Harvard Design School
Prof. Spiro N. Pollalis

Version November 01, 2006

Channel Tunnel Rail Link

Risk Transfer and Innovation in Project Delivery

"Will this be the project that restores our belief that Britain can build a railway?" the *Guardian* asked in May 27, 2005, referring to the Channel Tunnel Rail Link (CTRL) project. The article added that although "*it is one of the biggest engineering projects in the UK and the country's first new train line in a century, few of us know the real success story*."[1] At the same time, the CTRL team was looking forward to the next challenge in the infrastructure field: to transfer the significant experience gained from CTRL in UK to other parts of the globe. A major focus was on risk management and the need for new modes of cooperation and collaboration between all parties involved in a project, issues that had been dealt with successfully in the CTRL project. There were still issues to be addressed like the similarities and differences in the relationships between designers, contractors, government officials, and the public in each part of the world, and the identification, measurement, transfer, and handling of risk. CTRL provided lessons for all of the above.

---

[1] Jonathan Glancey, "Tunnel vision," *The Guardian*, May 27, 2005.

Doctor of Design candidate Andreas Georgoulias prepared this case under the supervision of Professor Spiro N. Pollalis as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

The authors would like to thank Terry Hill and Mike Glover of Arup and Brian Kenet of EFCG. The case was based on publicly available information and interviews conducted by the authors.

1. The CTRL project

The Channel Tunnel Rail Link project creates a new rail line to connect London with the Channel Tunnel and thence with France and Paris. The integration of Europe through rail lines has been one of the major targets and issues of every European country. The Channel Tunnel was one of the most difficult parts of this new network, since it faced the challenge of passing under the Channel waters. CTRL faced further issues involved with the development of the new technology of high-speed trains and also the construction of lines through greenfield lands and despite citizen opposition. As of 2006 the high-speed rail network in Europe still has to be completed, with individual countries facing various issues, risks, and challenges.

2. The Client

The Channel Tunnel Rail Link project was initiated in 1971 by the UK Government. Since the earlier conceptions, the planning of the route was a major challenge for the British Government and the agency delegated to the task, British Railways. British Railways worked to establish Union Railways Limited as the project team. This team worked for pre-construction planning services, including preliminary design, consultation, and procurement work for the rail route. It has to be noted that the Channel Tunnel Rail Link was one of the many privatization projects initiated by the British Government. The term Public – Private Development (PPD) and Private Finance Initiative (PFI) acquired their publicity through the efforts of the many teams involved in all these projects. So, the CTRL should not be viewed as a large project in isolation, but as a (significant) part of major change in the way a country deals with its public infrastructure.

3. The project in 1970s and 1980s

In 1971 UK started to study the British section of a direct rail link between London and Paris. British Railways (BR) worked in conjunction with French Railways (SNCF) to study a tunnel under the Channel and the links from there to their capital cities. However, public opposition and fears of negative impacts arising from faster and more frequent trains made the UK Government abandon the plan in 1975.[2] It was not until 1986 that BR and SNCF agreed on the Channel tunnel, with no mention being made yet of a new UK rail line. The concession contract was awarded the same year to Trans Manche Link (later Eurotunnel) and the Channel Tunnel Act was approved by the parliament in 1987.

[2] UK and France decided to stick with the development of Concorde, which was a far easier option in political terms.

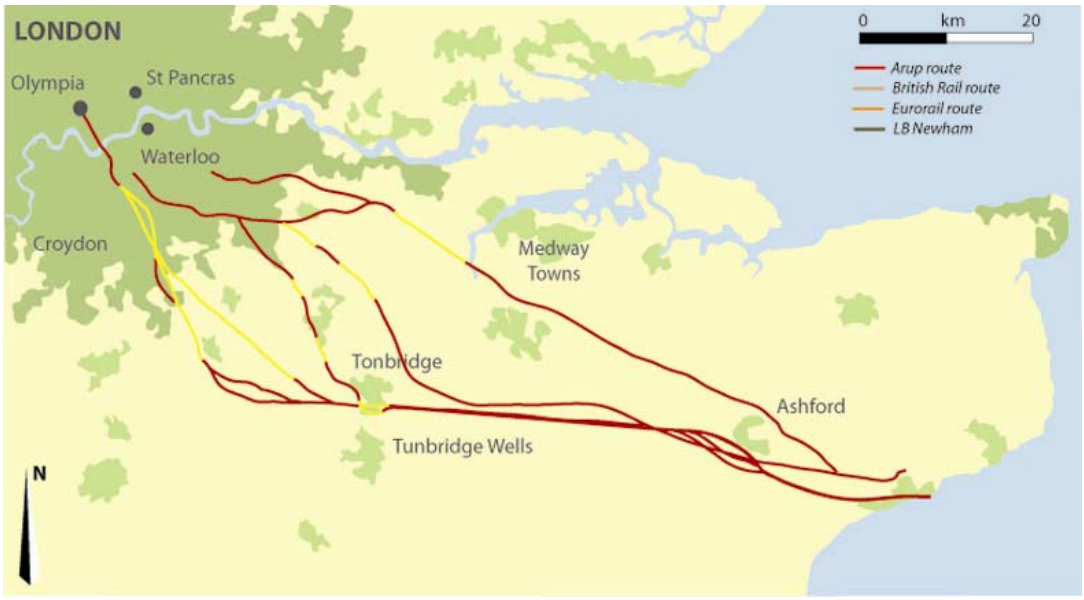


Figure 1: The 1972 proposed route

Later that year BR formed a team led by Sir Alexander Gibb & Partners to perform studies for the rail link of the Channel Tunnel to London. The study report, made public in 1988, identified four possible routes that could provide 300km/h running speeds. Public reaction was immediate and totally adverse.[3] Protest groups, demonstrations, and public hostility came after the rather immature publication of the four routes with no sufficient information gathered about each option.

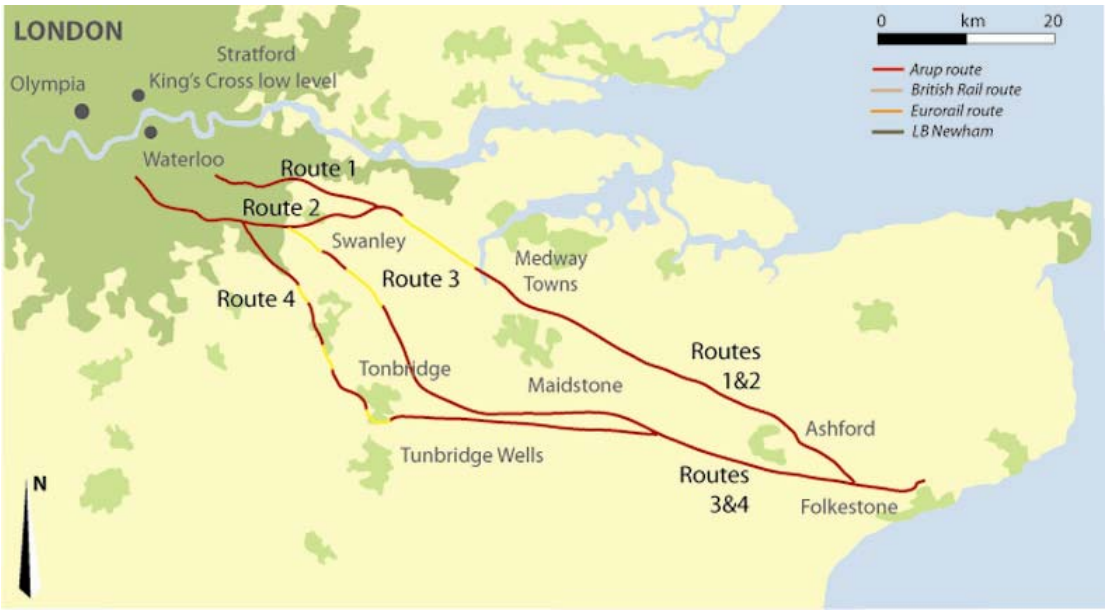


Figure 2: The 1988 proposed routes

[3] It has been said that conclusions were based on financial, environmental, and transport issues rather than from any community consideration.

In 1989 BR announced that a single route has been chosen (starting in London from King's Cross station) together with the details of the consultation process that would accompany the next stages of design. The team dealing with the project was transferred from British Rail Civil Engineering Special Projects to the direct control of the British Railways Board and grew to 400 persons. Between March and November 1989 engineering and parliamentary drawings were developed, aiming at submitting a private bill in November. As the year progressed, the definition of the route became firmer but the opposition to the project was still overwhelmingly hostile. The consultation team had to deal with over 20 local authorities, two counties, 50 parish council and community groups, and over 50 anti-rail action groups. Even though this period saw the emergence of a project style using a set of consultation documents with distinctive branding, the consultation team acknowledged they had little knowledge about the councils and groups with whom they were speaking.[4]

Figure 3: The 1989 proposed route

Simultaneously, BR started a competition to select a joint venture for the construction of CTRL. The JV selected in November announced that the cost of the project had risen due to "an extensive program of consultation which led to detailed proposals designed to overcome the main environmental concerns." In June 1990 the Government transport secretary announced he was unable to accept the JV's proposal as it required public funds. The project went to a dead end while the Channel Tunnel was under construction, connecting UK and France.

[4] Another problem was the lack of detailed knowledge of the impact of new trains traveling at speeds higher than those anywhere else in the UK at the time.

4. The project in the 1990s

CTRL had a new start when BR started studying four new route proposals. The first was based on a revised version of its failed 1989 route. The next one was studied by Ove Arup & Partners (Arup) and the last two were by Eurorail (containing large tunnel parts) and London Borough of Newham. Arup's role in this stage was significant and the firm participated as risk-taking, pioneering promoter of the CTRL route that met community aspirations, and addressed national, domestic, freight and regeneration benefits. Strategically the four routes were judged against two existing Government objectives: a 50% increase in capacity between London and the Channel Tunnel, and the ability to maximize use of the new line for domestic users. The Government received the route options report in June 1991, and in October 1991 the transport secretary announced:

> *"I am now inviting British Rail to undertake such refinement of the route proposed by Ove Arup as is needed to safeguard it . It is the Government's intention that the rail link should be taken forward by the private sector. As to the precise financial arrangements this will be left for the Government to decide in the circumstances of the time."*

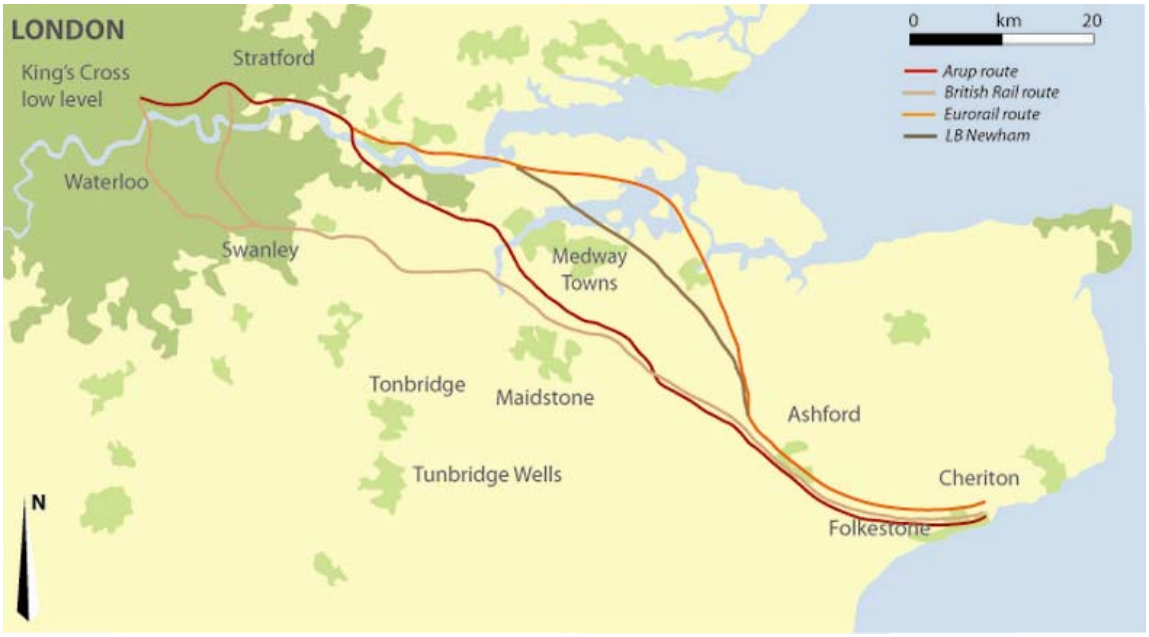


Figure 4: The four routes proposed in 1990

The government's decision led to a need to restructure the project group. An Arup team joined the existing group for the preparation of the next report. The project team was divided in two parts, the London and the country part, and the whole team underwent a significant optimization process. The route optimization identified several options. These were partial alterations of the whole route, focused on the most difficult segments. The route options were to be synthesized so that they could be

turned into a publicly acceptable proposal, combining strategic planning and business aspects. This process lasted two years. During the second year local authorities were allowed to be confidentially consulted throughout the optioneering process and prior to public consultation, putting off the complications of media scrutiny and public anxiety. The decision to start the public consultation was announced in March 1993. Making an innovation to the process, it was agreed that rail action groups should be co-opted by their respective parish councils. Local authority officers were also able to use their knowledge of the optioneering process to inform their council's decisions. Also, when the public was involved in the process it was decided to use an agenda to constrain the debate to those matters the Government thought appropriable. In the meanwhile, in 1992 BR's project team became Union Railways Limited (URL), which included private staff from leading engineering offices.

5. Finalizing the design

After spending over 20 years studying new route proposals and dealing with protest groups, demonstrations, and public hostility, the UK Government finally confirmed a preferred final scheme for the Channel Tunnel Rail Link in 1994. The selected route is illustrated in the image that follows.

Figure 5: The final 1994 route

The Government decided to procure the project using the Build-Operate-Transfer project delivery method. This particular method was a no-brainer considering the size of the project and the institutional environment of the time, as it was mentioned earlier. The effort of the British Government to promote privatization was much depended on the success of this project, since it not only involved enormous amounts of capital (projected cost £5.2 billion) but also was a "connection" of UK to the rest of

the European Union, and as such many organizations outside UK kept a close look to the project. A failure to implement and complete the endeavor would not only hinder further attempts to raise capital for similar projects, but also demeanor UK's status in the privatization race. The various project delivery methods and the selection for this project are illustrated in the chart that follows.

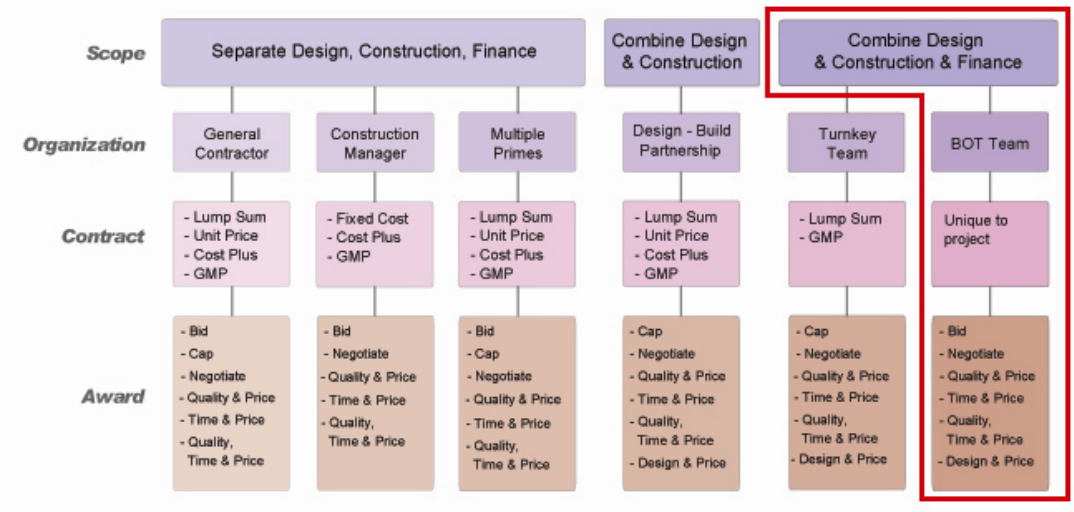


Figure 6: Various project delivery methods and the British Government's choice

6. The 1994 concession contract

In 1994 a competition was launched to appoint a private-sector promoter to design, build, finance, and operate the £5.2 billion Channel Tunnel Rail Link. Four of the nine consortia that applied for pre-qualification were selected to submit full proposals for the project: Green Arrow, Eurorail, London & Continental Railways, and Union Link. The Government also announced the key criteria for the competition: the amount of the monetary Government contribution required and the willingness of the tenderer to accept risk, such as contractual, operational, and financial. For this concession, the owner did not provided guarantees similar to what we see on other projects, such as an off-take contract, guaranteed return on equity, or securitization of cash flows. The contract stated a concession period of 60 years, after which ownership of the project would be returned to the UK government. There was no cap on the price the BOT Team could charge to the users of the rail link. In many ways Channel Tunnel Rail Link was an unconventional deal. It was over ten times larger than a conventional public-private project made at the time. The concession contract also contained some rather unusual terms for a BOT project.

First, it gave ownership of Union Railways Limited and its 100-person team, which had taken forward the project from inception. The acquisition of the Union Railways Limited team gave direct access to a large amount of collective knowledge and

intellectual capital. This could hardly have been transferred by means only of a data room and due diligence. The benefits in the continuity of the project team were substantial due to the large number of external parties with whom the project had to interface. Each interface was capable of making a significant impact on cost and program, with the most significant interface probably being with the domestic rail network operator Railtrack.

The second unconventional term of the concession was that it gave ownership of developable lands in Stratford and King's Cross for urban regeneration and property development, along with an interest in developable land at Ebbsfleet.

The third and most important term of the concession was that it gave ownership of Eurostar UK Limited, the high speed train operating company for the project. Eurostar was involved in another project running in parallel, the Channel Tunnel. Even if this case does not intend to analyze this other project, it has to be noted that the Chunnel (as it was referred) was having a myriad of problems. The contracting scheme was in a continuous claims confrontation with the British and French governments and the budgeted cost had significantly increased. Moreover, traffic forecast seemed that were unable to be achieved, due to over-optimism and the emergence of the low-cost airlines, such as Easy Jet.

The CTRL project, as the link from London to the Chunnel was much depended on the success of this other project, and as such the owner decided to tie the two projects together by offering an equity share of the high speed train operator. This move although made CTRL the first public-private deal to include an operating business in loss. (Some projects have involved the transfer of operating business but invariably these were profitable and cash-generating.) In this case, as will appear later, the turn-around risk, i.e., the need for growing revenues to reach break-even in the Eurostar business, forced the first and radical restructuring of the project in 1998.

7. Award and BOT team selection

The BOT concession was awarded to London & Continental Railways based on their assembled set of skills required to finance and manage construction of the railway. London & Continental Railways was created specifically for the project from a consortium of companies, including Arup, Bechtel, Halcrow, and Systra as design/ project manager, UBS Warburg for the project financing, and finally National Express together with Virgin for the transport operation. The contractual relationships for this BOT project are illustrated in the figure below.

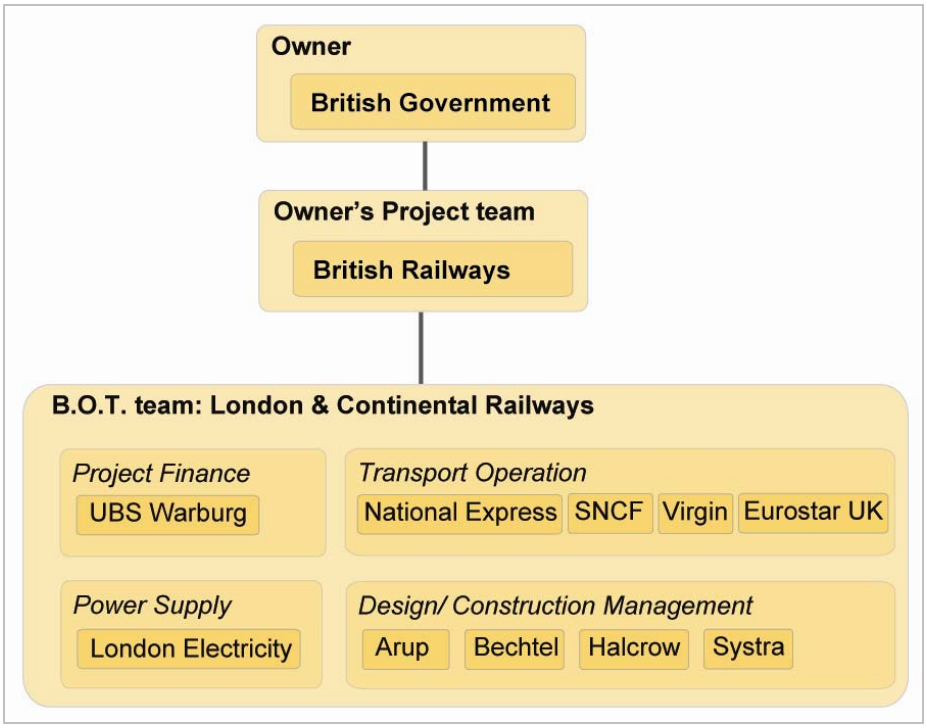


Figure 7: The BOT team organization chart

Each of the companies forming the concession had control of the project's equity, creating a vested interest in the success of the project. The percentage of equity controlled by each company is illustrated in the chart on the right.

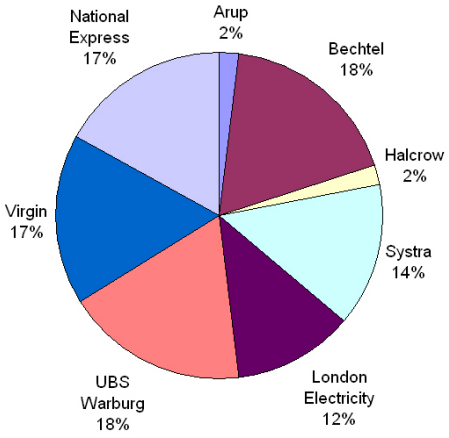


Figure 8: Equity shares in the BOT team

8. BOT Project Financing

The BOT project team, even if it had control of the project's equity, it lacked the required funds to contribute. The required amount, about £800 million, was planned to be raised from the London Stock Exchange, through an initial public offering (IPO). This equity offering would be accompanied by substantial debt-raising to cover a forecast peak debt requirement of around £3.2 billion. Once the project had been

completed, much of the debt would then be refinanced in the bond markets. The latter offered longer-term and cheaper financing than the banks, but bond investors would never invest in an incomplete project of such scale.

This particular point can be viewed as an attempt for risk transfer of the CTRL operations to the investors in the stock market. Data is not clear about how much equity would be offered in the IPO, but the amount to be raised was substantial. Investors were aware at the time of this risk transfer. Peter Weston of *Project & Trade Finance journal* writes on the March 1995 issue:

"[ ] the key question of how much risk the private sector will assume with CTRL has still to be addressed. On a technical level, there are likely to be few problems.[ ] Revenue levels will be hard to prove, however."[5]

As many have feared, the important and overoptimistic assumption about Eurostar breaking even, before the Central Tunnel Rail Line flotation, never happened. By August 1997 it became apparent from the due diligence between the BOT team and the investment banks that initial forecasts for the passenger service could not be achieved. In fact, Eurostar's volume of business has since proved to be significantly below all forecasts made in the Channel Tunnel Rail Link competition, including those made by consultants issued by the Government to potential bidders. As a result there was a growing concern within the capital markets that Channel Tunnel Rail Link's traffic projections and consequent revenue stream were unrealistic, ending in a shortfall for potential investors or debt providers. The following chart illustrates the estimated and actual traffic in the Eurostar.

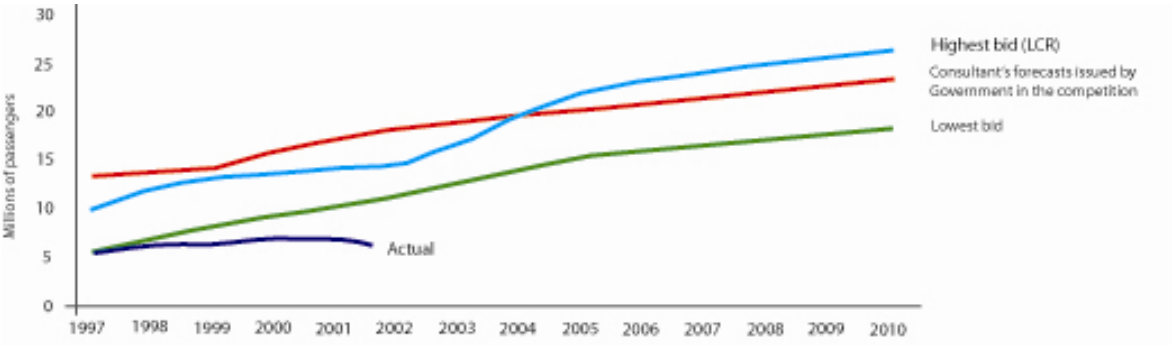


Figure 9: Planned vs actual passenger traffic in Eurostar

As it was evident, in January 1998 the project came to a halt. The BOT team, London & Continental Railways, could not raise the necessary private-sector finance. The BOT team made a request for help to the British government. The BOT team had already much in stake in the project and could not afford a failure. Charis Gresser of Financial Times writes:

[5] Peter Weston, "PFI on the line" *Project and Trade Finance,* 143: March 1995

"Shareholders stand to lose a total equity investment of £100m. It may not sound like all that much in the context of a £5.4bn project heading for the plug hole, but there is more than just cash at stake here. It is the fear of damaged credibility and soured relations with government that will trouble shareholders more than anything else."[6]

A grant support of £1.2 billion was requested in exchange for equity share and future cash flows. The Deputy Prime Minister refused this request, but it created an important dilemma for the Government. It could not abandon UK's first attempt to build a high-speed railway, and at the same time it was not acceptable to undertake the project in the public sector. Starting again with a new competition would have taken around two years. The Government therefore gave some breathing space to London & Continental Railways and directed it to meet some additional objectives. The most important one was for London & Continental Railways to find risk-sharing partners. If the BOT team could meet the Government's objectives, the UK Government would guarantee the project's bonds before the construction had even started.

At the time the press was full of articles portraying the extreme sensitivity of the situation and the dynamics that have evolved, within the BOT team, but also in UK Parliament. Juliette Jowit of Financial Times wrote:

"The government's deal to bail out the Channel tunnel high-speed rail link has been condemned by the Commons public accounts committee, which warns it is very likely that further "substantial" public money will be needed to keep it going. [ ] The report, published today, examines the deal with London & Continental Railways. In 1996 LCR won the deal to build and run the high-speed link, which would be financed by revenues from Eurostar passenger services. In 1998 it became apparent that fare income would not sustain the £5bn project, and John Prescott, the deputy prime minister, brokered a rescue package under which government would underwrite £4bn of debt.

The cross-party committee of MPs says it "condemned the fact that the taxpayer had been left to pick up the tab for a flawed deal that failed to transfer the risk". Shareholders in LCR were insulated from risk in two ways, the report says .Four LCR shareholders, Bechtel, Arup, Halcrow and Systra, also formed the Rail Link Engineering consortium, which won the contract for the design and project management, it says. When the project was close to collapse, the government "felt obliged" to bail them out.

"The shareholders were in a win-win position," said Edward Leigh, the committee's Conservative chairman. "They were awarding themselves substantial contracts from the company and their so-called 'risk capital' was never actually at risk. The

[6] Gresser, Charris, "Troubles threaten the credibility of shareholders" *Financial Times,* January 30 1998, pg.10

imperative to complete the project meant that the shareholders had to be kept sweet, at the expense of the taxpayer."[7]

9. BOT Team Restructuring

In response to the UK Government's demands, London & Continental Railways and its banking shareholder, UBS Warburg, promoted a new structure for the project. The risks of Eurostar's performance where separated from the risks of railway construction. Eurostar's performance risk was shared under a management contract with Inter-Capital and Regional Railways Limited, the latter being a consortium including the two train operators still holding equity shares in London & Continental Railways (National Express and French Railways), the Belgian rail operator SNCB as the third Eurostar partner, and British Airways. Virgin exited the BOT team. The contract was structured around target levels of Eurostar's operating cash flow in each year based on an expected target at the time of agreement. The consortium would receive a management fee based on passenger revenue and a "gain share" of cash flow above target. Against this, the consortium is obliged to contribute to Eurostar a "pain share" of cash flow below target. Both the "gain and pain" share amounts were capped, but were sufficiently large to give the consortium an incentive to maximize performance.

The construction risk was shared with Railtrack, the domestic rail operator. Railtrack was initially deterred from participating in the Central Tunnel Rail Link by the size of the project. To facilitate Railtrack's involvement, the project was phased into two sections. The image below illustrates the separation of the route into the two sections.

Figure 10: The two sections of the project.

[7] Jowit, Juliette, "MPs attack "taxpayer's bail-out of Channel link"" *Financial Times,* March 21 2002, pg.07

Railtrack assumed management control of the section 1 project and agreed to purchase it following completion at a price based on the outrun cost. In return, Railtrack would have received access charges over 50 years from Eurostar and domestic capacity charge payments from the Government calculated to deliver a return on the basis of a target cost. Railtrack's exposure on section 1 was in turn mitigated by "pain and gain" share arrangements in the project management and construction contracts with Rail Link Engineering and the contractors. There was also an option to take forward section 2 on a similar basis.

Arup, Bechtel, Halcrow, and Systra formed Rail Link Engineering. RLE continued to offer design engineering and project management services, but now under a contract with London & Continental Railways. These changes are reflected in the project organization chart illustrated below.

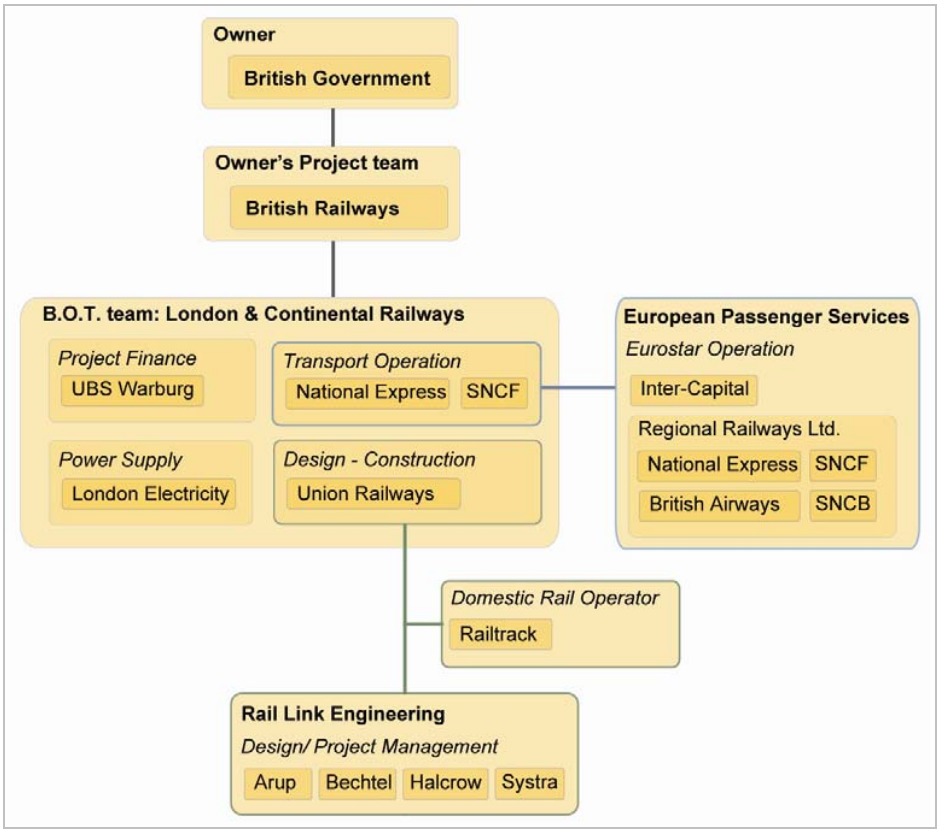


Figure 11: The re-structured BOT team organization

In view of the risk transferred to private-sector participants in both Eurostar and section 1 of the railway, the Government agreed to secure £3.75 billion of debt issued by London & Continental Railways in form of Government-guaranteed bonds. This securitization has provided two fundamental benefits. First, it enabled London & Continental Railways to finance the project at a very low annual cost of debt of 4.8%, saving up to £150 million annually over the original financing plan. Second, London & Continental Railways could extend the maturity of its debt significantly from 25 years

to 30, 40, and 50 with section 2. Also the project maintained its status as Government-supported rather than Government-funded, affecting the attitude of all the involved parties. Now finally the contractor selection could begin.

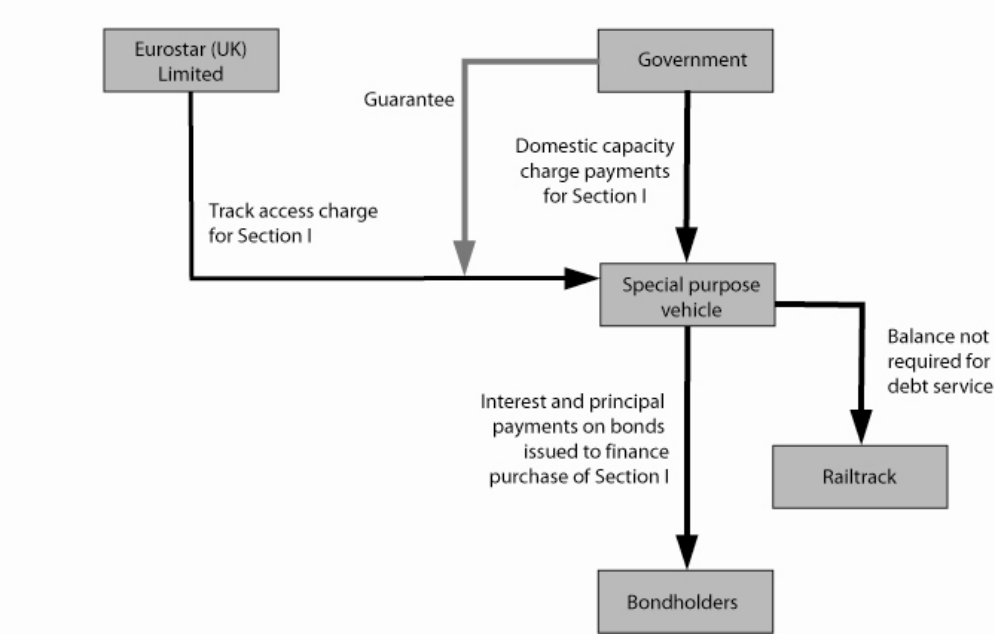


Figure 12: "Cash waterfall" structure for the securitization of the project's bonds

8. Partnering as an integrated solution for design and construction delivery

One of the big challenges for London & Continental Railways, as the concessionaire, was to select the form of contractor procurement. It was decided that the construction of Sections 1 and 2 of the Channel Tunnel Rail Link would each be broken into 16 sub-sections, each of which to be built in parallel by different local contractors. A panel was formed to study various contract types and the resulting implementation and performance of major projects in terms of cost and schedule. One of the issues that emerged in the root cause analysis of past projects was how to maximize contractors' profit and minimize cost. The only solution seemed to be the tying together of both the contractor and the owner in terms of cost and profit. This could be achieved by a target cost mechanism whereby both parties share the gain or pain when comparing cost with price. All of these guided the panel to propose the adoption of a partnering approach to project delivery as the option most likely to provide the best chance of successfully completing the project. The target contract with activity schedule was selected as the contract type, from the various contract options illustrated in the following chart.

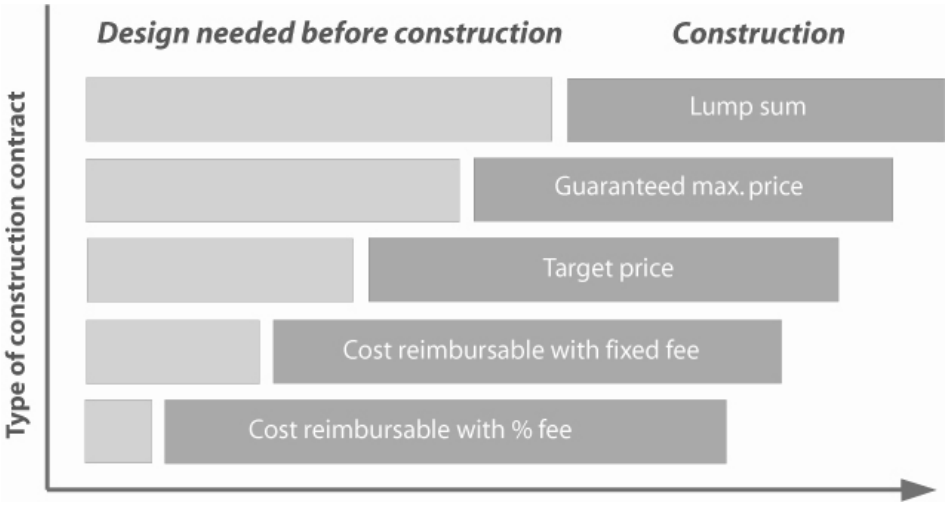


Figure 13: Various contract types and the relationship of design and construction time needed for completion

The partnering method worked as such: The project manager would invite for pre-qualification a number of contractors. At the moment of the bid, the project manager would have 30% design and a target price. When a contractor would be selected, they would work together with the project manager, Rail Link Engineering, in a way similar to design-build, taking the section of the project from 30% design completion to 60%, within a time frame of 6 months. Once 60% design was reached, the contractor together with the project manager would have a much better understanding of the costs and provide a target price for construction much closer to reality. If at this point one of the two parties would not want to continue in the actual construction, they would break the contract, but the contractor would get paid for the design work done. This is illustrated in the organization chart below. The complete organization chart can be found in the Appendix.

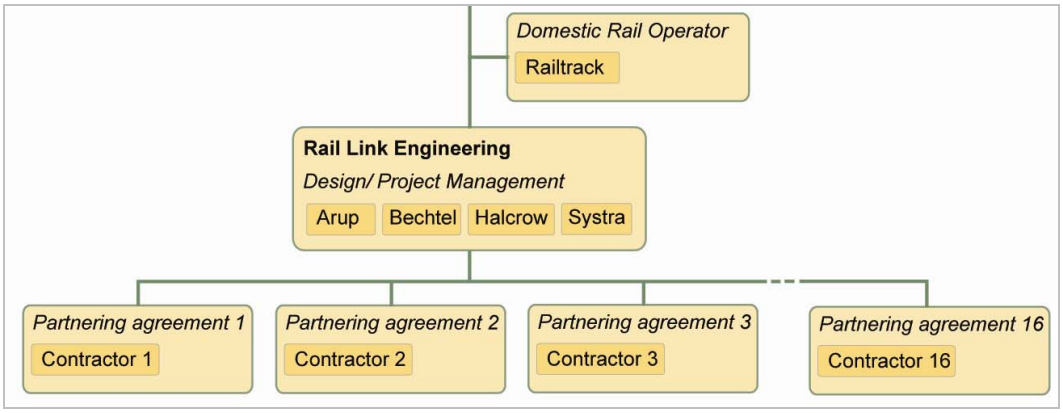


Figure 14: The organization chart of the partnering approach

A total open book approach would be made, reinforced by a single set of documents. Both teams would be co-located in a single set of offices, further reinforcing the

partnering approach. The details of the method would be facilitated through workshops, addressing awareness first and then specific problem solving. Everything would be supplemented by commitment to value engineering and an effective issue resolution process. One significant change made by the project manager, Rail Link Engineering, to the standard form of contract was to pay for the correction of defects, as long as they were identified timely by the contractor.

Going for the contractor selection, Rail Link Engineering decided to issue indicative quantities to save time during the bidding process. The project manager also offered site visits and presentations to all bidders concurrently. By offering all information and making the effort to communicate it as effectively as possible, Rail Link Engineering gave the clearest indication about their seriousness to the partnering approach. The individual bids were evaluated on three main elements: technical, commercial, and partnering. Especially the partnering was assessed against the following criteria: partnering experience; trust/ openness/ honesty; good neighbors; flexibility; business synergy; one-team approach; commitment to alliancing; personal chemistry.

It was very critical that construction made a safe and efficient start in October 1998, only three weeks after contract signing. Each of the 16 contractors who pre-qualified was appointed 6 months before the actual works started. Having a 30% complete design and a target price, Rail Link Engineering and the contractors held “early warning” meetings on a weekly basis for a period of six months. The project cost was analyzed in schedule/ time and risk component and broken into 6,000 items/activities. Contractual entitlement was established before either the project manager or the contractor determined the cost or the schedule impact of each item. A specialized risk assessment team identified individuals within the project who were the best ones to “own” these risks, based on expertise and experience. Interviews were held and every “risk owner” was asked to give three prices: what would be the expected cost of the item, what would be the cost in the best situation, and what would be the cost if everything went wrong. All of these prices were summed, distributed, and weighted in a computer model, and Monte Carlo simulations were performed to identify worst case scenarios and confidence levels.

This process was done in a cooperative and collaborative setting. The field engineering and construction groups discussed all aspects in an open and honest environment. This 6-month period resulted in a 60% complete design and a much greater understanding of the costs. It was after this time that Rail Link Engineering and each contractor signed the exclusivity agreement of the partnering process. It has to be noted that none of the contractors were dismissed. This procedure proved to be very important for the success of the project, and the error rate in Channel Tunnel Rail Link dropped by 75%, to 25% of the normal industry rate. Another key issue was the truly open book accounting. To ensure there was only one set of books, Rail Link Engineering produced the monthly payment assessment based on the one set, the logic being that if the project manager could not see the costs, it could not pay them.

10. Risk management

The target cost arrangements in place force all participants (client, RLE, and the individual construction contractors) to bear some financial risk. As a consequence of the financial exposure both to the client and Rail Link Engineering, the project has developed and implemented an active risk management program, encompassing both qualitative and quantitative risk management processes. The former was specifically developed on CTRL, and essentially comprises the following elements:

- Workshops with key project participants are held to brainstorm potential risks, their likely severity and consequences.
- The GATES risk database is populated with the potential risks.
- Risks identified are assessed for their likely severity and consequences.
- Management responsibility is allocated and risk mitigation plans and actions developed.
- Regular reviews are held to review progress with risk mitigation plans and actions, amend existing risks, add new risks, and update the risk database.
- Management of contractor risks is agreed between Rail Link Engineering and the contractor and the risks formally passed to the contractor as part of pre-construction activities.
- Progress with the closeout of project-wide risks is reviewed with Rail Link Engineering senior management at four-weekly progress reviews. The majority of the risk register is regularly reviewed by contract.
- Reporting of and progress with the risk management process is included in the project four-weekly report.

An overall risk regression curve plotting total risk severity over time is included in the report. The main benefits of the risk management process are that it documents good management practice, increases the visibility of risks, and encourages “ownership.” It also enables the project management team to focus effort and direct resources to dealing with the major project risks, whether through design change, alternative procurement or construction strategies, or insurance. The risk management process is also reviewed by the insurance companies involved. The project team has also implemented quantitative risk management tools, which aim to quantify the impact of cost and schedule risks. The quantitative risk analysis (QRA) was used for setting initial contingency and regular re-forecasting for monitoring of contingency draw-down.

The risk model is capable of assessing:

• The likely spread of total project cost (analysis is also available down to contract level),

• The level of project contingency required,

• The confidence in achieving the project completion date.

These tools are also used for scenario planning, to assess the likely impact on:

• The overall project final cost, based on possible fluctuations in the final costs of elements of individual contracts,

• The overall project completion dates for variations in the rates of construction progress; and cost and time implications of variations in the costs of elements of the works and cost overruns over time.

11. Information technology as system infrastructure

The main systems tools used on the CTRL are:

Procedures: These were developed to establish general guidance for the operation of the Rail Link Engineering project team. No individual firm had a set of procedures adequate for the CTRL, so many are project-specific. The aim is to give consistency of approach and ensure quality of service and product. The procedures form the basis of the QA audits and reviews undertaken by Government representatives, the client, and internal Rail Link Engineering auditors.

GATES: This central database, customized for use on the CTRL, stores all project information relating to items such as the risk register, site queries, commitments, and undertakings. Many other items are stored and the database can be interrogated by relevant groups within Rail Link Engineering.

DNA: The document navigation assistant (DNA) is a centrally maintained package of software containing all reference documents for the project, including all QA procedures, instructions, and standard forms. DNA is available to all Rail Link Engineering staff.

Data and standards: In parallel with the development of project procedures, Rail Link Engineering has also developed a library of in-house design standards and maintains an online library of design standards, including those of Railtrack.

Document management: The project has developed the *Infoworks* system for document management. This is an extension to the *Documentum* system, with additional features to both file and track receipt and issue of documentation. The system provides common access via the project network to the client, Rail Link Engineering, and contractors.

Further actions taken to ensure collaboration were to locate the project management and contracting staff in joint offices. Information transfer was much facilitated and the partnering culture enforced as the respective teams grew in size. Main site offices were created as open-plan layouts where staff was co-located according to discipline. A concern regarding the evolution of the team was that the integrity of the Rail Link Engineering people might be compromised once they were formally within the contractor's organization. There was a need for control in this environment to ensure that all members of the team maintained a balanced view of performance. A tool was also needed to benchmark performance on what had been already achieved.[8] After evaluating many options, the Balanced Scorecard approach by Harvard Business School professor P. Norton and Dr. R. Kaplan was selected. This choice offered the best method of communicating strategy using measurable goals and assessing success over time. By addressing financial and non-financial measures, and external and internal satisfaction by means of leading metrics, a balanced view of success was attained.

Figure 11: CTRL involved significant tunneling work

[8] Already a requirement of ISO 9001:2000.

13. The 2000 section 2 restructuring and cost-overrun protection

During 2000, Railtrack entered into financial difficulties and submitted a revised proposal for exercising its option and taking forward section 2.[9] These proposals were not acceptable to London & Continental Railways or to the Government as they would have increased the cost of taking forward section 2 by £560 million and diminished the amount of risk transfer to Railtrack. Instead, London & Continental Railways acquired Railtrack's share and put together a risk-transfer package for section 2 with a cost-overrun protection program developed and arranged by Bechtel. The program covered the first £600 million of cost overruns arising from the design, engineering, project management, and construction of section 2 above the target cost of these activities. This was equivalent to a 95% confidence level. Risk was shared between London & Continental Railways , Bechtel, Rail Link Engineering, and under an insurance program placed by a group of leading insurers.

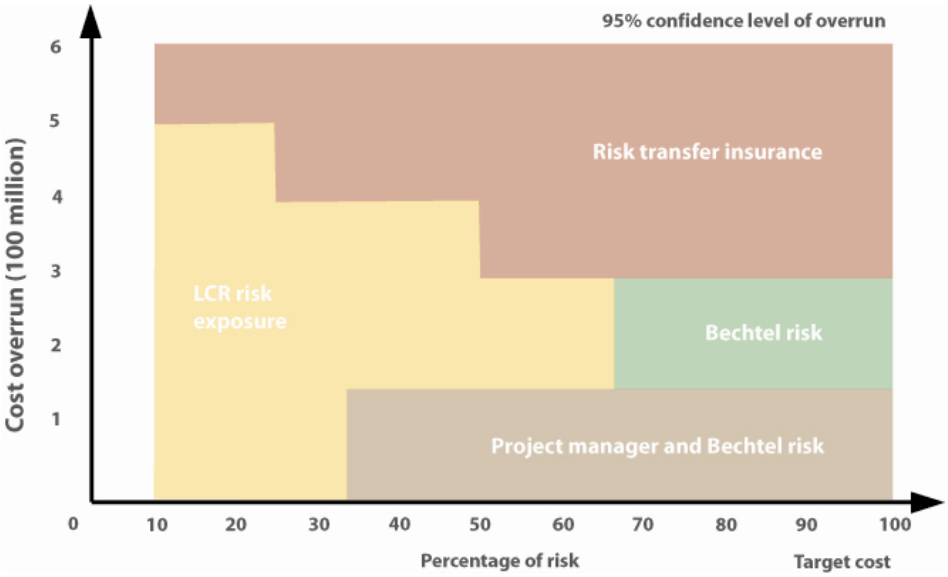


Figure 152: Cost overrun protection and risk sharing

The cost-overrun protection was highly innovative and unprecedented in scale. It exceeded all previous programs in the insurance market for cost overruns by an order of magnitude. The key to the structure was that Bechtel and Rail Link Engineering absorbed a substantial part of the first layers of cost overruns where, if they are going to materialize, they are most likely to do so. The insurers knew that the project managers and London & Continental Railways would suffer a significant loss before the insurers became liable to contribute. With this protection in place, the Government agreed to secure the remaining £1.1 billion of Government-guaranteed bonds for the section 2 financing.

[9] Railtrack soon after entered administration procedures (equivalent to filing for bankruptcy) and exited the project.

14. What is next?

In July 2003, the track of section 1 passed the official test and the Eurostar smashed the UK rail speed record with 334.7 Km/h. On September 16 of the same year, the British Prime Minister formally accepted the completion of section 1, and on the 28th commercial service commenced. At that time, section 2 was almost 50% complete. The track works are planned to be complete in June 2006 and then testing and commissioning will begin. The opening of section 2 is scheduled for the third quarter of 2007, at which time the Channel Tunnel Rail Link will become fully operational.

Essential to the successful outcome of a partnering approach in project delivery is the client/project manager's vision of what constitutes success. It is vital to establish a strategy early in the project's life for reaching the vision. At the completion of a project like CTRL, the next steps are to evaluate the experiences. What worked and what did not? Are they applicable for generalization, and to what degree? To what extent should the company's strategy be modified to incorporate lessons learned? Looking more specifically at risks and risk management, the main questions are: When and how should a design firm be an equity holder in a concession? Is partnering the best method to deal with all the risks involved in PFI/ PPP, and, while it manages existing risks, does it create new ones?

Figure 163: Section 1 of CTRL is finally complete

Appendix

A: Facts and figures

Distance
Channel Tunnel to St Pancras: *109km*
Section 1: Channel Tunnel to Fawkham Junction: *74km*
Section 2: Southfleet to St Pancras: *39km*
Distance in tunnel: *26km (25% of route)*
Maximum design speed: *300km/hour*

Performance: Section 1 (September 2003 to 2007)
Maximum use: *Up to four Eurostars/hour each way*

Journey times:
Waterloo to Channel Tunnel: *55 minutes*
Waterloo to Paris: *2 hours 35 minutes*
Waterloo to Brussels: *2 hours 25 minutes*

Performance: Whole line (2007 onwards)
Maximum use: *Eight Eurostar trains/ hour each way,*
Eight domestic operator trains/ hour each way,
Provision for freight traffic.

Journey times:
St Pancras to Channel Tunnel: *35 minutes*
St Pancras to Paris: *2 hours 15 minutes*
St Pancras to Brussels: *2 hours*

Tunnels
London Tunnels (Islington to Dagenham): *total 19km*
Longest single London Tunnel: *10.5km* (Stratford to Ripple Lane)
Thames Tunnel: *3km*
North Downs Tunnel: *3.2km*
Stratford Station Box: *1.1km*
Ashford International Station Box: *1.7km*
A Eurostar takes 38.4 seconds to go through North Downs Tunnel at 300km/hr.

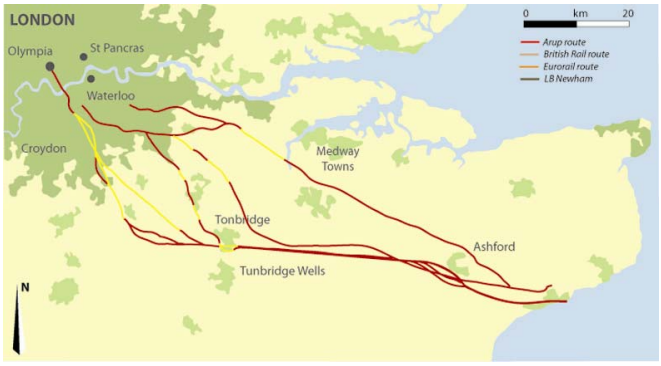
Bridges and viaducts
Rail bridges: *60*
Road bridges: *62*
Footbridges: *30*
Thurrock Viaduct: *1.3km* (beneath the Queen Elizabeth II Bridge)
Medway Viaduct: *1.2km* (alongside the existing and new M2 bridges, with a main span of 152m)
Ashford Viaduct: *1.4km* (over Great and East Stour Rivers and Ashford-Canterbury line)
The CTRL has a total of 152 bridges.
A Eurostar takes 15 seconds to cross the Medway Viaduct at 300km/hr.

Quantities
Ballast used: *850,000 tons*
General excavation: *14Mm3* (enough to fill London's Wembley Stadium 12 times)
Structural fill: *5Mm3* (formation of embankments/increased height of embankments)
Mitigation fill: *7Mm3* (formation of bunds for landscaping and to reduce airborne noise)
Material transferred to non-CTRL uses: *1Mm3*

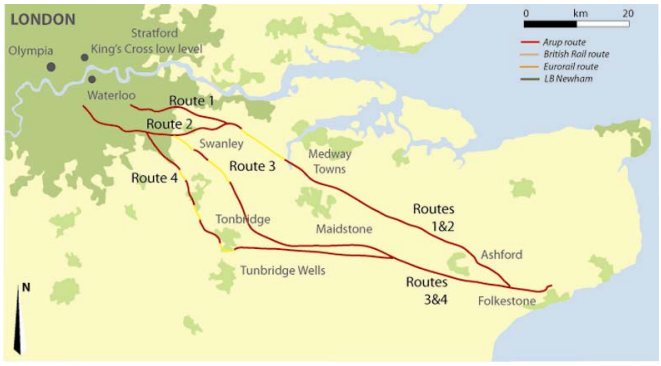
Total budget
£5.2 billion = $9.13 billion (exchange rate as of March 21, 2006: £1 = $1.75546)

The CTRL created 8,000 new construction jobs.

B: The evolution of the route

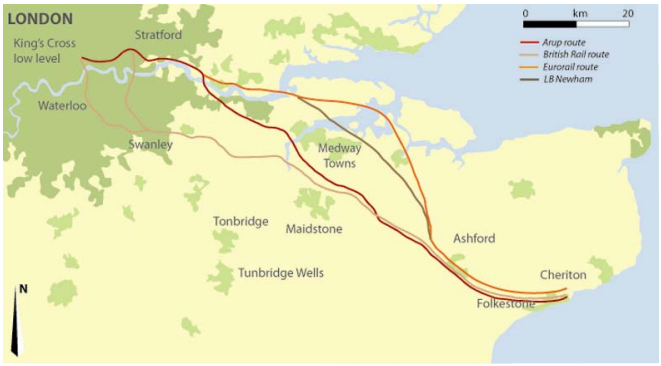


The 1974 proposed routes



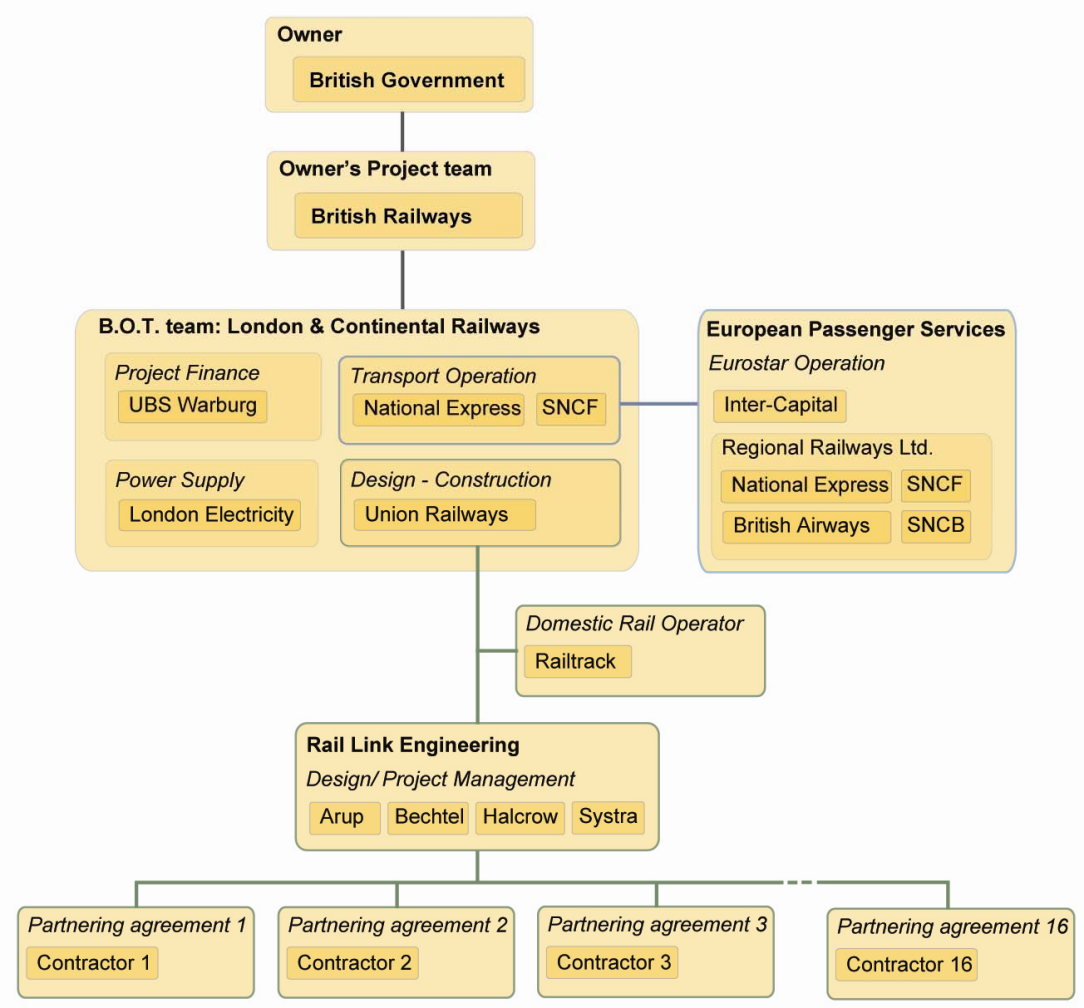
The 1988 proposed routes

The 1989 proposed route



The 1990 proposed routes

C: The complete organization chart of the BOT team after the re-structuring



D: Contracts Section 1

Contract 330: East Thames to the Medway Valley and Waterloo connection
Joint venture contractors: Alfred McAlpine, AMEC Civil Engineering Ltd

Contract 339A: Trackwork at Fawkham Junction
Contractor: GrantRail

Contract 339B: Upgrading works at Fawkham Junction
Contractor: Westinghouse Signals Ltd

Contract 339C: Power supply upgrade at Fawkham Junction
Contractor: Seeboard Contracting Services

Contract 340: Stratford & Ebbsfleet International Stations
Construction manager: Rail Link Engineering (for 13 trade contracts)

Contract 342: Highways work connecting A2 to Ebbsfleet station
Joint venture contractors: Hochtief (UK) Construction Ltd, Norwest Holst Construction Ltd

Contract 350: Medway Crossing
Joint venture contractor: Eurolink JV (Beton und Monierbau GMBH, Morgan Est plc, Vinci Construction Grands Projets)

Contract 361: Pipe diversions: Thames utilities
Contractor: J Murphy & Sons

Contract 365: Ripple Lane undertrack crossing
Contractor: AMEC Civil Engineering Ltd
Contract 410: North Downs Tunnel
Joint venture contractor: Eurolink JV (Beton und Monierbau GMBH, Morgan Est plc, Vinci Construction Grands Projects)

Contract 420: Mid-Kent: Boxley to Lenham Heath
Joint venture contractor: Hochtief (UK) Construction Ltd, Norwest Holst Construction Ltd

Contract 430: Ashford
Contractor: Skanska Construction UK Ltd

Contract 434: Railway infrastructure modifications
Contractor: J Mowlem & Co plc

Contract 440: East Kent-Ashford (town centre) to Cheriton
Contractor: Balfour Beatty Major Projects

Contract 550: Signalling, train control, and communications
Joint venture contractor: CCA (CSEE Transport, Corning Communications Ltd, Amey Rail Ltd)

Contract 552: Ashford resignalling
Contractor: Westinghouse Signals

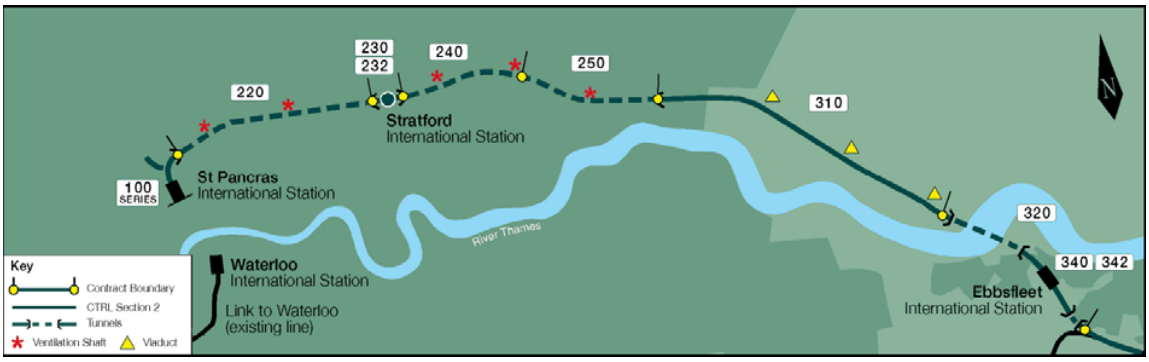
Contract 556: Signalling and control, Section 2
Contractor: CSEE transport

Contract 557 Communications systems, Section 2
Contractor: Optilan (UK) Ltd

Contract 570: Trackwork, catenary, mechanical, and electrical systems
Contractor: AMEC Spie Rail Systems Ltd

Contract CTRL M01 – Infrastructure maintenance, Section 1
Contractor: Carillion Rai

E: Contracts Section 2



Contract 102: Removal of gas holders and gas governer relocations
Contractor: Edmund Nuttall Ltd

Contract 103: Civil engineering works at King's Cross Railway Lands
Joint venture contractors: Kier Construction Ltd, Edmund Nuttall Ltd

Contract 104A: Signalling and associated telecommunications work on eastern track slew, St Pancras Station
Contractor: Westinghouse Signals Ltd

Contract 104B: Trackwork at eastern track slew, St Pancras Station
Contractor: Motherwell Bridge Construction

Contract 104C: Telecommunications for eastern track slew, St Pancras Station
Contractor: Tales Telecommunication Services Ltd

Contract 104E: Midland Main Line slewing at St Pancras Station
Contractor: Westinghouse Rail Systems Ltd

Contract 104F: Slewing of Midland Main Line to the west at St Pancras station
Contractor: Mowlem Railways

Contract 104G: Signalling and associated telecommunications for St Pancras Station
Contractor: Westinghouse Rail Systems Ltd

Contract 104H: Design and installation of overhead lines at St Pancras Station
Contractor: J Mowlem & Company plc

Contract 105 (combined): St Pancras Station
Joint venture contractors: Costain Ltd, O'Rourke Civil Engineering,Bachy Soletanche Ltd, Emcor Drake & Scull Group plc

Contract 124: Railway staging and interface enabling works at Kentish Town
Contractor: Railtrack Midland Zone

Contract 125: Camden Depot, York Way
Contractor: J Mowlem & Co plc

Contract 135: Highways and utilities diversions, St Pancras Station
Contractor: Edmund Nuttall Ltd

Contract 137: Lifts at the international stations
Contractor: Fujitec UK

Contract 138: Escalators at the international stations
Contractor: Otis

Contract 220: London Portal (edge of King's Cross Railway Lands) to Stratford Box
Joint venture contractors: Skanska Construction UK Ltd, Nishimatsu Construction Co Ltd

Contract 230: Stratford Box
Contractor: Skanska Construction (UK) Ltd

Contract 240: Stratford to Barrington Road
Joint venture contractors: Costain Ltd, Skanska JV Projects Ltd, Bachy Soletanche Ltd

Contract 250: Barrington Road to Ripple Lane
Joint venture contractors: Edmund Nuttall Ltd, Kier Construction Ltd, Wayss & Freytag Ingenieur Bau AG

Contract 302: Diversion of utilities at Thames & Kent Avenues: Ford Motor Company
Joint venture contractors: Alfred McAlpine, AMEC Civil Engineering Ltd

Contract 303: Ford and Choats Manor Way bridges
Contractor: Kier Construction Ltd

Contract 310: West Thames: Ripple Lane to Thames
Joint venture contractors: Morgan Est plc, Vinci Construction Grands Projets

Contract 320: Thames Tunnel and route civil engineering works
Joint venture contractors: J Murphy & Sons, Hochtief Aktiengesellschaft

Contract 576: Track and overhead catenary systems, Section 2
Joint venture contractor: ACT JV (Alstom Transportation Projects Ltd, Carillion Construction Ltd, Travaux du Sud-Ouest)

Contract 588: Mechanical and electrical systems, Section 2
Joint venture contractor: EMCOR Drake, Skull Group plc

References

www.ctrl.co.uk
www.arup.com
www.bechtel.com
www.systra.com
www.halcrow.com
www.rail.co.uk

Batchelor, Charles. "Eurostar accelerates towards break-even: London & Continental Railways seeks to raise L1bn in new equity in stock market flotation." *Financial Times* [London edition], July 9, 1997.

Batchelor, Charles. "Rail link problems denied as costs rise by £1.4bn." *Financial Times* [London edition], October 18, 1997.

Batchelor, Charles, and CharisGresser. "Warburg snubbed over LCR rescue." *Financial Times* [London edition], February 9, 1998.

Cohen, Norma. "Transport: the missing link." *Financial Times* [London edition], February 7, 2003.

Glover, Mike. "The CTRL and Arup: Introduction to the history." *The Arup Journal,* 1/2004

Gresser, Charis. "Troubles threaten credibility of shareholders." *Financial Times* [London edition], January 30, 1998.

Plowden, Stephen. "Coming soon: The Dome on wheels." *New Statesman*, April 2, 2001, 25-27.

Rees, Jon. "Lines are drawn in battle for Eurostar." *Marketing Week*, February 9, 1996, 22.

Rich, Motoko. "Aitken-Davies to navigate rail link toward flotation." *Financial Times* [London edition], October 29, 1996.

Rich, Motoko. "Removing the shadow of Eurotunnel doubt: Channel link builders hope investors are still interested in developing a high-speed connection: [London edition]." *Financial Times*, November 16, 1996,

Taylor, Andrew. "Fragility in the concrete jungle: Turmoil in financial markets has forced a re-evaluation of several projects but demand for private sector funds will remain high. Andrew Taylor reports." *Financial Times* [Surveys edition], September 23, 1997.

Weston, Peter. "PFI on the line." *Project & Trade Finance*, March 1, 1995, 3.

Wright, Robert. "LCR working on break-up plan for a year." *Financial Times* [London 1st edition], February 20, 2006.

"Banks square up for L1.6bn Channel Tunnel mandate." *Euroweek*, December 6, 2002, 1,64.

"The Channel tunnel: Invasion route." *The Economist*, June 24, 1995, 63.

"Channel Tunnel Rail Link." *Railway Gazette International*, September 1, 2004, 637.

"CTRL smashes all records with $4.4bn guaranteed bond issue." *Asset Finance International*, March 1, 1999, 14.

"High speed sale for LCR Channel Tunnel rail ABS." *Euroweek*, November 10, 2003, 1,73.

"HSBC, WDR win coveted mandate for first tranche of Chunnel Link financing." *Euroweek*, December 18, 1998, 18.

"Rail Transport: No State Aid Involved in Channel Tunnel Link, Says Commission." *European Report*, May 1, 1996, 1.

"Sterling stymied by silence on L2.65bn CTRL." *Euroweek*, January 15, 1999, 4.

"Will Virgin nous save Eurostar?" *Marketing Week*, March 5, 1998, 5.