Missing Links

Upgrading Europe’s Transborder Ground Transport Infrastructure:
A Report for the Roundtable of European Industrialists
Contents

Foreword: Statement by the Roundtable of European Industrialists .......................... 1
Introduction .................................................................................................................. 3
Large-scale Infrastructure Projects: lessons from the past financing future projects 5
EuroRoute .................................................................................................................. 12
The Scandinavian Link .......................................................................................... 21
High-speed Train Links ......................................................................................... 29
Alpine Links; note on status of proposed projects .............................................. 42

Appendix 1  Information Sources. Data. Bibliography.

General questions on this report, in addition to those specified in Appendix 1, can be addressed to:
Roundtable Secretariat Paris Office
49 Avenue d'Iéna
75116 PARIS
(France)
Tel: (33) 1 723.72.62
Tx: 613977
Foreword

Statement by the roundtable of European industrialists

On a continental scale, deficiencies in Europe's ground transport system constitute an effective barrier to European economic and social progress.

Europeans have enjoyed enormous improvements in their national road and rail infrastructure in the last 30 years. But these improvements have not been matched in cross-border transport provision. Europe's railways suffer from incompatible technical standards and poor services between major European cities. The motorway system is good in central Europe and within national borders, but some key connections to the rim of the continent are not satisfactory—UK, Scandinavia, Italy, the Iberian peninsula, the Balkans.

The Roundtable of European Industrialists has special reason to be concerned at these cross-border weaknesses. To be competitive, Europe's industry must extract more productivity from its invested capital. Europe's international businesses must not be prevented from achieving economies of scale and optimum marketing and manufacturing strategies by shortcomings in transport and unnecessary frontier bureaucracy. Equally, Europe can only become a thriving, unified market if there is the freest possible movement of goods, people, capital and ideas.

It is for these reasons that the Roundtable decided one year ago to examine the continent's ground transport system and to review projects offering the necessary European-scale benefits.

The result is this report: Missing Links. The projects which form the core of the report (Anglo-French Channel road/rail link, Scandinavian road/rail link to Northern Germany; a European high-speed train network) have a number of things in common. Each would bring major economic and industrial benefits to the countries directly involved. Easing cross-border flows, they all offer major travel time improvements—Scanlink, for example, cuts road and rail journey times from Oslo to the centre of Europe from around 25 to 10 hours. They all, if in varying degrees, involve opportunities to apply European technology and develop export potential; this is particularly significant in the case of high-speed trains, both wheel-on-rail and magnetic levitation.

In focusing on three specific link projects, the report's contents are illustrative and selective, but a clear message does emerge. This is that not only are such projects desirable in terms of their economic and social impact, but they are affordable, and can be profitable, environmentally acceptable and financeable without heavy extra commitments to public spending.

However, from the Roundtable's point of view, perhaps the most notable point which emerges from the report is that all these link projects and others which could be named become more attractive, in financial terms, if they are considered as part of a coherent European-scale programme. The viability of a high-speed train system in Europe, for example, would be greatly enhanced by the existence of a suitable cross-Channel link. This is true also for Italy; it is clear that a comprehensive European high-speed train network would require one or more new Alpine crossings or the upgrading of existing ones.
A 20-year $60 Bn programme to build the three schemes described, plus a high-grade TransAlpine link, would have employment benefits. Building the Anglo-French road/rail link, for example, would call for 100,000 jobs for five years. But the most important employment stimulus of a Missing Links programme would not arise from construction work. Through its obvious contribution to improving the climate for business in Europe, a Missing Links programme would save some jobs as well as creating others for the future in a wide range of industries, services and regions.

A crucial point about the link projects is that some could be financed in very large measure by the private sector. If governments were prepared to set the right investment climate in terms of fiscal incentives and operating licences, the money could be raised. Missing Links contributes some ideas on specific investment vehicles, such as the EuroShare concept, which could ensure the success of private fund raising.

Although Europe has become culturally programmed to see large transport infrastructure projects as the preserve of government, there is no reason why this should be so. The transport system which underpinned the first industrial revolution was largely conceived and paid for by the private sector. The bulk of US transport infrastructure and utilities is still today financed by private capital.

Equally, the widespread notion that big transport programmes inevitably lose money and require large subsidies is not borne out by the evidence. Several major projects in recent years have paid handsome dividends to their financial backers. The Mont Blanc tunnel, the bridges and tunnels of the New York and New Jersey Port Authority are among them; the French National Railways Train à Grande Vitesse seems to be proving a promising investment. There are also operational benefits in placing certain transport systems in independent hands. There are many precedents for neighbouring countries or local governments co-operating to this effect—the New York Port Authority, the Scandinavian Airlines System.

Providing the Missing Links in Europe’s road and rail infrastructure addresses a market demand, but also goes further. With additional link transport infrastructure, Europe’s economic potential can be raised by improving the operating conditions for its industrial and commercial companies. From an international business point of view, a Missing Links programme could prove to be one of the soundest and most practical investments in the foundations for Europe’s industrial and commercial future.

The Roundtable of European Industrialists
December 1984.
Introduction

Without better international transport links, Western Europe cannot become a fully efficient market for goods and services.

This fact may not be so blindingly obvious as it was in earlier generations when roads, waterways, railways and air routes were laid out to remove bottlenecks in the way of industrial and social progress. But it remains true.

In the last 30 years, trade between European countries has increased dramatically, but the transport infrastructure to support this growth has been, for the most part, conceived and executed at the national level. The result is that most countries in Western Europe now have excellent internal road networks, adequate airport facilities and good national rail systems. But the connections between the fixed links of different countries—the roads and railways—remain haphazard and at many points unsatisfactory.

This is scarcely an original observation. Plans for a fixed link across the Channel to connect Britain and France have existed since the 19th century. The Alpine states have spent decades debating the need for additional crossings between Italy, Austria, Switzerland, Germany and France; and a group of business and government interests has been active since 1962 in pressing for a bridge or tunnel to link Southern Denmark with Northern Germany. The talk, however, has not been matched by action.

This is hardly surprising. Bridges and tunnels across mountains and seas are expensive, politically controversial and environmentally suspect. A Channel crossing would cost somewhere between £3 Bn and £6 Bn. To connect Germany and Denmark across the Fehmarn Belt would cost around £1.5 Bn. At the end of a decade of low economic growth, it would be remarkable if Western European governments possessed the self-confidence necessary to take on such major projects, even if they were ideologically predisposed towards major public spending initiatives in the first place, which some are not.

But even the opponents of schemes like the Channel tunnel and the Fehmarn Belt crossing seldom argue that such additional links between countries are undesirable; merely that they are too expensive, too risky or too politically problematic.

From a strictly industrial point of view, the creation of new, fixed transport links between European countries would speed distribution, permitting more efficient manufacturing systems. This in turn would raise the capital productivity of European industry. But strengthening Europe's transport connections would do more than this. It would be a force for integration, fostering more cohesive markets for all of business, not just those companies heavily dependent upon physical goods distribution.

Today, 27 years after the Treaty of Rome, West Europeans are four times more likely to make a long journey within their own country than to make a similar journey crossing a national frontier. Europe is a market of 360 million people still waiting, in some respects, to be served effectively by the continent's own industrial companies. The failure to integrate markets, the fragmentation, goes to the heart of Europe's most pressing economic and employment problems.

The aim of this report is to show that some of the proposals for European-scale ground transport links, although large and ambitious, are good business and political risks. To support this conclu-
sion, the report examines three specific proposals for transport investment:

- **EuroRoute**—a Channel link between England and France.
- **Scanlink**—a plan to fill in the road and rail gaps between Norway, Sweden, Denmark and Northern Germany.
- **Proposals for a transEuropean network of high-speed trains.**

The report contains a less detailed review of various proposals for additional Alpine links.

The group responsible for the report has reviewed a wide variety of questions, from technology to traffic forecasts. It has also attempted to apply some new thinking on alternative ways of financing major projects, through concepts such as a "EuroShare" applied to the transport sector. Detailed financing propositions have not been presented for the projects, since that would not be appropriate in a report of this nature. The details of how to finance the projects are a matter for the project promoters. But for the Channel link, the most advanced of the projects, an attempt has been made to describe a number of approaches which might unlock the logjam currently preventing agreement on a financial programme.

The report begins with a review of some recent examples of major infrastructure projects, involving both the public and private sector. Some general ideas on financing future projects are then advanced, before moving on to description and analysis of the three major projects selected as examples of what could be successfully achieved.

The working group responsible for this report was chaired by Albrecht Doehler (Siemens AG); in the early stages of the work, November 1983–February 1984, Bo Ekman (AB Volvo) was Chairman. Special advisers were invited to join the group and consultancy services were commissioned from a number of technical, engineering and business advisory organisations.

General responsibility for the opinions expressed and statements made in the report is assumed by the working group Chairman, Albrecht Doehler. Specific responsibilities are assumed by the following members and special advisers:

- Kenneth Groves
  (EuroRoute Consortium)  Channel Link (EuroRoute)
- Rolf Umbach
  (Thyssen Industrie)    High Speed Trains
- Bo Ekman/Per-Erik Jevne
  (Volvo)                Scandinavian Link

The sections "Lessons from the past" and "Financing future projects" were written from inputs compiled by the Paris office of the Telesis consultancy firm, drawing on advice and comment from group members and other sources. Ian Hargreaves was appointed by the group to provide editorial services in the compilation/format of the final report.

December 1984

**Note on currencies:** Since this report deals with figures in several currencies assembled over a period of some years, it would be inaccurate to convert them all to a single currency, desirable though that would be for ease of comparison. Consequently, the figures for each section are given in the currency used in the various source documents and research available to the working group.
Large-scale infrastructure projects

Lessons from the past

For the institutional investor or banker, the financial evaluation of infrastructure projects is complex.

Infrastructure projects, in investment terms, have little in common with industrial projects. They have a longer life, involve larger capital sums, have lower operating costs, are vulnerable to different types of risk and exist in an entirely different competitive environment.

As a result of these differences, infrastructure projects exhibit unusual cash flow characteristics and their profitability must be viewed on different terms from that of industrial investments.

Chart 1

Cash Flow illustrations: Industrial and Infrastructure Investments

Typical Industrial Investment

Typical Infrastructure Investment

Cumulative cash flow

In terms of project life, industrial investments are likely to have a short horizon, because markets and technology change rapidly to create obsolescence. Naturally, prudent investors seek a correspondingly short—normally less than 10 years—payback.

New pieces of infrastructure, whether for transport or utilities, however, may well last 50 years or more. Indeed, part of Europe's infrastructure problem is that its main transport arteries were defined in the first industrial revolution.

Construction of infrastructure is also expensive and time-consuming, which points to the main risk associated with this type of investment; that it will over-run its construction schedule and end up costing many times more than the original budget.

Because initial costs are high, construction slow and utilisation stretched over a long period, infrastructure projects financed by debt are bound to incur heavy financing charges and take a long time to pay back their investors. To ask investors to advance very large sums of money against the expectation of a return in the uncertain conditions of perhaps 20 years into the future presents a major problem. It is the main reason why, in recent decades, nearly all of Europe's infrastructure has been financed directly by government; or if not directly, finance has normally been government-guaranteed. But it is worth remembering that a good deal of the original hardware of the road, rail and waterway system laid down in Europe and North America in the late 19th and early 20th centuries was financed by private subscription in one form or another, and that in the United States, private sector finance of both transport infrastructure and utilities is still the norm. The fiefdoms of the original coal, steel and rail barons merged easily into one another because they shared the understanding that to market successfully, it is essential to have the right transport network.
It must also be remembered that a comparison of infrastructure investments with those in the industrial sector does not all work out to the latter’s advantage. Many infrastructure projects, for example, have low operating costs. Once a new road, bridge or tunnel is complete, it does not cost much to run it. Industrial items depend upon high recurring costs for raw materials, labour, energy and many other inputs.

Also, infrastructure projects are often relatively safe from competition for long periods of time or even indefinitely. It makes sense to build one Channel link, but not two. Although transport infrastructure will face competition from alternative services, such as air versus road or rail, there will often be clear segmentation of the market, creating a greater degree of predictability about demand (traffic flows) than exists for demand for most industrial products.

Two European infrastructure projects—the Mont Blanc Tunnel and the Paris–Lyon Train a Grand Vitesse (TGV) illustrate these points.

The Mont Blanc Tunnel:
When the Mont Blanc tunnel opened in 1966, the cost of the French half alone (FF 142 m) was double the original estimate in real terms.

In spite of this, the Mont Blanc tunnel has been highly profitable. Although tolls have declined by an average of 2 per cent a year in real terms since 1965, the tunnel has generated a positive cash flow after financing charges from its first full year of operation.

However, because the original investment included only FF 41 m in equity—the rest was debt—the economics looked shaky in the early years. The total sum invested continued to increase, financed by additional debt, until 1969, when it reached FF 168 m. In this year, debt reached a peak of FF 121 m.

As traffic increased—truck traffic grew by an average 20 per cent a year from 1966 to 79—revenues also rose sharply. The cash flow and debt profile at constant 1982 prices is illustrated in Chart 2. By 1977—year 12 of operation—the French concessionaire had generated over FF 400m of cash (1982 prices)—a sum equivalent to the peak debt figure. By 1979 (year 14), it had generated net income of FF 582 m, after financing charges, which is more in real terms than the project’s total investment. By 1982, all debt had been paid off and net cash flow before dividends stabilised at FF 80 m to FF 100 m a year.

### Chart 2
**Mont Blanc Tunnel: French Section 1982 Constant FF millions**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost Structure</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>2.5</td>
<td>55</td>
</tr>
<tr>
<td>1981</td>
<td>6</td>
<td>57</td>
</tr>
<tr>
<td>1982</td>
<td>55</td>
<td>34</td>
</tr>
</tbody>
</table>

- 25 11 25 2 2 Debt repayment
- 19 14 8 1.4 0.6 0.4 Interest
- 3.5 2 2 1.1 1.1 Operating costs + taxes

**Cumulative net income after financing charges**
- **Net income less financing charges**
- **Total revenues less operating costs + taxes**

- **Return on equity**
- **Total assets less non-interest bearing current liabilities**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt</td>
<td>1400</td>
<td>1200</td>
<td>1000</td>
<td>800</td>
<td>600</td>
</tr>
</tbody>
</table>

**Chart 2 Diagram**

- Cash Generation
- Financial Returns

6
A project which can clear its debt within 17 years and, at low operating costs, deliver thereafter a steady income flow of twice the equity holders’ original stake is obviously attractive. As Chart 2 shows, the Mont Blanc tunnel is today a highly lucrative investment for its original French backers. Returns were low for a decade, but rose dramatically beyond that point to be in excess of 100 per cent a year; and this level of income should continue until around 2035.

Yet, looking at the project from the investor’s viewpoint in the early 1960s, even with the benefit of information about what actually happened, it can be seen that a cautious investor would have taken some persuading to stump up his money.

The net present value of an investment of FF 140 m in 1965, less the annual cash flows after operating costs and tax but before financial charges, dividends or debt repayment, is minus FF 5 m, if the investor had assumed a 10 per cent discount rate over 15 years. Only by extending the period beyond 15 years does the project show a positive net present value at discount rates over 10 per cent. To back infrastructure projects, investors must be prepared to take the long view.

<table>
<thead>
<tr>
<th>Year</th>
<th>10%</th>
<th>15%</th>
<th>18%</th>
</tr>
</thead>
<tbody>
<tr>
<td>-52</td>
<td>-97</td>
<td>-53</td>
<td>-29</td>
</tr>
<tr>
<td>-81</td>
<td>-36</td>
<td>+2</td>
<td></td>
</tr>
<tr>
<td>-72</td>
<td>-5</td>
<td>+44</td>
<td></td>
</tr>
<tr>
<td>-65</td>
<td>+23</td>
<td>+91</td>
<td></td>
</tr>
<tr>
<td>-53</td>
<td>+63</td>
<td>+160</td>
<td></td>
</tr>
</tbody>
</table>

The Paris-Lyon TGV:
This project involved building an entirely new 426 km railway line between Paris and Lyon, compared with 512 km for the old line. With trains running up to 300 km/h, the Paris-Lyon journey time was reduced from over four to just over two hours. Construction began in 1976 and the first phase of operations started in 1981, reaching completion at the end of 1983.

The cost of the TGV project was FF 11.6 bn (1982 prices), of which rolling stock accounted for FF 4.6 bn and infrastructure FF 7 bn. These costs, in real terms, were one per cent over budget for infrastructure and 4 per cent for the rolling stock.

This year (1984), the first full year of operation, the project is in line to create a cash surplus after all operating costs and finance charges—it is entirely debt-financed—of FF 1 bn.

Debt for the project peaked in 1982–83 at FF 15 bn, but with net cash flows growing strongly, it is expected to pay back its investment between 1988 and 1992—within ten years of coming into operation and 15 years after construction started (these figures assume an average interest rate of 12 per cent).
What were the reasons for the success of the Mont Blanc and TGV projects? There is one critical element. Both offered users a major improvement in service compared with existing links. The Mont Blanc tunnel connected with the initial network of French autoroutes to offer large journey time savings, especially for goods traffic. The TGV almost halved the rail journey time between two key centres and was competitively priced. Cheaper than air and faster than road, the TGV has established a strong position in its market, especially since even with a cut in air fares, many passengers would still choose rail on grounds of convenience.

These two cases also provide some reassurance that success in infrastructure investment is not limited to periods of high economic growth, low interest rates and low inflation. These conditions certainly help infrastructure projects, but they are not essential. The chief requirement is to select projects well and to understand the economic forces at work. French autoroutes, for example, continue to be supported by toll revenue, but now that the main network is complete, the subsidiary routes still being built are incapable of financing themselves if funded entirely from debt.

Today, it costs FF 20 m (1983 prices) to build one kilometre of autoroute, compared with FF 16 m in the late 1960s. Borrowing conditions have also worsened dramatically. Together, these factors meant that the breakeven level for a new stretch of road more than doubled between 1968 and 1982–83 from 16,400 vehicles per day per km to 43,300 vehicles/day/km.

Since the highest traffic density on any French autoroute is 24,000 vehicles/day/km—as on the major north-south autoroute—it is not possible any longer to finance new autoroute entirely by debt.

Likewise the Frejus tunnel, which links Italy and southern France on the Turin–Lyon axis, was completed in 1980 and still has inadequate cash flow to meet its debt repayments. Frejus, like the newer autoroutes, is a subsidiary link, but even this tunnel should eventually pay off its debt if only because inflation will increase the value of its income stream against debt fixed in nominal terms.

**Financing future projects:**

Clearly, the traditional financier's manual, weighted in favour of short, higher risk projects or longer-term, risk-free opportunities, is unlikely to contain a sympathetic chapter on infrastructure projects. It is difficult enough for investors to evaluate an income stream which lies 15 or 20 years down the road, but close to impossible when that income stream is subject to a high degree of uncertainty, as is the case with major transport infrastructure projects. Although in some fields, such as gas pipelines, investors can cover themselves by demanding take-or-pay contracts from the customers of the pipeline, this option is not available in the transport field.

Faced with these difficulties, promoters of infrastructure projects must look for other sources of funds. Governments have been the main providers in recent European history, but there are other potential ways of obtaining funds for infrastructure projects.

One avenue is the concept of a portfolio of infrastructure investments, such as the one held by the Port Authority of New York and New Jersey, which was set up in 1921 to make improvements to terminals, transport links and other commercial facilities in the New
York area. It raises capital by issuing tax free bonds; it borrows against the security of its revenues and it draws its income from tolls, fees and rents. Although financing was initially linked to single projects, the Port Authority now raises finance by consolidated bonds secured on its revenues as a whole. This debt is not guaranteed by state or federal government.

The authority has assembled a highly effective package of assets, ranging from the Manhattan World Trade Centre to its three airports. The financially strong parts of the portfolio, like JFK airport and bridges and tunnels, support the weak, such as New York City's bus services.

A similar principle has been applied on a smaller scale in France, where cash flows from the early autoroutes, the Mont Blanc Tunnel and the Pont de Tancarville across the Seine at Le Havre, have been used to finance feeder autoroutes. The device enables the investor—the portfolio authority—to take the long term view. It also permits a degree of integrated thinking about transport systems. As discussed later in this report, the financial viability of the proposed high speed train network is greatly enhanced if a suitable Channel link is built. Likewise, the case for various fixed links involved in Scanlink is enhanced by examining transport patterns across the entire geographical region. As a regional system, Scanlink has higher traffic potential than the sum of individual projections which have been made for its various fixed links.

Is it possible to imagine groups of portfolios of European transport investments, based on profitable "core" projects? It may sound fanciful, but the history of the New York-New Jersey Port Authority demonstrates that it is not without either historical precedent or business sense. The example of SAS, the Scandinavian Airlines System, demonstrates that international membership is not an insuperable problem for the creation of such consortia.

Another avenue (an equity capital avenue for individual projects) is that of "EuroShare". The EuroShare concept is a response to the notion that at a time when governments either cannot or will not embark upon major infrastructure investments, ways must be found of financing such enterprises through the private sector, with only limited government support.
Essentially, the idea is that government should offer incentives to the private sector in the form of tax concessions. The terms of the concessions would vary from case to case and probably within an individual project and between different stages of risk. The biggest tax concessions would be reserved for early, risky parts of any venture.

EuroShares could be either pure equity or a mixture of debt and equity and could be quoted on stock and bond markets in the countries directly involved in or affected by the project. How the EuroShare might work in a detailed case is being tested within the EuroRoute consortium (see EuroRoute Section—Financing EuroRoute).

Although the Euroshare, which might be sold through a variety of outlets from savings associations to PTTs, could be applied to any sector of investment, it is particularly suitable for infrastructure financing.

By introducing private sector capital, Euroshare would offset public sector debt or government-guaranteed debt, while encouraging construction of links which are of major economic benefit to Europe and therefore in the long term exchequer and political interest of all governments.

There are plenty of precedents in Europe, not to mention the US, for tax incentives towards investments in desirable projects. Currently the UK’s Business Expansion Scheme is offering high tax payers a tax break for their investments in growing companies, but that is only a recent and rather novel example. The principle of tax concessions for savings is common to most developed countries; the rebuilding of Berlin after the war was stimulated by a wide range of tax concessions; Norwegians have been encouraged to invest in parts of the country’s oil industry with the aid of tax concessions.

In the case of infrastructure investment, Governments know that they are bound to be involved at some level, even if not as the direct financier of projects. Since major transport links tend to be monopolistic in character, governments are bound to want a say in the regulatory regime which should accompany any project. A Euroshare prospectus would be an ideal place in which a government could set out the terms on which a group of promoters could build and operate any transport link and over what period. To see the terms of an infrastructure concession set out in this way in public and in a legally binding document would in itself be a useful encouragement to the private sector to become involved.

Once Euroshares were in being—traded widely in the same way as other bonds—it is not too difficult to envisage one project spinning off the funds to finance other infrastructure projects, as in the New York Port Authority model.
The Euroshare Concept and European Infrastructure Investments

THE PROBLEM
Many large-scale European transportation infrastructure projects are caught in a financing trap...

- Private risk capital
  - Dissuaded by long payback

- Large scale infrastructure projects
  - Projected returns are satisfactory, but long-term
  - And high risks
    - cost overruns?
    - completion guarantees?

- Government
  - Public sector financing constraints
  - Unwilling to give guarantees

- Long term debt
  - Banks will not issue without govt guarantees

... Where such viable projects clearly contribute to European economic development, the financing trap must be cleared.

SOLUTION?
Reduce public sector exposure; reduce exposure of long term lenders; attract private risk capital with Euroshares.

What is EUROSHARE?
- A new financial instrument to attract private risk capital
  (for large-scale infrastructure projects)
- Equity or mixed debt/equity
- Issued directly by project operator (those holding the concession to operate)
- Widely tradeable through many channels—stock markets, banks, savings associations
- Carrying tax concessions varying according to the risk/attractiveness of the project, and the project's contribution to European economic development.
EuroRoute

A fixed link across the Channel between England and France has been a glimmer in the eye of engineers and transport planners since early last century. Since that time many schemes have come and gone.

Today, however, conditions are ripe for the Channel crossing to become a reality because of the dramatic increase in cross-Channel traffic in recent years. In the last decade, cross-Channel road haulage movements have grown fivefold and the number of Channel car crossings has more than doubled. Since Britain joined the Common Market in 1973, its exports to Europe have grown from £4.2 bn a year to £30 bn a year. Imports have grown at a similar pace.

Noting these trends, the British and French governments in 1980 invited a new round of proposals for a Channel link. The result, in the end, boiled down to competition between two concepts: EuroRoute and a rail-only tunnel.

The main obvious advantage of the rail-only option is its cost. At around £2 bn, it is under half the cost of the £4 bn to £4.4 bn it would take to build EuroRoute’s combined road and rail facilities.

But the idea of a rail-only tunnel has many shortcomings. It would mean road vehicles piggy-backing upon rail vehicles, which would offer road hauliers and motorists no significant advantages over the present ferry service. It would also place the fragmented and independent road transport industry under the control of the railways. Moreover, as opinion polls in both Britain and France have shown, a combined road and rail crossing is clearly preferable to the general public. Traffic forecasts also indicate that a rail-only tunnel could not cope with the scale of business projected for the early part of the next century: it would rapidly become a bottleneck, eased only by greater reliance upon ferries.

Equally, however, a road-only option—some promoters have suggested a road bridge—would be inadequate. Railways have an important role as high-speed passenger carriers and for the movement of heavy freight.

![Chart 5](image_url)

Where EuroRoute would cross the Channel

- INSHORE SHIPPING - TWO WAY
- MAJOR SHIPPING - ONE WAY
- SHIPPING SEPARATION ZONES
- NON-NAVIGABLE AREAS
- VENTILATION ISLANDS
- SURFACE RAILWAYS
- TUNNEL RAILWAYS
- SURFACE ROADS
- TUNNEL ROADS
EuroRoute is designed to use proven technology to meet the needs of the cross-Channel market. It would span the 36 kilometre distance between Kent and the French coast with a mixture of road bridges and submerged tube tunnels.

The bridge spans would carry road vehicles to two man-made islands; one 11 kilometres from the English coast, the second 7 km from the French coast. From there, vehicles would descend a spiral roadway into tunnels connecting the two islands. In between the two road tunnels, a rail tunnel would carry both a potentially high-speed railway and air ducts for the road tunnels. The railway tunnel, unlike the road tunnels, would not surface at the offshore islands, but would continue underground to the mainland.

Nothing in the EuroRoute design calls for new or risky construction methods. Submerged tube tunnels, whereby pre-fabricated tubes are set into dredged trenches in the sea-bed, avoid the danger associated with rock tunnelling of unpredictable geological occurrences. Submerged tube tunnels have been built all over the world, one of the most recent successes being the 1.5 mile Baltimore Harbour tunnel, which has just been completed to time and cost by one of the EuroRoute associates, Raymond International. San Francisco’s Bay Area Rapid Transit system also used submerged tube tunnels and was completed exactly on time within 29 months and within 3 per cent of budget.

The bridge spans in the EuroRoute design—125 metre supported box-girder lengths across the inshore shipping lanes, are unremarkable. The man-made islands will present no problems to offshore construction yards which have already built floating gravity structures of similar weight for North Sea oil fields.

Moreover, the combined bridge and tunnel, research indicates, provides better conditions for drivers. The central tunnel section of 19 km is an acceptable distance for underground driving. The full 36 km distance would be too great.

Since its formation, the EuroRoute consortium of eight companies from the UK and France and an associate member, Raymond International of the US, has carried out much work on construction methods and schedules, traffic forecasts, costing, finance and the political aspects of the programme. Attention has also been paid to the implications for shipping, for employment and for the environment.
Politics:
Both the British and the French governments are in favour in principle of a Channel fixed link, but the British Government insists that any scheme be funded by the private sector. The governments would, without doubt, be willing to negotiate the necessary international treaty for the project and offer a guarantee to backers that should the link be abandoned in part-constructed form for political reasons, full compensation would be paid. The question of government guarantees against major and unforeseen problems in the construction phase or guarantees against shortfalls in projected revenues have been discussed, but not agreed.

It was in part to discover whether any of the proposed schemes could go ahead without construction and revenue guarantees that the two governments in 1982 accepted an offer by a group of five banks—two British, three French—to assess the financial prospects of the proposed schemes. Unfortunately, the banks were given as their base document a 1981–82 report by government officials which was prepared before the EuroRoute concept had been fully developed.

The five banks concluded that the rail-only option would be both easier to finance and more profitable than a combined road-rail version. Since then, Coopers and Lybrand, the London-based consultants, have analysed the banks’ report and found that the real rate of return available on EuroRoute matches almost exactly that on a rail tunnel, without allowing for the fact that EuroRoute offers much greater capacity and therefore, arguably, much greater financial potential in the long run.

Meanwhile, the British Government says it is still waiting for a private sector proposal to build the link. EuroRoute is proceeding towards such a submission, as outlined below.
Construction:
Prefabricated modular construction of EuroRoute will permit it to be completed in only seven years, including two years pre-construction work. The dispersal of the major fabrication contracts around many construction yards and shipyards avoids the danger of the project being badly held up by a single problem at any main site.

The road viaducts will consist of a series of supported steel spans, each 125 metres long. Piers are formed from large diameter steel or concrete cylindrical piles, driven or drilled into the seabed.

Offshore islands—both the two main islands and two to three ventilating islands—will be constructed around a large central concrete element on the seabed. Flanked by rock and hydraulic fill, the islands’ superstructure will be built from large sub-assemblies of steel and concrete made in offshore construction yards. Initial investigations indicate that the hydraulic effects of these structures in the Channel should not cause problems, but a further £4 m of work is needed to carry out detailed model testing, along with further geophysical and geotechnical surveys.

The tubes for the tunnels will be formed from 125 m long steel shell or concrete elements cast in special basins. They will then be towed to site and sunk into a dredged trench. Dredging work at the depths required is normal, although the laying of a tunnel of these dimensions will, for 17 per cent of the route length, involve greater depths than experienced in previous projects. Even so, this extra depth is only 12 metres greater than in similar US tunnels.

Shipping:
The Dover Strait, with 500 shipping movements a day, is one of the busiest in the world, but EuroRoute will meet requirements of the International Maritime Organisation. The two main ventilation islands are located on sandbanks and so will help to delineate the existing traffic separation scheme. The large offshore islands are set outside the main shipping lanes and the spans and height of the road bridge are designed to create five, 500 metre navigation spans for inshore shipping.
Environment:
Disturbance to the environment would be minimal. At the UK end, there would be hardly any effect upon the beautiful Kent coastline; all support facilities for the link will be based on the offshore island and both the rail and roadways will enter the mainland by tunnel, emerging beyond the cliffs to link with existing road and railway lines. No problems are envisaged at the French end.

Employment:
Total employment effect of EuroRoute in the construction-related industries is put at over 250,000 man-years; overall employment is estimated at 500,000 man-years. Average employment will reach 100,000 jobs a year. Many of the jobs will be in areas of high unemployment.

Traffic and revenues:
Traffic forecasts for EuroRoute have been made by Coopers and Lybrand, based partly upon work done for the European Commission in 1979. Figures for the Coopers central case, which is somewhat more pessimistic than the 1982 projections of the British and French Governments, are set out below.

**EuroRoute: Traffic forecasts**

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>passengers (000s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>car</td>
<td>6164</td>
<td>7600</td>
<td>11552</td>
<td>17559</td>
</tr>
<tr>
<td>coach</td>
<td>6083</td>
<td>7400</td>
<td>10952</td>
<td>16209</td>
</tr>
<tr>
<td>rail</td>
<td>6249</td>
<td>7100</td>
<td>9165</td>
<td>11032</td>
</tr>
<tr>
<td>short-stay</td>
<td>4021</td>
<td>4900</td>
<td>7276</td>
<td>10003</td>
</tr>
<tr>
<td>Total</td>
<td>22,517</td>
<td>27,000</td>
<td>38,945</td>
<td>54,803</td>
</tr>
<tr>
<td>freight (000 tonnes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>road</td>
<td>9263</td>
<td>11000</td>
<td>15513</td>
<td>21877</td>
</tr>
<tr>
<td>rail</td>
<td>2236</td>
<td>2500</td>
<td>3125</td>
<td>3906</td>
</tr>
<tr>
<td>Total</td>
<td>11,499</td>
<td>13,500</td>
<td>18,638</td>
<td>25,783</td>
</tr>
</tbody>
</table>

In the year 2000, it is expected that EuroRoute’s 27 m passengers would give it 61 per cent of the cross-Channel surface transport market. Its share of the freight market would be 36 per cent.

Assuming tariffs, in line with present ferry rates, to be £60 per car; £7 per coach and rail passenger; £4 per short-stay customer and £10 a tonne for freight, gross revenues are projected as follows:

**EuroRoute: Gross revenues**

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>revenues (£m 1983 prices)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cars</td>
<td>131</td>
<td>162</td>
<td>248</td>
<td>376</td>
</tr>
<tr>
<td>coaches</td>
<td>43</td>
<td>52</td>
<td>77</td>
<td>113</td>
</tr>
<tr>
<td>short-stay</td>
<td>16</td>
<td>20</td>
<td>29</td>
<td>43</td>
</tr>
<tr>
<td>road freight</td>
<td>93</td>
<td>110</td>
<td>155</td>
<td>219</td>
</tr>
<tr>
<td>rail</td>
<td>53</td>
<td>60</td>
<td>76</td>
<td>99</td>
</tr>
<tr>
<td>Total</td>
<td>336</td>
<td>404</td>
<td>585</td>
<td>850</td>
</tr>
</tbody>
</table>
Costs and profitability:

EuroRoute has been costed in some detail by engineering consultants Mott, Hay and Anderson. Construction is estimated to cost between £4.06 bn and £4.4 bn. These figures could be reduced by £200 m if the rail tunnel were reduced to single track.

Assuming the higher figure and that both road and rail open together at the end of year eight, the spending profile is as follows:

**EuroRoute: Spending profile**

<table>
<thead>
<tr>
<th>Year</th>
<th>one</th>
<th>two</th>
<th>three</th>
<th>four</th>
<th>five</th>
<th>six</th>
<th>seven</th>
<th>eight</th>
</tr>
</thead>
<tbody>
<tr>
<td>£m</td>
<td>35</td>
<td>70</td>
<td>783</td>
<td>1157</td>
<td>993</td>
<td>748</td>
<td>397</td>
<td>257</td>
</tr>
</tbody>
</table>

Operating costs are estimated at £20 m to £25 m a year, giving the following net annual surpluses:

**EuroRoute: Net annual surpluses**

<table>
<thead>
<tr>
<th>Year</th>
<th>1995</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>(£m 1983 prices)</td>
<td>336</td>
<td>404</td>
<td>585</td>
<td>850</td>
</tr>
<tr>
<td>gross revenues</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>operating costs</td>
<td>312</td>
<td>380</td>
<td>561</td>
<td>826</td>
</tr>
<tr>
<td>operating surplus</td>
<td>312</td>
<td>380</td>
<td>561</td>
<td>826</td>
</tr>
</tbody>
</table>

The project’s cash flow, according to these estimates, turns positive in 1993 (year nine) but cumulative cash flow is negative for the first 20 years of EuroRoute before turning strongly positive in years 25 to 50. On the basis of these numbers, the real rate of return of EuroRoute over 50 years is 8.6 per cent.

Here lies the problem—the classic difficulty of an infrastructure project. How will the money be raised for an investment with such a long payback period, even though the rewards when they come are likely to be substantial?

**Financing EuroRoute:**

Any private sector financing plan for EuroRoute must start from the principle that ways have to be found of drawing equity capital as well as debt into EuroRoute and an acceptance that little if any of this money is likely to come either from national governments (at least, not on the British side) or international institutions, although there is probably some scope for borrowing through EEC institutions. It is not necessarily the case that both sides of the link will be financed in the same way, although securities floated to raise money for EuroRoute would presumably be tradeable in any major financial centre.

It is possible that the French government would put capital into the scheme even if the British end was financed privately, but it is not likely because of the complications which could ensue.

The problem may not be, as the recent five banks’ report suggested, that EuroRoute will generate a wholly unmanageable level of debt. Coopers and Lybrand have challenged the banks’ assumptions on the cost and construction time of EuroRoute.

But EuroRoute remains an expensive project, with heavy cash demands in the early years, and one subject to the risks of a major problem in construction will inflate the cost
and that for some reason the anticipated revenue flow will not be forthcoming. The latter point turns in part upon the debate about how the ferry operators will behave. They have threatened to cut their fares in order to undermine the economics of a fixed link, but this is a strategy which makes sense for them as a threat but which would not be in the ferry companies' own interest once the link was built.

The amount of capital which needs to be raised is between £4.06 bn and £4.4 bn; with 2.5 per cent for contingencies, this would give a top limit for the median figure of £5.3 bn. The task is to devise a package of investment vehicles and loans which will reflect the varying degrees of risk at different stages of the project—the early years are obviously the riskiest, when in theory a part-built link could still be abandoned—and to find ways of offering lenders and investors an attractive reward. For the purposes of this outline financing package, two periods have been distinguished: the first three years, including all pre-construction and some early construction, and the remainder.

Clearly EuroRoute would have to raise a substantial portion of these funds in the form of bank loans, which would normally be repayable over eight to ten years and would therefore probably need to be refinanced at that point with some form of equity or mixture of longer-term debt and equity. One model here might be the US tax-free revenue bond market, which is a major source of funds for large capital projects. Since by that time, the link would either be built or the scale of its construction delay evident, the risk to new lenders or investors would be more precisely quantifiable.

The amount which could be raised from banks is a matter of judgment, but some analogies can be drawn with the way in which banks finance oil production developments in the form of non-recourse loans. These are essentially loans made against the security of the future cash flow of the oil field, rather than against the security of the borrowing group’s balance sheet. They have become common in North Sea financing.

In making non-recourse loans, the banks normally work on a fixed cover ratio; meaning that they cover the net present value of the anticipated cash flow of the project normally in a ratio between 1.5 and 2 to one. In this type of lending, the banks take considerable risks—about the price of oil, about the taxation regime of a country, and about the technical performance of the oilwell equipment. The sums involved have frequently been in excess of $1 bn, spread over periods of many years.

The analogy with EuroRoute is not precise—the project is both bigger and longer-range than most oil programmes—but it is not without foundation. The banks are assumed to supply £2 bn of EuroRoute’s needs in the form of non-recourse loans.

Another major financial vehicle could be Euroshare. This concept, outlined earlier in this report, might be used to raise £1.2 bn. Under it, Governments would offer tax incentives to high tax-paying individuals to invest in EuroRoute, rather in the way the British Government attracted funds for the Business Expansion Scheme. The justification for Government would be that EuroRoute offers large and quantifiable economic benefits to Britain and France in terms of stimulating trade and, in the short term, reducing unem-
ployment. The latter has a direct exchequer benefit, estimated by Coopers and Lybrand at £732 m to the UK Government alone.

It would also be possible to structure the tax relief element associated with Euroshare in a phased way, so that once the link was built and generating cash, the tax incentive would disappear.

A third idea, well tried in France as a means of financing nationalised industry, is the so-called participating bond (obligation participante), which is a type of mixed debt-equity instrument, carrying a low or zero coupon. The bonds are non-repayable, but carry entitlement to a share in the profits of a project. The definition of profit, in line with previous French participating bonds, could be made in a number of ways. It might be possible to make payments to bondholders when traffic levels reached certain points or to have them based upon cash flow. The flexibility of this type of payment mechanism could be very useful in assembling a EuroRoute package. A credible target for fund-raising from this source is £1.2 bn.

It would be important in promoting a project like EuroRoute to appeal to a broader financial market than banks and mainstream investors, rather in the way that recent British Government privatisations have included special provisions for small investors. The sale of British Telecom, for example, includes an element whereby ordinary telephone subscribers are entitled to a discount on shares—paid through a concession on their telephone rental.

For EuroRoute, this might take the form of preferential passage bonds: instruments for sale to motorists and other potential users of EuroRoute, which would offer worthwhile concessions on travel across the Channel, e.g. a £100 bond would bear no interest but would give reduced tariff rights for a number of passages between 1993 and 1997. The value of the ticket concessions might be set at twice the projected real rate of interest—i.e 10 per cent a year—although it may not need to be so high, since it would be a tax-free investment. Its main attraction is in increasing the retailing spread of EuroRoute investment vehicles—the bonds could be sold through banks, travel agents, and perhaps even purchased and given away as promotions by companies. The sum raised would probably be modest—say £400 m—but would increase the UK political appeal of the programme.

Together, these sources should yield £4.4 bn, and could be extended to cover finance for contingencies. The EEC, through its transport infrastructure fund, might be persuaded to advance a grant to cover some of the earlier expenditure, such as the remaining hydraulic testing. Loans from community institutions, such as the European Investment Bank and the New Community Instrument, are also possibilities, but face the difficulty that they need guarantees from either a first class bank or a member state.

All of these ideas require more careful examination, quantification and relative subordination before being ready to form part of a firm financing plan, but they give an indication of the type of private or mixed private/public sector financing packages which might be devised for EuroRoute or any of the other infrastructure projects described in this report.
Financing EuroRoute:  
Euroshare illustration

<table>
<thead>
<tr>
<th>Phase one:</th>
<th>sum</th>
<th>timing</th>
<th>terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>“risk” construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euroshare stage one</td>
<td>£105 m</td>
<td>1985–86</td>
<td>50% tax subsidy.</td>
</tr>
<tr>
<td>Bank project loans</td>
<td>£2044 m</td>
<td>1987–89</td>
<td>Six year grace period on repayment. First call on revenues post-completion. Non-recourse loans, secured against cash flow.</td>
</tr>
<tr>
<td>Euroshare stage two</td>
<td>£1155 m</td>
<td>1987–89</td>
<td>30% tax subsidy.</td>
</tr>
</tbody>
</table>

Phase two:  
Low risk construction

| Participating bond | £1180 m | 1990 | Non-repayable; mixed debt-equity; 4 per cent real coupon in years one to ten; 50 per cent of net operating cash flow (after loan service in years 11–20; premium coupon of £565 m in year 21) |

| Preferential passage bonds | £400 m | 1991–92 | Zero-coupon bond, carries entitlement to discounts on use of EuroRoute. |

| Total: | £4884 m |
The Scandinavian link

The Scandinavian Link, or Scanlink for short, would in its most ambitious version, create a high quality road and rail connection between the cities of Oslo in Norway and Lubeck in northern Germany. On a wider plane, Scanlink can be seen as the crucial northern leg of a transcontinental road and rail corridor connecting Scandinavia with the autobahn and rail networks of central Europe.

Some of the bone structure of the Scandinavian leg of such a route already exists in the form of motorway but there are major gaps. As the map shows, the truck travelling from Oslo to north Germany, a distance of 725 km, must today make two ferry crossings.

The quality of roads which form the existing components of Scanlink is also variable—almost half the length is only two-lane highway—and the present rail infrastructure is even weaker. Declining traffic has led to a failure to modernise and most sections of the Oslo-Fehmarn railway operate at low speeds by European standards—between Oslo and Gothenburg, for example, the average speed is a mere 66 km/h. Swedish Railways have some plans to upgrade sections of line, including Gothenburg-Malmo, but no public plans exist to create high speed railways on the Norwegian or Danish sections of the route. The only way in which such an investment would become logical is in the context of the stimulus to business which would stem from the building of a major international link to the rest of Europe.

The philosophy behind Scanlink is straightforward. The Nordic countries lie at the northern edge of Europe and rely for their prosperity upon trade with their southern neighbours. As transport links, especially roads, between other European countries have
improved, the Nordic states have slipped into a position of disadvantage. At present, it would take a car around 20 hours to travel between Oslo and Hamburg. To cover the same distance between, say, Rotterdam and southern France would require only half that time.

Chart 7
Scanlink: Cutting travel times to and from main European road/rail networks

Recognition of these facts lay behind the various proposals of recent years to bridge one or other of the missing links in the Scandinavian transport chain. But the approach was fragmentary; only through Scanlink is the problem of transport barriers between Scandinavia and the rest of Europe coherently addressed.

In identifying the two fixed link projects—to build a bridge or tunnel between southern Sweden and Denmark across the Oresund and a similar link across the Fehmarn Belt connecting Denmark with northern Germany—Scanlink greatly strengthens the economic case for each individual link.

The Oresund link has been the subject of several ambitious studies, including a joint Danish-Swedish investigation in 1978. This study examined a variety of bridge and tunnel possibilities between Copenhagen and Malmo, along with a rival alignment between Helsingborg and Helsingor. The study was updated in 1983 by the Swedish Ministry of Transport, but there has been no action. In the Nordic countries, as in the rest of Europe, governments have been preoccupied with other economic problems.

Likewise the Fehmarn Belt crossing has been subject to detailed study since 1962, but little engineering or financial information has been made publicly available.

On the basis of information from these two sets of studies however, it is possible to assemble rough traffic projections and cost estimates for the various schemes and, setting these against existing tariff structures of the ferry companies which ply across the two stretches of water, to make an estimate of toll revenue from any new fixed links. In this way, the likely financial rate of return and the cash flow for these sections of Scanlink can be assessed.

Estimates about the cost of the whole of Scanlink must remain more tentative, since the sum involved will be determined by the
standards chosen—motorway widths, for example. In any case, since Scanlink is in its entirety a project to be undertaken in sections over a period of some years, it would be pointless to provide anything other than general indications of what standards of construction might be appropriate and broad estimates of their cost.

The key to Scanlink, initially, is to build the two sea crossings. Once this is achieved, Scanlink will in a sense be operational. The build-up of traffic caused by the completion of the fixed links, however, would create the momentum needed for the upgrading of related road and rail systems.

Chart 8

Scanlink: Where the work has to be done

Costs and routes
For the purpose of making an approximate overall estimate of the cost of Scanlink, two alternative standards of construction have been postulated. The first, a high-standard alternative, consists of a combined four-lane motorway and double-track high speed train system along the entire route from Oslo to Hamburg. A lower-standard version calls for four-lane motorway only at those points where this standard of road has already been planned. The fixed links across Fehmarn Belt and Oresund, however, would have four lanes. Under this alternative, there is no provision for upgrading the railway, apart from building the new fixed links.

The cost of the high-standard alternative is approximately S4–4.2 bn and the lower-standard option approximately S2.7 bn. These figures are broken down as follows:
Scanlink costs

<table>
<thead>
<tr>
<th></th>
<th>high standard</th>
<th>low standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oresund link</td>
<td>$900 m</td>
<td>$900 m</td>
</tr>
<tr>
<td>Fehmarn link</td>
<td>$1500 m</td>
<td>$1500 m</td>
</tr>
<tr>
<td>Rail upgrading</td>
<td>$1100 m</td>
<td>–</td>
</tr>
<tr>
<td>Road upgrading</td>
<td>*570–650 m</td>
<td>$210–250 m</td>
</tr>
<tr>
<td>Total</td>
<td>$4070–4150 m</td>
<td>$2610–2650 m</td>
</tr>
</tbody>
</table>

*(excludes cost of road upgrading already planned to 1990.)*

Routes, design standards and construction methods:
The Swedish-Danish committee which investigated a link across the Oresund in 1978 looked at a number of possible routes and design standards. The routes preferred were Copenhagen-Malmö for road and passenger trains, and Helsingor-Helsingborg for rail. A new joint government commission is due to report on the Oresund link by July 1985. In addition to this research, a consortium of contractors in 1982 submitted a proposal to construct the Copenhagen-Malmö link in a road-only version.

A wide variety of construction methods has also been suggested. The Government study looked at bridges, submerged tube tunnel, rock tunnel and mixtures of bridge and tunnel. The contractor group proposed a mix of bridge and road embankment across small islands and tunnels.

For the Fehmarn Belt, there is little disagreement about the best potential route—the shortest distance crossing between the existing ferry ports of Rodby and Puttgarten; a distance of 16.5 kilometres.

A proposal to build a bridge across this route has been under study for some time by the Fehmarn-Lolland group—an organisation which was set up in 1962 and which is sponsored by a group of industrial companies, banks, chambers of commerce and the Germany Transport Ministry. The roadway would consist of four lanes and the railway of dual track. This bridge, it is envisaged, would also carry water and gas pipelines and a high tension electricity connection. The possibility of a tunnel design has also been considered and seems realistic.
Financing the project:

For the purposes of assessing the likely financial performance and therefore the business potential of the Oresund and Fehmarn Belt links, three routes and designs have been studied. These are:

(A)—a bridge/tunnel between Copenhagen and Malmö, consisting of four-lane highway and all-purpose railway.

(B)—a bridge/tunnel between Copenhagen and Malmo for a four-lane highway and a separate all-purpose railway crossing between Helsingborg and Helsingor.

(C)—a bridge containing a four-lane highway and dual track railway across the Fehmarn Belt.

According to figures contained in the 1983 Transport Ministry update of research into the Oresund link, option A would cost around 4,800 m Swedish Kroner at 1982 prices and option B 4,900 m Kroner. So a reasonable working figure for the Oresund link is SKR 5,000 m or $625 m.

Assuming an interest rate of 12.5 per cent, the Oresund project would accumulate $283 m of interest charges, giving a gross cost for the link of $908 m.

Construction time and expenditure profile, assuming they follow the pattern proposed by the contractors’ group for the Oresund crossing, would be six years, distributed as follows:

Scanlink: Spending profile

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
<td>22%</td>
<td>28%</td>
<td>28%</td>
<td>13%</td>
<td>6%</td>
</tr>
</tbody>
</table>

For the Fehmarn bridge, less information is available, but working figures can be derived by using estimates drawn up for the construction of the Great Belt bridge in Denmark, which is similar to the Fehmarn Belt in terms of distance, technical specifications and water depth. In this way, the cost of building the Fehmarn Belt bridge is estimated at 51,500 m, including accumulated interest costs.

Traffic forecasts and financial viability:

Recent traffic forecasts for the Oresund and Fehmarn Belt crossings probably understate the potential because they fail for the most part to take into consideration the knock-on traffic effects from building other links and the diversion of traffic from other ferry services across the Baltic and the Kattegatt. At present, half of Sweden’s rail traffic to and from Western Europe, for example, is routed through East Germany. With the Oresund and Fehmarn Belt links in place, it is possible that as much as 90 per cent of this rail traffic would cross Denmark.

Taking the macroeconomic assumptions used in the Government studies on Oresund—real GNP growth of 2 per cent a year, real disposable income growth at 1 per cent, goods traffic growth at 2.5 per cent and passengers traffic at 1 per cent—but adjusting for the knock-on effects generated by Scanlink, the following traffic estimates for the year 2000 emerge:
Scanlink: Traffic estimates for year 2000

<table>
<thead>
<tr>
<th></th>
<th>rail freight (m. tonnes)</th>
<th>road freight (m. tonnes)</th>
<th>road vehicles (millions)</th>
<th>passengers (exc. drivers)</th>
<th>rail (millions)</th>
<th>bus (millions)</th>
<th>car (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route A</td>
<td>7.6</td>
<td>4.9</td>
<td>2.01</td>
<td>5.3</td>
<td>0.75</td>
<td>2.39</td>
<td></td>
</tr>
<tr>
<td>(Oresund)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route B</td>
<td>7.6</td>
<td>4.9</td>
<td>2.24</td>
<td>1.47</td>
<td>4.65</td>
<td>2.48</td>
<td></td>
</tr>
<tr>
<td>(Oresund)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route C</td>
<td>7.6</td>
<td>5.3</td>
<td>2.47</td>
<td>6</td>
<td>1.8</td>
<td>4.06</td>
<td></td>
</tr>
<tr>
<td>(Fehmarn Belt)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Route A is Copenhagen-Malmo for road and rail; Route B is Copenhagen-Malmo for road and Helsingor-Helsingborg for rail. Route C is Fehmarn Belt. Figures assume tolls equivalent in real terms to current ferry charges.)

Although these figures must be considered tentative and would need to be examined more rigorously in a full-scale feasibility test of the projects, they are satisfactory as orders of magnitude. From them, assuming that it will be both possible and desirable to charge passengers and freight similar fees for crossing by fixed link to those they pay now for ferry services—even though the fixed link will provide many advantages over the ferry—an estimate of operating revenue can be made for each link.

If the traffic figure at the year 2000 as taken as indicative—too high in the early years of the project, but probably too low in the later years—the gross revenues from each of the options are as follows:

- Route A $129.1 m
- Route B $132.6 m
- Route C $209.4 m

About 80 per cent of the revenues derive from commercial traffic. This points to the fact that without an improvement in transport links, all the Nordic countries are placing in jeopardy considerable potential industrial and commercial activity.

The annual operating costs for each link will be very small in relation to revenues—of the order of $3 m to $3.5 m a year. The annual operating surplus on the Oresund A alignment is therefore $126 m and on the Fehmarn Belt link (route C) is $202 m. With a total investment cost for link A of $900 m, that means an internal rate of return for the project of 13.8 per cent a year, using a project life of 30 years. For the Fehmarn link, whose total cost is $1.5 bn, the internal rate of return works out at 13.1 per cent. Both these rates of return are expressed in real terms. These figures are not sufficiently robust to form the basis of a firm plan, but they indicate without question the desirability of testing the financial viability of the link projects as soon as possible. On the figures presented, both projects would have strong cash flow, even in the early years of operation, and could be financed largely with loan capital, so long as there was no need for major repayment during the first few years.
Shipping, environment, employment:
In practice, there would be no disadvantages to shipping as a result of the new fixed links. Indeed, the reduction in ferry services, which cut across the main shipping lanes, would be an improvement from the safety viewpoint. It will be possible to design bridge spans and tunnel ventilation shafts in such a way as to comply with shipping authority requirements.

Environmental aspects of the schemes will require detailed study, but the Oresund commission’s analysis raised no major problems. Land has already been reserved for the link’s shore-side construction.

There would be major employment effects from Scanlink. The Oresund crossing alone would generate 12,500 man-years of work or about 2,000 jobs a year, without allowing for indirect job creation effects.

Financial viability of the rest of Scanlink:
Since the average construction cost of Scandinavian motorway is $2 m a kilometre, it is simple enough to calculate the tolls needed to achieve a return on capital commensurate with that offered by the fixed links.

On a very busy stretch of road—one with 30,000 vehicles a day in one direction—a toll of three cents a kilometre would suffice. The toll would need to be 30 cents a kilometre on a road with only 3,000 vehicles a day. The obvious problem for Scanlink is that the traffic density on the roads involved will vary enormously and with the seasons. So, although some form of novel financing plan is a possibility for Scanlink’s road sections, it would require careful assessment of each case on its merits.

Next steps:
The Scanlink concept is at an early stage of development. To take the project further would require more detailed work in the following areas:

1. Market analysis with special attention to pricing strategy.
2. Capital structure and external financing, including tax status.
3. Legal status of the corporation or corporations which will operate Scanlink.
4. Detailed costing of the rail elements of Scanlink.
5. More detailed analysis of road costings.
6. Detailed technical analysis of certain aspects of the fixed links, including ice pressure forces in the Oresund, geological investigations and technical work on long-span bridge design.
For items 2 and 3 above, the feasibility of a finance package similar to that illustrated in the case of EuroRoute could be examined. On structure and status, the example of SAS (Scandinavian Airlines System) could also be used advantage.

Chart 10

**Scandinavian Airlines System**
Three-Country Public-Private Consortium

- **Swedish government** (50%)
- **SILA private** (50%)
- **Danish government** (50%)
- **Private** (50%)
- **Norwegian government** (50%)
- **Private** (50%)

ABA
Sweden

DDL
Denmark

DNL
Norway

SAS

SAS is a consortium owned by three companies—the Swedish ABA, the Danish DDL and the Norwegian DNL. These three companies are each owned 50-50 by the public and private sectors in the respective countries. In Sweden, the private sector interest in ABA is vested in the company SILA which is quoted on the Swedish Bourse. SAS financial statements do not include taxes; these are paid in Sweden, Denmark and Norway by the SAS owners.
High-speed train links

Western European railways have not had a happy history in the last three decades. Suffering strong competition from cars and airlines, there has been a steady decline in traffic, especially freight, and most national rail systems have recorded heavy financial losses.

More recently, however, two changes have occurred: the decline in passenger volumes, especially for longer distance express trains, has halted and technological advances in high-speed rail systems have enabled the rail industry to take a decisive step forward in terms of quality.

The most striking success has been the Train a Grand Vitesse (TGV) of the French National Railways, which cut the journey time for the 425 kilometre Paris–Lyon run from four to just over two hours. This project is expected to make a handsome financial surplus this year—its first full year of operation.

<table>
<thead>
<tr>
<th>TGV: A Wheel on Rail Technology Success Story</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost and Cash Balance</strong></td>
</tr>
<tr>
<td>FF Bn current</td>
</tr>
<tr>
<td>Financing Charges</td>
</tr>
<tr>
<td>Operating Costs</td>
</tr>
<tr>
<td>Operating Receipts</td>
</tr>
<tr>
<td>Cash Balance</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Other railways have also made significant progress in high-speed technology. The German National Railway will start its high-speed service on sections of the Hanover–Wurzburg line next year, whilst a Government-backed consortium of industrial companies is making major advances with a magnetic levitation (maglev) train. The latest maglev development vehicle recently set a new world speed record of over 300 km/h on its test track in northern Germany.
Italian Railways are also close to completing the Rome–Florence Direttissima, which uses advanced tilting technology (the Pendolino system) for rapid cornering. The Direttissima is intended to run at speeds up to 250 km/h, compared with up to 300 km/h for the TGV and a vehicle design speed of 350 km/h on the Hanover–Würzburg inter-city express. The standard current definition of a high-speed train is that it must be designed to operate up to 300 km/h.

These developments mean that railways are now in a position to make a major competitive thrust over longer distances against air travel. Airlines have gained business at the expense of rail chiefly because of speed. Rail has a clear advantage in terms of energy consumption, environmental disturbance and passenger comfort. By creating new high-speed lines for passenger trains, Europe would also be creating the conditions for better and faster freight services.

The new generation of high-speed trains also illustrates the fact that Europe's rail industry is again in a position of technological leadership in the world; a position which it should be able to exploit in export markets. There is thus a strong case on industrial as well as transport grounds for pressing ahead with high-speed train development.

It is a fact of life that Europe's railways, having developed over a century with their own technologies and national corporate bases, are weak in terms of trans-boundary connections. Higher speed operation makes international rail movements an attractive proposition for the 1990s and beyond. The 1983 Economic Summit at Williamsburg recognised the same point when it set up its own investigation into high-speed rail potential as part of a working group on technology, growth and employment.

The aim of the Roundtable working group has been to review progress in high-speed train operation in Europe and to test in outline the financial viability of various possible international connections. The conclusion is that at realistic fare levels and feasible investment, a number of international rail links are ripe for high-speed development. The working group supports the suggestion that a start be made immediately upon a phased investigation of three sets of routes:

- phase two: Lille–London–Birmingham–Manchester;
- phase three: Cologne–Hanover and Paris–Frankfurt.

A study of Paris–Brussels–Cologne by the French, German and Belgian railway authorities is already well-advanced and would form the main element in phase one. The phase two investigation is dependent upon the construction of a fixed Channel link. In this respect, the high-speed train component of the working group's report is inseparable from the Channel Link proposals.

The current position:
Western Europe's electric railways employ four different traction systems, which is one of several reasons (different signalling systems and vehicle types are others) why international railway connections have remained poor. If adequate international co-ordination can be
achieved on high-speed strategies, it should be possible to avoid such incompatibilities in future high-speed services.

There is already sufficient experience of high-speed train operation, both in Europe and Japan, for acceptable operating and design parameters to be clear. For example, daily operating time should be limited to between 16 and 18 hours to permit necessary maintenance work; frequency, to meet passenger expectations, should be around one train per hour.

Experience of construction time shows a range from five years for the Japanese Sanyo Shinkansen (bullet train) to 13 years for the Tohoku Shinkansen. The TGV was built in 7.5 years, although its first 301 km stretch was ready in five.

A wide range of signalling and communication systems is in use and vehicle type varies from all-axles-powered (the Shinkansen) to various European configurations of power cars with a mix of free-wheeling and powered trailer cars. Although there has been no single common technical approach to high-speed operation, it is evident that Europe now possesses a wide range of technology in locomotive design, power systems, signalling, communication, track construction and other areas which ranks with the best in the world.

The magnetic levitation train:

Maglev—the idea of using magnetic systems to support, guide and propel vehicles—is not new. It was first suggested in the 1930s, but only in the last few years has a consortium of West German companies, sponsored by the Federal Government, brought the system to the threshold of commercial exploitation.

Cross section drawing identifies principal lifting, guidance and propulsion elements of the Transrapid 06 magnetic levitation system.
Unlike the Japanese National Railways technology, which uses two energised electro-magnets in the track and the vehicle to repel each other, the German system uses magnetic attraction to support and guide the train. This creates the advantage that unlike the Japanese technology it does not require a back-up wheel on rail system for acceleration and braking phases. The German system, which uses a long stator linear electric motor, is simpler and more robust than the Japanese version.

The TR06 vehicle, currently being tested at the Emsland Transrapid test track in northern Germany, is designed to run at up to 400 km/h and has already achieved speeds in excess of 300 km/h. Being light, friction free and inherently safe, because it runs on guideways, Maglev may well prove capable of commercial operation at speeds which are beyond the reach of conventional trains. Maglev can be controlled entirely from a remote centre, or manually from the cab. In any event, the control system permits automatic braking at certain speeds, constant monitoring of speed and vehicle dynamics and sophisticated switch control.

Each Maglev vehicle can seat 120 passengers and a train could be formed from up to eight vehicles. Containerised goods could also be carried, with a payload per vehicle of 25,000 kg.

Guideways for Maglev trains are normally raised, which permits other traffic to pass beneath. If a Maglev train runs through farmland, for example, as the Emsland track does, farm animals are not disturbed. Also, because Maglev is free from friction, its only noise is aerodynamic swishing. Maglev is also capable of rounding corners and climbing gradients in a way which makes it a highly effective competitor for conventional trains.

Maglev glides along a test track in Emsland, West Germany,
Potential demand for high-speed rail networks:
In 1840, the average citizen of Prussia travelled 10 kilometres a year. Today, the average West German covers around 10,000 km. This pattern of growth—5 to 8 per cent a year over many years—has for the present come to an end—the victim of lower economic growth; the fact that in higher income households, transport spending tends to grow slowly; the saturation of the motoring market and low-to-negative population growth. So growth in transport activity will be lower, especially for commuting, shopping and personal business trips. Longer distance leisure travel and especially international travel, however, represent on recent trends, exceptions to these low-growth patterns. These exceptions, as it happens, are the markets for which high-speed trains are well-suited, if imaginatively developed.

In order to make rough estimates of the potential for high speed rail travel, it is useful to hypothesise a network such as that shown on Chart 11. This is essentially a central European network, with rapid connections to major peripheral areas in Britain and Italy. It does not show, although it well could, connections to Scandinavia via Scanlink, nor possible connections to the Iberian peninsula.

Chart 11
Possible European High-Speed Rail Network

2 Lille
4 Bruxelles
5 Randstad
6 Rhein-Ruhr
7 Rhein-Main
8 Rhein-Neckar
9 Stuttgart
11 Zürich/Basel
12 Milano
13 Torino
14 Lyon
15 Hannover
17 Birmingham
18 Manchester/Liverp.
19 Newcastle
20 Glasgow/Edinburgh
21 Luxemburg/Saar
22 Geneve
23 Marseille
24 Bologna
25 Firenze
This 6000 km network connects 26 cities with a population of 60 million people. A total of 325 interconnections between these cities is theoretically possible, of which 83 per cent require border crossings. Trip times would vary across this network according to speed. London–Lille (assuming a suitable Channel fixed link) takes 2 hours 20 minutes with a maximum train speed of 200 km/h and one hour 45 minutes at 400 km/h. Turin–Lyon (assuming a suitable Alpine link) takes 2 hrs 13 min and 1 hour 42 min, on the same basis.

By taking pairs of cities and traffic flow information from a 1975 survey, rough and ready calculations reveal an important fact: for comparable distances, the flow between two points within any country is on average four times greater than it is between similar points separated by national borders. This so-called frontier-impedance factor, although lower than the 5:1 ratio found in a survey a few years earlier, is still significant. Even though the ratio varies considerably (high for UK-continent; low for France–Belgium), it suggests that in all parts of Europe there may be further scope for eroding frontier impedence by improving transport links, although this is by no means certain.

For the purpose of analysing performance of the possible European high-speed rail network two cases have been examined: a lower-case version, based upon the assumption that there will be no further reduction in frontier impedence and where rail traffic both domestically and internationally increases at a rate of only 1.5 per cent a year to the year 2000; and an upper case, whereby cross-border traffic increases at 4 per cent a year.

Projected growth is in part a function of increased travel requirements, but is very largely a result of transfers to high-speed rail of business from conventional rail services and other modes of transport, such as car and air.

A study of the Frankfurt–Paris corridor in 1982 found that Maglev on that route operating at a maximum speed of 400 km/h could draw 50 per cent of its business from conventional rail, 9 per cent from road, 19 per cent from air and that 15 per cent would be newly generated traffic. The general picture which emerged from this study on the effect of higher speeds upon traffic is summarised in Chart 12.
Chart 12
Faster Trains Take Bigger Travel Market Shares

Simulation of effect of speed on trains share of typical high-density corridor travel market. At 300/400 km/h train would be market leader for distance of 500-700 km.
As can be seen, increasing maximum speed from 200 km/h—the existing maximum on many inter-city routes—to 300 km/h, which is the typical design speed for the new generation of high speed trains, raises traffic volume by around 40 per cent.

An impression of how this relative increase in demand would be felt on the various parts of the possible European high-speed network is displayed in Chart 13. The biggest effects, unsurprisingly, are on the densely populated corridors in the centre of the network, but substantial growth in flows from the UK is also a feature.

Chart 13
Thicker lines indicate bigger traffic volumes

---

Financial viability

A considerable amount of information about the costs and potential revenues of high-speed rail networks is available from the various national high-speed programmes and from a number of international studies by the national railway authorities, bodies like the EEC and the OECD and specific corridor studies, such as the 1982 Frankfurt-Paris route studied for the Maglev consortium.

An attempt has been made in this report to draw together this information and to apply its cost and revenue messages to the concept of the 26-city, 6,000 km European high-speed network. The results, quite clearly, do not take into account detailed topographic or planning conditions on the various route sections, but they do give a reliable overview about the economics of high speed trains against differing sets of assumptions about interest rates, traffic volumes and speed profiles.

The key inputs to any analysis are the price of tickets, the level of demand and the cost of building and operating the railway.
Pricing:
Railway tariffs are normally set as a function of trip length and class of travel. In Germany, the current averages are DM 0.27 (10 US cents) per kilometre for first class and DM 0.18 (7 US cents) for second class. (French tariffs work out at nine cents per km first class and six cents per km second class for a 300 km journey). A reasonable middle tariff assumption, therefore, in testing the viability of a European network, is DM 0.20 per kilometre.

Demand:
Demand will depend upon speed and quality of service offered, as well as upon general economic conditions. The most important speed parameter to be tested, since it is now available as a practical top speed for today's generation of trains, is 300 km/h, but for the purposes of comparison, 400 km/h (the apparent potential of Maglev) and 200 km/h, the standard of a previous generation of fast trains, such as British Rail's Inter City 125 fleet, have also been examined. Assuming the two, low and high, growth possibilities already referred to, demand in the year 2000 is projected as follows for the total network:

Possible European high-speed rail network
Traffic volumes in year 2000 (billions of passenger-km)

<table>
<thead>
<tr>
<th></th>
<th>200 km/h</th>
<th></th>
<th>300 km/h</th>
<th></th>
<th>400 km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>200 km/h</td>
<td>14.57</td>
<td>22.28</td>
<td>23.83</td>
<td>39.6</td>
<td>30.32</td>
</tr>
</tbody>
</table>

Key assumptions:
A nominal discount factor of 10 per cent has been used and an inflation assumption of 3% to 7% per year, giving a real discount factor of 3-7%. In practice, the most widely used real discount rate currently employed to test major capital projects is 5 per cent real. Depreciation rates used are those normal in the rail industry (e.g. rolling stock 25 years.) As for timing, the report works from the basis that on present plans, the Paris–Brussels–Cologne link might be under construction by 1992 and in operation by 1996, so the investment period examined for financial purposes for the network is 1992–2016.

Revenues:
At a 5 per cent real discount rate, and at various speed and demand levels, the cumulative cash take of the network during the entire project period is as follows:

Possible European high-speed rail network
Revenues 1992–2016, assuming tariff of DM 0.2 per passenger/kilometre. (DM billions)

<table>
<thead>
<tr>
<th></th>
<th>200 km/h</th>
<th></th>
<th>300 km/h</th>
<th></th>
<th>400 km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>200 km/h</td>
<td>30.5</td>
<td>46.6</td>
<td>49.9</td>
<td>83.2</td>
<td>50.7</td>
</tr>
</tbody>
</table>
It can be seen from these figures that DM 66.5 bn is the middle value for cumulative present-value revenues at the most likely discount rate (5 per cent), the attainable maximum speed (300 km/h) and a reasonable ticket price (DM 0.2 per km).

Expenditures:
A lot of cost information on high-speed trains is available, but it is of mixed quality. Costs for Maglev, for example, are in part theoretical at this stage, whereas for conventional high-speed trains, the construction cost has varied widely from project to project. The first TGV, for example, with a relatively curve and hill-free route, cost only DM 7.6 m per kilometre, compared with DM 12.5 m for the German rapid rail system, DM 9.9 m for Direttissima, DM 16.8 m for Sanyo Shinkansen and an estimated DM 13.5 m for Maglev. For the present analysis, it has been assumed that a European network would experience a mixture of costs within the French and German ranges.

Non-capital costs present less of a problem. These operational costs are well known and show little variance from country to country. Therefore, it can be calculated that at a 5 per cent discount rate, the following costs (including interest charges and depreciation) will be accumulated between 1992 and 2016 (stated in terms of present value)—DM 64.7 bn for the low demand scenario; DM 81.9 bn for the high scenario; and a middle value of DM 73.3 bn. This compares with DM 49.9 bn; DM 83.2 bn and DM 66.5 bn for revenues. In other words, the high speed network taken as whole and assuming a tariff of DM 0.20 per km, fails to cover its costs in two of the three scenarios.

Revenues and expenditure compared:
It is possible on the basis of this information to work out at what average tariff level costs would be covered across the entire network hypothesised. The table below shows the ratio between revenue and expenditure for the different possible fare levels and the various demand scenarios. When the ratio reaches one, break-even is achieved.

Possible European high-speed rail network
Tariffs needed for 300 km/h network to cover costs

<table>
<thead>
<tr>
<th>Tariffs DM per km</th>
<th>Low demand</th>
<th>Medium demand</th>
<th>High demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15</td>
<td>0.58</td>
<td>0.68</td>
<td>0.76</td>
</tr>
<tr>
<td>0.18</td>
<td>0.69</td>
<td>0.82</td>
<td>0.91</td>
</tr>
<tr>
<td>0.20</td>
<td>0.77</td>
<td>0.91</td>
<td>1.02</td>
</tr>
<tr>
<td>0.25</td>
<td>0.96</td>
<td>1.14</td>
<td>1.27</td>
</tr>
<tr>
<td>0.27</td>
<td>1.04</td>
<td>1.23</td>
<td>1.37</td>
</tr>
<tr>
<td>0.30</td>
<td>1.16</td>
<td>1.36</td>
<td>1.52</td>
</tr>
<tr>
<td>0.35</td>
<td>1.35</td>
<td>1.59</td>
<td>1.78</td>
</tr>
</tbody>
</table>

The break-even fare for the entire 300 km/h network is thus seen to be DM 0.19 per kilometre in the high demand scenario, and DM
0.26 per kilometre in the low scenario. Both these fares are below the current price of a first-class rail ticket on German Railways. For Maglev, which has higher unit construction costs, the analysis shows the break-even fare to be somewhat higher: DM 0.23 per km for the high scenario and DM 0.31 per km in the low scenario. It is important to note, however, that all these figures assume the existence of a Channel link. Without such a link the potential of the high-speed network is reduced.

Building the network: Starting points.

Since it is unlikely that a decision would be taken to go ahead with a planned construction of the entire high-speed network described here, it is necessary to look at various sections of the system and to test their freestanding economic viability, without, for example, the assumption of a feed of traffic from a fixed Channel link. In examining individual parts of the network in this way, it is also possible to calculate in outline potential rates of return for these sections.

The most sensible strategy would be to concentrate new construction for high-speed links in the most heavily used corridors and, initially at least, to press for the upgrading to 200 km/h of lines on the periphery of the network. The highest traffic densities are found on the Paris-Brussels-Cologne-Frankfurt-Mannheim-Basle axis, which already contains the high-speed Paris-Lyon and Mannheim-Stuttgart services. Excluding these existing links, 1,237 km of route remains to be upgraded.

A second phase, with dense potential traffic—Lille-London-Birmingham-Manchester—depends upon the completion of a Channel link. Beyond that, the best bets would seem to be Cologne-Hannover-Hamburg (372 km); Paris-Frankfurt (470 km) and Lyon-Marseille (227 km). The link to Italy should also be upgraded perhaps via Basle/Zurich-Milan-Bologna, to connect with the Florence-Rome Direttissima. It may be, however, that given the likely completion of the Lyon-Marseille link by SNCF, that a better high-grade Italian link would be Marseilles-Turin-Milan, rather than building an additional Alpine tunnel.

Traffic volumes for each of the first three phases is projected as follows:

Possible European high-speed rail network: Traffic volumes

<table>
<thead>
<tr>
<th>Phase</th>
<th>low demand (bn passenger kilometres per year)</th>
<th>high demand (bn passenger kilometres per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase one (1,237 km)</td>
<td>8.91</td>
<td>15.24</td>
</tr>
<tr>
<td>Phase two (559 km)</td>
<td>4.94</td>
<td>9.19</td>
</tr>
<tr>
<td>Phase three (1,560 km)</td>
<td>5.44</td>
<td>8.27</td>
</tr>
</tbody>
</table>
Traffic density—passengers per kilometre per year—is as follows:

**Possible European high-speed rail network: Traffic density (10^6 passengers/km/year)**

<table>
<thead>
<tr>
<th></th>
<th>low demand</th>
<th>high demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase one (1,237 km)</td>
<td>7.2</td>
<td>12.3</td>
</tr>
<tr>
<td>Phase two (559 km)</td>
<td>8.8</td>
<td>16.4</td>
</tr>
<tr>
<td>Phase three (1,560 km)</td>
<td>3.5</td>
<td>5.3</td>
</tr>
</tbody>
</table>

These figures compare with traffic densities for the total network of 4.3 to 7.2. The highest density sections clearly will have the best financial potential, as is illustrated in the following table:

**Possible European high-speed rail network**

**Revenue versus expenditure for the three phases*—DM bn.**

<table>
<thead>
<tr>
<th></th>
<th>low demand</th>
<th>medium demand</th>
<th>high demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase one revenues:</td>
<td>17.4</td>
<td>23.6</td>
<td>29.8</td>
</tr>
<tr>
<td>Phase one costs:</td>
<td>16.7</td>
<td>19.5</td>
<td>22.3</td>
</tr>
<tr>
<td>Phase two revenues:</td>
<td>9.7</td>
<td>13.8</td>
<td>17.9</td>
</tr>
<tr>
<td>Phase two costs:</td>
<td>7.8</td>
<td>9.8</td>
<td>11.8</td>
</tr>
<tr>
<td>Phase three revenues:</td>
<td>10.6</td>
<td>13.4</td>
<td>16.2</td>
</tr>
<tr>
<td>Phase three costs:</td>
<td>13.4</td>
<td>15.7</td>
<td>18</td>
</tr>
<tr>
<td>Total revenues:</td>
<td>37.7</td>
<td>50.8</td>
<td>63.9</td>
</tr>
<tr>
<td>Total costs:</td>
<td>37.9</td>
<td>45.0</td>
<td>52.1</td>
</tr>
</tbody>
</table>

*Assumes 5 per cent discount rate; mix of TGV/German Rail costs: 300 km/h max. speed and DM 0.20 per km average tariff.

Since these revenue figures are based upon an average tariff of only DM 0.20 per kilometre, it can be seen that even at a distinctly modest fare level, these projects, with the exception of phase three, cover their costs.

From here, it is possible to state the internal rate of return of each phase at differing traffic assumptions and tariffs. Phase one shows a rate of return of 6 per cent, with an average tariff of DM 0.18 on the high demand scenario. If the tariff becomes DM 0.27 per km, the rate of return is 14 per cent.

It would also be necessary, in further developing the concept of a high-speed train network, to carry out detailed economic cost-benefit analysis. Preliminary indications, based upon assessment of time-saving, environmental advantages, reduction in traffic accidents and avoided investment in other transport modes suggests there would be considerable net benefit from building such a network. In terms of energy consumption alone, high-speed trains offer considerable advantages. The TGV, for example, uses 250 watt-hours of primary energy per passenger kilometre, compared with 690 for the average car and 910 for the Airbus A300 at average load factor.
Politics and the next steps:

Since all of Europe’s major railways are state-owned, their development is bound to be a political matter. So far as backing for high-speed rail technology is concerned, the French Government has taken the most aggressive lead, based upon the success of the TGV. The German and Italian Governments have pursued a more cautious policy, with less overt emphasis upon high-speed passenger links. British Rail, which has had a disappointing experience with its own high-speed train—the tilting Advanced Passenger Train—finds itself in an uncertain position.

In addition to the major national interests, a number of bilateral or trilateral efforts are under way, such as the joint investigation between Belgium, France and Germany of a high-speed rail or Maglev system for Paris-Brussels-Cologne. The EEC also has interest in transborder transport developments and might contribute to investment in an international high-speed rail network. The International Union of Railways (UIC) also has a research programme, linked to the work of the Williamsburg and Versailles summits. This November, the French Transport Ministry will host a post-summit working group meeting on high-speed trains.

Governments, however, must consider other aspects of the transport equation in addition to rail. One particularly sensitive area concerns Europe’s airlines, which stand to suffer losses of passenger volume if high-speed rail plans go ahead. SNCF estimates that this year air traffic on the Paris-Lyon route will be 31 per cent lower than it would have been in the case without competition from TGV. Equally, the economic calculations presented in this report and the assumptions about diverting traffic from air services rests upon the fact that European air fares are high, some would say artificially high. If the move towards a more deregulated civil aviation structure continues, this may not be the case indefinitely.

Nonetheless, from the evidence available, it is clear that high-speed rail links have much to recommend them in industrial, economic and social terms. Before proceeding to specific investment plans, more work would be needed on all the aspects discussed in this report—demand, topography, balance between different modes of transport, technical questions and finance.

There is much activity in the field and it is important that efforts to co-ordinate these varying initiatives are sustained, so that in the next phase of Europe’s railway development networks will be more coherent than those we have inherited.
Alpine links: 
Note on status of proposed projects.

The working group did not study in detail individual transAlpine projects, but is aware of a number of proposed additional crossings which are at various stages of debate and planning.

A useful round-up of the numerous rail options considered in recent years is contained in a 1982 report by Coopers and Lybrand for the European Commission.

This report looked at three proposals:

- 1. A plan under consideration by Swiss Railways and the Swiss Government to build a rail tunnel at St. Gotthard.
- 2. A tunnel at Brenner. There are three rival versions of this plan - a long, low version proposed by members of the International Railway Union (UIR) and supported by provincial government in Trentino-Alto Adige; a short, high and cheaper tunnel proposed by the Italian State Railways and an intermediate solution agreed upon in 1981 by Austrian, Italian and German Railways. Details of the latter project have not been made public.
- 3. Two possible designs for a tunnel at Spluggen — a long, low and therefore expensive tunnel considered by the Swiss Government and a cheaper, higher version considered by Regione Lombardia and other Lombardian interests.

Coopers and Lybrand found that the quality of information available made it difficult to compare the economic and financial merits of these schemes. The fact that each had been considered in isolation, sometimes with regard only to the impact upon railway industry finances rather than general economic benefit, meant that the attractions of any of the schemes may well have been understated.

This fits in with the working group's contention that if international transport projects are to be properly assessed, the work must be carried out on the broadest basis possible, allowing for the ripple-down effects between one scheme and another.

Notwithstanding these limitations, Coopers worked out potential rates of return for three of the projects — one at each site — and found that even the most profitable project, the Swiss Gotthard tunnel, would not generate sufficient profit to cover any realistic financing costs. The long, low version of the Brenner tunnel was clearly in operating deficit, and the operating surplus of the Spluggen tunnel was lower than that for Gotthard.

Coopers comments in its report, "it should not be inferred from this illustration, however, that the Gotthard project is the best from the global viewpoint, nor even that it is not worth undertaking on normal criteria. Given the great uncertainty about many of the items used in the calculation, and the purely illustrative nature of the calculation, we should rather ask under what circumstances would a Gotthard project be worthwhile? and under what circumstances would a Spluggen or Brenner project be preferable to a Gotthard?"

Clearly much more work would need to be done before selecting any transAlpine route for sponsorship, but the fact remains that existing rail routes were all built between 1860 and 1920 and involve heavy restrictions upon speed and size of trains.

An investigation of the most attractive transAlpine projects — both road and rail — from the international business standpoint would be worthwhile.
Information sources.
Data. Bibliography

The working group aimed to provide a concise and readable report. For this reason, data sources and references are conspicuously absent from the text, charts and tables.

The group's report is compiled from the following written submissions and reports:

Channel Link (EuroRoute) Kenneth Groves
High Speed Trains Perspectives & Opportunities in Europe Rolf Umbach
Scandinavian Link A Technical & Economic Assessment Bo Ekman/Per-Erik Jevne
Financing Large-Scale Infrastructure Projects: Successful Examples Telesis Paris
The TransAlpine Tunnels Case Study Fidiger Coopers and Lybrand SpA for the EC Commission

The "pedigree" of the facts and figures quoted in the "Missing Links" report is finely detailed in the written submissions and reports listed above. Questions on the pedigree of facts and figures should be addressed to Michael Hinks-Edwards at the Roundtable Secretariat Paris Office (see address below).

Roundtable Secretariat Paris Office
49 Avenue d'lena
75116 PARIS
(France)
Tel: (33) 1 723.72.62
Tx: 613977