1.28	1.13
3	UK-France Leisure	1.37	1.06
4	France-UK Leisure	1.30	1.20
5	Overseas France	1.32	1.32
6	UK-Belgium Business	1.41	1.16
7	Belgium-UK Business	1.30	1.19
8	UK-Belgium Leisure	1.37	1.06
9	Belgium-UK Leisure	1.32	1.27
10	Overseas Brussels	1.32	1.32
	Total	1.34	1.14

Source Booz & Co. analysis

The model included a procedure for adjusting this growth for 'off-corridor' competition, based on changes in the relative Eurostar/air fares to near-Europe and to elsewhere in Europe. The adjustment applied to leisure travel and reduced the forecast growth factors within the corridor (see Table 5.4)**.** This reduced forecast growth rates to near-Europe to 50-60% of that for total travel but still over forecasts the actual travel to near-Europe.

Table 5.4 2004 model near-Europe market growth forecasts

Segment	Model forecast of market growth 2003:2010	
	With forecast GDP	With actual GDP
1 UK-France Business	1.41	1.16
2 France-UK Business	1.28	1.13
3 UK-France Leisure	1.15	0.95
4 France-UK Leisure	1.09	1.09
5 Overseas France	1.32	1.32
6 UK-Belgium Business	1.41	1.16
7 Belgium-UK Business	1.30	1.19
8 UK-Belgium Leisure	1.15	0.95
9 Belgium-UK Leisure	1.11	1.15
10 Overseas Brussels	1.32	1.32
Total	1.20	1.07

Source Booz & Co. analysis

5.3   ADDITIONAL ADJUSTMENTS

As in the two previous models, the 2004 model also included a series of adjustments for changes in service level and prices and other network changes. These covered:
- CTRL 1 and CTRL 2;
- Eurostar performance;
- real changes in air and Eurostar fares; and,
- capacity constraints as demand increases.

The impact of all these changes was estimated using a common framework. This was a pivot-point model with a generation component. The change in utility was estimated using parameters broadly in line with PDFH (the UK Passenger Demand Forecasting Handbook) and the sensitivity of demand derived from assumed fare elasticities of -0.6 for business travel and -1.2 for leisure.

5.3.1   CTRL 1
The 2004 model assumed a time-saving of between 16 and 20 minutes depending on market segment (reflecting different proportions using Ashford and Waterloo) but with no frequency benefit, unlike the 2000 models. The forecast increase in demand was 8% for both business and leisure traffic, with a ramp-up period of three years.

5.3.2   CTRL 2
For CTRL2 the 2004 model assumed a further time-saving of 15-20 minutes, depending on market segment, together with some small access time savings and reduced waiting times of 6 minutes for Brussels passengers and 2 minutes for Paris passengers. As in the 2000 model, these savings were based on a detailed model of access to Waterloo and St. Pancras. Little in the way of frequency benefits or transfer benefits for north of London passengers were considered. The forecast impact on demand was an increase of about 10%, an under-estimate of what occurred in practice.

5.3.3   Eurostar performance
Eurostar's punctuality had been patchy during its early years when it was using the conventional rail network but it deteriorated badly in the period following the Hatfield accident, so that by 2002, the average delay for Paris services was over 15 minutes – this meant many trains were up to half-an-hour late. This was clearly having a significant effect on demand and the model included a component to reflect a reduction in average delay for the Paris trains to 8 minutes following the CTRL 1 opening and 7 minutes following CTRL2, with corresponding reductions for the Brussels services. This was

forecast to increase demand by 10%. In the event, the actual average delay since 2004 has been close to that assumed in the model.

5.3.4 Real changes in air and Eurostar fares

Small increases in business air fares were assumed for the Paris route for 2004-8, with larger ones for Brussels for the first year. Leisure air fares had small reductions in the first two years. Eurostar fares were assumed to increase steadily by 1-2% p.a. The overall impact was a forecast reduction in demand of 2%, with business travel increasing slightly and leisure travel reducing. In practice, Eurostar fares have increased by about 15% over the period to 2010. Air fares have fluctuated, with business fares reducing whilst leisure fares have increased with the demise of the low-cost carriers on the route.

5.3.5 Capacity constraints

Similar to the 2000 model, the 2004 model included a small adjustment to allow for capacity constraints suppressing demand. In the period to 2010 this adjustment had comparatively little impact.

5.4 EX POST ASSESSMENTS

The forecast of 9.3m was some 2% below the actual demand of 9.5m passengers. Table 5.5 summarizes the contribution of the various components to the overall forecast.

Table 5.5 Components of 2010 demand in 2004 model forecast independent variables

		Passengers (000)	%	Comment
1	Base	6232		
2	Near-Europe market growth	2103	34	Negligible in practice
3	Off Corridor Diversion	-871	-10	Reasonable (reduces growth from 34 to 20%)
4	CTRL 1	605	8	Reasonable
5	CTRL 2	777	10	Probably under-forecast
6	Eurostar performance	866	10	Probably reasonable
7	Fare changes	-227	-2	Probably reasonable
8	Constrained demand	-169	-2	Possibly occurs in practice
	Total	9315		

Source Booz & Co. analysis

The 2004 model forecast for 2010 is very close to the actual demand but still has the same basic problem of over-forecasting market growth and under-forecasting market share. The impact of fare changes on both the airlines and Eurostar is underestimated but the model did not take any account of the counterbalancing deterioration of the airline level-of-service. As was the case with the 2000 model, this is difficult to measure precisely but has been assumed at 60% of the order-of-magnitude estimate derived using the 2000 model framework (this allows for the initial disruption to air quality of service after 2001 but takes account of the fact that in 2006 a major quality deterioration was brought about by the liquid and gels rules, which has had more of an impact on airport waiting, security and 'hassle' issues than any other factor).

Table 5.6 summarizes the possible components of 2010 demand on this basis using the 2004 model framework, with 'actual' independent variables.

The following estimated variables were replaced by actual values:
- GDP;
- exchange rates;
- off-corridor air fares in Europe;

- Eurostar performance;
- CTRL 1 inputs unchanged;
- CTRL 2 travel times 8 minutes faster then assumed; and
- actual fare changes have seen Eurostar fares increase in real terms over forecast period by about 2% p.a. while business air fares have reduced in real terms by 2-3% p.a. and leisure airfares have remained constant (France) or increased by 3%p.a. (Belgium).

This results in a rather larger under-forecast mainly caused by an underestimate of CTRL 1 and CTRL2 and a failure to pick up airline level of service deterioration.

Table 5.6 Components of 2010 demand in 2004 model actual independent variables

		Passengers (000)	% Impact	Comment
1	Base	6232		
2	Near-Europe market growth	885	14	Negligible in practice
3	Off Corridor Diversion	-470	-7	Reasonable
4	CTRL 1	524	8	Probably under forecast
5	CTRL 2	889	12	Probably under forecast
5	Eurostar performance	765	9	Reasonable
6	Fare changes	-585	-7	Probably reasonable
7	Constrained demand	-107	-1	Possibly occurs in practice
	Total	8133		

Source Booz & Co. analysis

Table 5.7 substitutes what we believe were the actual impacts of the variables, CTRL1 and 2 are much higher but market growth is lower. However we are still some 1 million trips below the actual 2010 out turn.

Table 5.7 Components of 2010 demand in 2004 model assessment of what occurred in practice

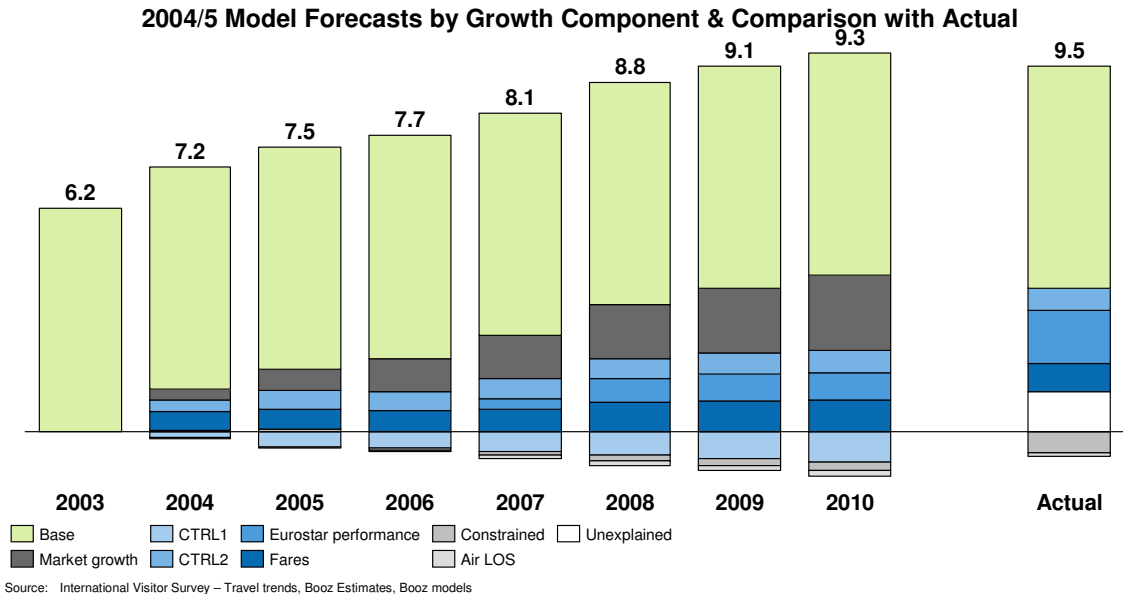|		Passengers (000)	% Impact	Comment
1	Base	6232		
2	Near-Europe market growth	-	0	2 & 3 together observed to be negligible
3	Off Corridor Diversion	-	0	
4	CTRL 1	605	10	Observed
5	CTRL 2	1500	22	Observed
5	Eurostar performance	791	9	2004 model
6	Fare changes	-605	-7	From 2004 model
7	Airline Level of service	-		Probably some 2/3rds of 2000 model
8	Constrained demand	-111	-1	Possibly occurs in practice 2004 model
	Total	8412		
	Unexplained	1088		

Source Booz & Co. analysis

If airline quality of service impacts were taken into account (i.e., the impact of liquid and gels security impacts in 2005/6), say 0.7 to 0.8 million, we would only be a little off the 2010 actuals, a difference that can probably be accounted for by the impact of the 2010 volcano eruption on air traffic in Europe, which temporarily boosted Eurostar demand in the first half of the year.

5.5   SUMMARY

The 2004 forecasts were remarkably accurate, predicting actual traffic to within approximately 2%. However, this was more a matter of compensating errors and when actual levels of independent variables etc were entered the under-forecast error increased to over 10%. The 2004 model did not have a variable to account for airline level of service impacts. It is likely that this would account for much of the variation. That is, the impact of the restrictions on carrying liquid and gels and other security issues in 2005/6 on airline demand would raise Eurostar trips by some 0.7 to 0.8 million. At this stage, we would only be a little off the 2010 actuals, a difference that can probably be accounted for by the impact of the 2010 volcano eruption on air traffic in Europe, which will have temporarily boosted Eurostar demand in the first half of the year.

Figure 5.1

2004/5 Model Forecasts by Growth Component & Comparison with Actual

Source: International Visitor Survey – Travel trends, Booz Estimates, Booz models

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