
EXPLORING RAIL FUTURES USING SCENARIOS: EXPERIENCE AND POTENTIAL

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Abstract

In 1995 the author of this paper undertook a scenario exercise for British Rail to identify priorities for rail science and technology developments under the new privatised regime. Four market-based 2010 scenarios were developed for UK rail transport: *cost-driven*, *quality-driven*, *technology-driven* and *environmentally-driven*. These helped to identify areas of strategic R&D that were needed to improve rail's competitiveness.

It is now over a decade since this scenario exercise took place. This paper, updating an earlier review (Potter and Roy, 2000), revisits the 1995 scenarios and compares them to what actual market strategies emerged within the privatised railway industry. It explores whether the four scenarios did succeed in capturing the range of market responses that emerged from rail privatisation and what lessons this contains for the use of scenarios transport research.

1. Scenarios and Technology Foresight

Various forms of technological forecasting have emerged since first attempts were made in the 1940s to arrive at an 'informed judgement' of how innovations and technologies may develop in the future. Technological forecasting emerged as a recognised management discipline in the 1960s and has become important for many large business organisations. In recent years the practice of technological forecasting has moved to the public policy arena; for example, following the example of Japan, in 1994 the UK Government established a Technology Foresight Programme. The aim of the Foresight Programme and the related *Horizon Scanning Centre* has been to bring together government, research and industry, with a series of sector-specific expert panels to explore technological opportunities that will improve the competitiveness of the UK economy. (Office of Science and Technology, 2006).

Despite its growing use, technological forecasting is fraught with uncertainty. One of the subject's pioneers, Jantsch (1967) noted:

Technological forecasting is not yet a science but an art, and is characterised by attitudes, not tools; human judgement is enhanced, not substituted by it.

This perceptive comment on the nature of forecasting is worth emphasising. It was developed later by Wills (1972), who suggested that:

...to be useful forecasts do not necessarily have to predict the precise form technology will take at some specific future date. As with other forecasts, their purpose is simply to help evaluate the probability and significance of various possible future developments in order that management may take better informed decisions.

Technological forecasts have proved problematic in our increasingly complex society and economy, particularly in areas of characterised by radical change and uncertainty. Technological forecasts seem to work best when markets and societies are more stable and technological change is incremental. This is becoming less so, even for transport, where technological trends were once thought to be reasonably predictable. But technological forecasting also faces an epistemological critique for its positivist/reductionist research philosophy. Such an approach to research involving social processes is now viewed as insufficient (e.g. Stainton-Rogers, 2006). Yet strategic transport decisions seem to continue to be based on reductionist technological forecasting-style approaches (e.g. in the 1990s on the market penetration of battery-electric vehicles and now the widespread assumption of the eventual dominance of the hydrogen fuel cell vehicle).

Although it may be more for pragmatic than epistemological reasons, in situations of technological, social and economic uncertainty, scenario planning has emerged as an alternative to technological

forecasting. Scenarios are not attempts to predict a single future, but aim to explore how different future states might develop. Porter (1985) defined scenarios as:

an internally consistent view of what the future might turn out to be – not a forecast, but one possible future outcome.

Gill Ringland's seminal study of scenario planning (Ringland, 1998) develops this definition to say that scenario planning is:

that part of strategic planning which relates to the tools and technologies for managing the uncertainties of the future.

Scenarios are not intended to foresee the unforeseeable. As Ringland (1998) documented,, scenarios permit an exploration of potential paths into the future and so contribute to a strategy for a company, industry or country to effectively manage uncertainty. Crucial to this is that scenarios are very effective as a means of communicating ideas about the future without requiring either a detailed understanding (or blind acceptance) of the mathematics and statistics associated with other forecasting techniques. They are a method of technological forecasting that is understandable to all actors in an organisation and in which effective participation is not restricted to a small number of technical experts.

The purpose of scenario building is to focus attention on causal processes and decision points. Scenarios attempt to answer two kinds of question. The first is, how might some hypothetical future evolve, step by step; secondly, what alternatives exist for each actor, at each step, to adapt to the change or to prevent, divert or facilitate the process?

The research philosophy behind scenarios is one that seeks to accept and explores complexity and key drivers rather than seeking to identify rules for a model that permits a prediction. As well as possibly being more pragmatic than technology forecasting, scenarios are also more towards a constructionist paradigm.

2. Scenarios and Future Rail Technologies

In 1994/95 Robin Roy and the author of this paper were invited by British Rail's Director of Technical Strategy to take part in a 'futures' exercise in a situation of great uncertainty, namely British Rail's privatisation. A conference, *The Railways: Challenges to Science and Technology*, (Smith et. al, 1995) was held at the Royal Society and a detailed briefing note was prepared by Potter and Roy to help structure contributions to this conference from technical experts.

Although rail privatisation was expected to result in a major upheaval and significant organisational change (as indeed was the case), to a large extent privatisation only heightened or modified major changes that were already happening in the rail's markets, coupled with a move for all railways to concentrate on their operating functions and to outsource non-core activities, including rolling stock design, maintenance, catering and other ancillary services. Privatisation was expected to accelerate and redirect these existing trends, but the implications for rail technology were far from clear. Our briefing paper therefore took a scenario approach to explore this uncertainty.

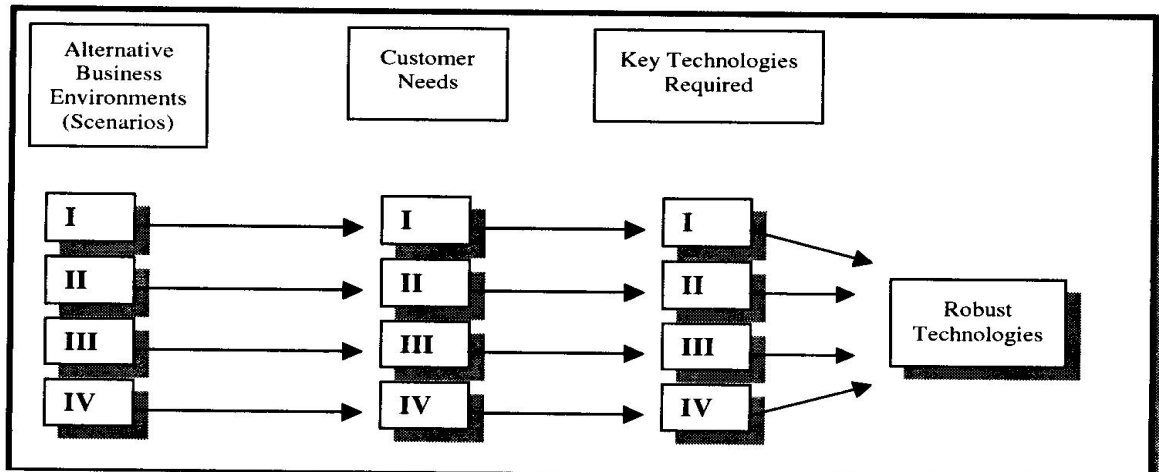
The method for developing the rail market scenarios relates closely to that used by the Futures Group and documented in Ringland (op. cit. pp 223-226), although we did not have access to this work at the time. Our approach involved three stages as illustrated in Figure 1.

The first two stages involved developing four alternative ways that the new privatised rail companies might develop the market base for the railways in Britain, including the key attributes of the types of market envisaged and how they addressed different customer needs. These were then subject to a brainstorming workshop of key actors in order that the scenarios could be refined.

We identified broad science and technology implications of each scenario, which were then used to brief the technical experts. The intention was that these expert conference speakers would explore:

- The likely technological opportunities and barriers should the market develop in the way envisaged in each scenario;
- Existing and emerging technologies that have most relevance to each scenario and across several scenarios;
- Science and technology 'gaps' where there is a need for new R&D and technical innovation in order for each scenario to be achieved.

Figure 1: The Scenario Development Process



(Adapted from the Futures Group in Ringland, 1998, p. 223).

(adapted from the Futures Group in Ringland, 1998, p 223)

The aim was that the experts and the conference would compare the results from the alternative scenarios to identify 'robust' areas of science and technology crucial in more than one of the scenarios. Clearly there would be some overlaps between the scenarios; also some aspects of one scenario may be needed to achieve another.

The time period adopted was fifteen years to 2010. Each scenario was developed within a structuring framework. Firstly context and issues were established; then the nature of market development was specified, followed by the identification of consequent technical needs and challenges. In addition, a 'typical passenger journey' under the conditions of each scenario was described. This, we felt, helped enhance the accessibility of the scenarios to all actors in the exercise. The conference participants found this future 'journey' particularly useful for developing their suggested innovation priorities.

3. The Four Rail Market Scenarios

The following are edited versions of the four scenarios as they were presented in the briefing paper to the 1995 Royal Society conference speakers. Following a brainstorming workshop held before the conference, the scenarios were built around four alternative market approaches: *cost*; *new technologies*; *quality* and *environment*. The report of the conference (Smith et al, 1995) details the work that stemmed from these scenarios, but this paper concentrates on the development of the scenarios themselves and their use in transport research. Although the scenario exercise covered both passenger and freight, this paper contains only the work on the passenger market.

1. Cost-driven Scenario

Context and Issues

This scenario is based on the assumption that cost-reduction will dominate the requirements for rail science and technology. Cost reduction had been a major focus for British Rail for at least the last decade of its existence. Under privatisation there are likely to be further cost reduction pressures (as this is a key part of the rationale for privatisation). Independent companies for train operations, stock leasing and maintenance will each have their own overheads and will have legal/contractual relationships with each other, plus the requirement to make a profit. This will provide additional incentives for financial savings in all areas of railway operations.

Market Demands

- Rail services need to offer value for money against their major rivals, particularly cars and airlines.
- Although cost reduction is crucial to achieving value for money, but a lowest possible cost ('cattle truck') scenario is not realistic.
- Rail's passenger market has become increasingly segmented and is likely to become more so (OECD, 1991). This is addressed via the ticketing structure, but, in the future there will be

engineering and design implications. For example, a commuter train designed with high density seating may not be best to attract off peak users at the weekend.

• Markets that are expensive to serve (e.g. traditional large commuter flows) could well be the subject of particular attention. Developments of markets that have low marginal costs (e.g. off peak leisure trips) would become increasingly attractive under such a scenario. Rail's market would become a series of distinct niches with stronger quality/cost distinctions than today.

Technical Challenges

This scenario is based on examining where science and technology could address major cost drivers in rail operations. Savings based on science and technology (or other) changes could be:

Investment (Capital) Costs

- Lighter and stronger materials for rolling stock.
- At the bottom of the market, use of old refurbished stock at lower fares as has happened with buses after deregulation in the UK. Refurbishment technologies would be crucial.
- Increased reliability reduces capital costs by requiring fewer trains via increasing availability and reducing unscheduled repairs and maintenance.
- If passenger and freight traffic were segregated, passenger rail vehicles need not be as strong and could be more like cheaper light rail vehicles. Systems that permit such segregation, or permit safe mixed operations, could yield substantial cost savings.
- High speed is expensive. 125mph (200km/h) is a key threshold above which costs increase significantly. Eliminating lower speed restrictions and rolling stock designs for good acceleration and braking (particularly for stopping services) would be important challenges.

Fuel - Diesel (or other on-board) power is cheaper to operate on partially electrified routes because it avoids the need for engine/crew changes and energy charges to Railtrack.

Safety regulations and standards - Good engineering-led analysis is needed regarding rail safety. This has become a major cost in all rail projects with little concept of the marginal benefits and costs. A rethink on APT (automatic train protection) and other safety systems is long overdue. Could new signalling or other systems result in a simpler and more cost effective safety system?

Access charges for track and stations- If there is a move to charging according to use and track wear, then low track force designs will be crucial combined with operational systems that produce good (but not overcrowded) train loadings. With the operator not owning stations, operators would be likely to offer more services on board the trains.

Signalling and Telecommunications - Could signalling be reinvented in a more cost-effective way?

Maintenance - Low maintenance designs, design for reliability (use of Life Cycle Costing in design), or transfer of low maintenance technologies from outside the railway could reduce costs.

Staff Costs- Today's railway operates on large number of (generally) low skilled staff. The railway could be operated with fewer, multi-skilled staff to cope with complex equipment and systems. Rail staff will be broadly graduate level for all areas.

Widening the cost base - There would be pressure to spread rail's costs to non-rail services. There would be a role for science and technology developments to facilitate this. For example (a) the planned use of a rail telecoms network as a competitor to BT (British Telecom); (b) could power transmission using the railways' overhead lines be possible as an alternative to the National Grid? Are there other areas of the railway which could be opened up through science and technology developments to widen the cost burden?

There will not only be general cost reduction pressures, but also demands stemming from a price-focused system organised around niche markets, for example, more complex booking systems would be needed if there are a range of discounted tickets; short-notice seat reservations and onboard controls and perhaps even flexible train interiors to match the mix of customers carried.

Cost-driven Scenario: Typical Passenger Journey

I drove to the station and found a space in the large pay and display car park. Worked my way through the station's market and the car boot sale to the booking machines. Checked up on the 'late bargains'. My gamble paid off; there were still club seats available on the 8.30 at a 30% discount. That is nearly as cheap as prebooked economy and this train is faster and more

comfortable. My train arrived just after the business class express. It was one of the new lightweight electro diesels for partly electrified routes like this.

Confirmed my seat, as usual, by punching in my credit card number on the display. The train was pretty full and the buffet and trolleys were doing good trade. It is remarkable what you can buy on a train these days. I hear they make nearly as much on franchises and sales as from tickets. The last part of the journey was on the Shrewsbury branch. This has been modernised and converted to diesel light rail system now that freight is only allowed at night. The Canadian rail manufacture, Bombardier, won the contract and now have a 20 year lease on the line. The station has been redeveloped as a small shopping complex. There are no rail staff here any more, but there is the radio link to the Passenger Care Centre at Shrewsbury and the local travel agent can deal with any ticket problems should the machines fail. I had no trouble, the taxi I booked from the train was awaiting me.

2. Technology-driven Scenario

Context and Issues

This scenario is based on the assumption that market opportunities for railways could be opened up through major technological innovations (although cost and value for money relative to other transport modes cannot be ignored).

Market Demands

In the past, technology-driven innovation has largely been led by the upper end of the market - focusing on markets such as business travel, upmarket leisure, white collar commuting, links to international airports and international rail stations. Could science and technology give an edge across all rail's markets? Much of rail's market will be less concentrated on high flow trunk routes than today, with less of a worktrip peak. Flows will be more evenly spread in time and space.

Technical Challenges

Rail's technical strengths

- Journey time - can be reduced not only by adopting tilt technologies and new high-speed lines, or even magnetic levitation (MAGLEV) trains, but also overcoming the lower speed restrictions that affect journey times badly. Ride comfort – this is determined by suspension, braking systems and track quality.

Rail's technical weaknesses

- Unreliability - deficiencies in rolling stock, signalling and points reliability and capacity constraints. There is the potential for more flexible, high-capacity signalling systems, increased reliability of rolling stock and on-train diagnostics to spot potential failures.
- Passenger information - improvements are needed in passenger information technology on-board, at stations and at home.
- Integration with other transport modes affects several aspects including through ticketing and journey planning; signalling systems to increase capacity.

Generic Technologies

- Information Technology - Passenger information systems is area where there is much potential for technical improvement and needs to be based on real-time railway operations. 'Smart Card' ticketing needs developing to permit effective through ticketing in the emerging privatised railway.
- Materials - Composite materials (e.g. fibre reinforced plastics; metal matrix composites) are likely to be important for strength and rigidity as well as fire and crash protection.
- Electrical Transmission Technologies - Very high speed (300 km/h) services, requiring 12MW or more electric trains, will cause serious problem of local power supplies.
- Mechanical Engineering /Vehicle Technologies - There is a need for advanced bogie designs to reduce unsprung mass and improve performance. Microprocessor controlled active suspension and steering bogies could increase comfort and speed. Improved braking technologies for high speed are required. Weight saving technologies will increase in importance.

- Signalling and Telecoms- Higher speeds require alternative signalling systems. For example, speed signalling, used in France, that indicates a safe speed to the driver rather than route signalling likely to spread to UK.
- Traction/Fuels - For non-electrified routes gas turbines could be considered for high performance trains, but there have been considerable advances in diesel technology too.

Key Related Technical Developments

There are non-rail technical developments which could have major implications for rail. For example IT will alter the way in which many professional jobs are undertaken. Teleworking from home appears unlikely to become very widespread, but the dispersal of many jobs from city centre offices to suburban teleoffices could occur. This could threaten rail's core commuter market, but would also represent an opportunity for rail to develop a new market. Key suburban stations could be developed with 'teleoffice villages' and rail-based teleoffices could service rural areas with advanced telematic services.

Technology-driven Scenario: Typical Passenger Journey

I made my seat reservation on-line just before leaving home to get the train to Ashford. There I would meet my colleagues for a quick conference before we catch the overnight service to Berlin. I joined the Autoguide™ people mover at our local stop which connected with my train via a covered walkway. I was rather behind with the job at hand, so I had booked into the teleoffice carriage and ordered a working lunch to be delivered to my workstation. The conductor checked my reservation via his mobile control station.

Managed to pick up the data from Boston via the Internet, which got me well ahead, and sent an e-mail to Berlin to confirm the details of tomorrow's meeting. Found the one showing the train's speed (280km/h), where we were, and expected time of arrival. On the last German trip I tried out the Hamburg - Berlin MAGLEV, which had just opened. It was very spectacular, but ends in the suburbs and it took a good while to get to the city centre. Now the Eurostars run at 350km/h between city centres, the MAGLEV is looking very Concorde-sque!

3. Quality-driven Scenario

Market Demands

This scenario assumes that market opportunities could be opened through an emphasis on high levels of reliability, safety, comfort, ride, in-train services and information systems. Quality has tended to be treated as something that applies more to business class travel than the more 'price oriented' other categories. Could quality be a key competitive force across all of rail's market segments? This would use a number of technologies considered in the technology-driven scenario, but concentrating very much on the service offered to the passenger.

A study by the Henley Centre for Forecasting (1993) argued that quality of service will be the central factor that will win or lose rail its passenger market. This will be in terms of:

- value for money compared to rival transport modes;
- relevance and user-friendliness of routing and scheduling;
- reliability, punctuality and short journey times.

Probably the most important determinant of perceived quality is providing rail customers with a high quality 'familiar' environment during their journey. For example, the business traveller wants his/her office environment, together with the best facilities they could expect at work; the leisure traveller wants his/her 'living room environment' and all the best things they value there. Refurbishment technologies would likely to be crucial to maintain quality and for quality to be applied to the bottom of the market where older stock is likely to be used.

Apart from the strengths and weaknesses already identified under the cost-driven and technology-driven scenarios, these could be categorised as:

- Strengths:
- Interior design - seating, lighting, air conditioning, noise levels.
 - On-board services - catering, entertainment, business services.
 - Safety - including personal safety and security as well as operational safety.
- Weaknesses
- Passenger information - onboard, at stations and at home; passenger information technology.
 - Systems to integrate ground and onboard systems.

- Integration with other transport modes – there is a need to think less of the rail system in isolation and more how it is part of a high quality multi-modal network. Multimodal booking systems will be needed.
- cleanliness - not just cleaning, but design for cleanliness (e.g. materials used for interiors or technologies such as vacuum toilets).
- quality and availability of food and drink
- quality of customer service delivered by staff

Quality-driven Scenario: Typical Passenger Journey

The Stationshuttle™ taxi arrived dead on 8.00. I had booked the trip last week. It was nice that you can book the shuttles and train all in one transaction. Checked the baggage in on the Shuttle, which was the last we'd see of it until we arrived at Aunt Mary's house in Middlesborough. There were a couple of other passengers on the taxi, one was catching our train while the other was getting the 8.32 international to Brussels. Had a few minutes to spare at the station and so browsed around the shopping mall. The kids got a present for Aunt Mary.

We were welcomed into the carriage by one of the stewards who checked our booking via his mobile control station; the other steward was serving coffee to the passengers already on board. We had booked one of the family compartments, but even so Jean dropped the kids into the onboard creche/playgroup which left us free to settle down and watch one of the video programmes on the seat back entertainments/information centre. The kids joined us for lunch, which was included in the ticket price. The carriage had a mix of compartments of different sizes (some with business equipment, others laid out for families) and open seating. Apparently the layout can be changed quite a lot depending on the mix of people travelling. The ride was very smooth and quiet, even when we passed other trains.

Took a quick shower to freshen up before we arrived; tried not to think that the water is largely recycled to save weight! Checked up on the VDU on Middlesborough station's layout and which platform we would be using. The shuttles departed very close to where we would alight. Our luggage was already on board when we got to it. We were the second to be dropped off. I hope Aunt Mary is into the virtual reality video game the kids bought her!

4. Environmentally-driven Scenario

This scenario focuses upon an external policy context which could have major implications for the shaping of the future market for rail.

Context and Issues

In the Department of the Environment's UK Round Table on Sustainable Development (July 1994), transport emerged as the top agenda item from the consultation procedure. The 1993 UK Environmental Foresight Project also noted the importance of transport as source of environmental concerns. This report contains a number of indications of the way in which these concerns could manifest themselves. It concludes:

- Current (environmental) issues will persist and become more mature; issues currently on the agenda of other nations will become part of the UK agenda;
- The agenda is likely to be dominated by air pollution and global climate change;
- The environmental agenda of the future in the UK will become more closely aligned to its energy policy agenda.

The 1991 OECD report on future transport noted that "in the long term future, it is most likely that environmental constraints will be a major factor determining the extent to which demand for transport can be met and the ways in which this is done. For rail, its greater energy efficiency compared to travel by car or aircraft means that there will be increasing pressure for public policies that substitute rail travel for journeys currently accommodated by these modes.

Market Demands

An example of a rail substitution policy is the Dutch Rail 2000 plan, which arose out of their National Environmental Plan, resulting in a need to double rail capacity and reorganise services accordingly (including a new dedicated freight line). Modelling work at the Open University by Hughes (1993) indicates that, as part of an integrated plan to control carbon dioxide emissions

from passenger transport, something like a 90% increase in passenger rail capacity would be needed, concentrating on urban and motorway corridor movements.

There will not be an across-the-board expansion of rail services, but a targeted expansion on the market sectors where rail has greatest potential to reduce environmental impacts. The following could well feature as key target groups:

- all types of trips within towns and cities;
- intercity and major cross country trips;
- domestic business (and short haul international) trips currently served by air;
- feeder links to airports for international travel currently served by domestic air.

Overall, the challenge will not only be for rail to expand its existing markets, but to effectively move into some markets it currently only marginally serves, for example more dispersed intra-urban trips (rather than radial flows) or serving freight markets currently totally carried by road.

Technical Challenges

Rail capacity would have to be expanded while minimising rail's own environmental impacts (emissions, noise and land take of new/expanded lines). High capacity signalling systems and major upgrading of existing lines could be important for R&D.

High speed is not particularly important, but elimination of speed restrictions to improve journey times and frequency would be important in making rail a publicly acceptable 'green alternative' to the car or air. There could be major problems of passenger services being slowed down if freight carryings are substantially increased, so science and technology developments to address this would be important, possibly via faster freight, segregated systems or 'smart' signalling.

Integration with other 'green' passenger modes would be important - including cycling, (trains designed to carry bikes as in Denmark); and enhancing pedestrian access to stations and buses.

There would also be a need to address rail's own environmental impacts. A major capacity increase would produce environmental problems of its own. Landtake for new lines might be minimised via innovations in signalling to increase the capacity of existing track. Noise problems as traffic increases would also be of importance. Key issues would be:

Fuel choice, efficiency and emissions. Developments in this area include:

- Ultra-fuel efficient diesels with 'smart engine' controls to reduce emissions;
- Natural gas powered trains - a very much cleaner fuel than diesel and it is relatively easy to adapt diesel engines, but there is a serious power penalty which needs addressing.
- Electric traction needs to ensure cleaner power generation. The railways could generate their own 'cleaner' electricity, (for example, via combined heat and power [CHP] for depots, stations, railway premises and the overhead line; biomass or wind generation). Biodiesel could be used or hydrogen fuel cell trains could be developed.

Energy-efficient engine designs: lightweight construction; aerodynamics, and weight savings (e.g. vacuum toilets to reduce amount of water carried) are all areas for innovation. Energy efficiency of onboard systems (heat pump air conditioning, high efficiency insulating materials) is another area for development.

Noise and vibration - Use of noise reducing ballast and track design (e.g. rail pads in sleepers); vehicle cowling; non-steel wheels for lighter vehicles.

Environmental legislation: Only new lines are subject to noise limits; this is likely to change. Some diesel engines (IC 125 in particular) do not meet road vehicle emission standards. Refrigerants in air conditioning need to be assessed for environmental impacts. Major new rail construction projects will be subject to increasingly stringent Environmental Impact Analysis.

Discharges to track and other waste: Retention toilets (compatible with the need to reduce weight) and recycling of onboard services waste are two relevant issues.

Environmentally-driven Scenario: Typical Passenger Journey

Cycled to local light rail stop and left my bike in one of the lockers there. I didn't need the bike in Caernarvon and so I left it behind today. It was a five minute ride to the mainline station. This had been enlarged in the last few years and platform capacity doubled, taking most of the site of the old car park. The rest was new bike parking and the light rapid

transit (LRT) interchange. The weather was hot, but the station had been carefully redesigned to ventilate naturally. In winter the CHP system provided power for the station and trains and also heated the station and many nearby houses.

The train was one of the new Ecoliners, which are large, lightweight electric multiple units to make the most of the limited track capacity around London. Even given the new signalling system, it is close to capacity at times. We were held up by the Willesden-Glasgow freight shuttle. The trains run out of Euston every two minutes and then divide enroute to serve several destinations along the West Coast line. Some are not even physically joined, but run, electronically controlled, a couple of metres apart on busy stretches of line. The train has a top speed of 200km/h on the electrified sections, running at 150km/h using hydrogen fuel cells on other routes. I have some friends who live near this line and they really welcome the noise reduction from the 'neighbour friendly' bogies and new track construction.

My seat was near the bike compartment and showers (very handy when I bring a bike myself). I hear the discharge from the toilets is now composted; it sells well and provides some methane gas as well, whereas before the railway had to pay for sewerage services. The carriages are very comfortable, space has not been sacrificed in order to increase capacity, and the ride very smooth. Each train has two or three buffet bars, offering different sorts of food, or there is an at-seat service. Food can be ordered via the console at each seat. There are recycling bins for waste, plus a tray for the plates and cutlery to be collected for washing.

Our portion of the train split off at Crewe, heading for Holyhead and the Dublin hydrofoil. I changed at Bangor for the line to Caernarvon. This had been reopened as an LRT route, and at some places shares the road with coastal traffic. As we entered the town we passed the fields of genetically engineered rape and lupins that provide biodiesel for this line's trains.

4. A decade Later.....

We are now most of the way towards the 2010 scenario date. This scenario exercise worked well to provide a focus for the 1995 conference, *Railways: Challenges to Science and Technology*, but how successful were these scenarios as a futures exploration technique and what lessons can be drawn from this project?

The scenario construction was based around four alternative market responses and the consequent customer needs that these market approaches addressed. The scenario construction then moved on to identifying the technologies needed for each market approach.

It is worthwhile reflecting upon what has actually happened in Britain's privatised railway regarding market strategies and the technologies used to service them. This is not, of course, to see if any one scenario has come about; that is not the point of a scenario exercise. However, has the outcome fallen within the range of market and technical developments that were considered? Did the scenario exercise fail to identify a key emerging technology? Has the approach of building scenarios around market responses been useful?

The privatisation of British Rail, under the Conservative Government's 1993 Railways Act, involved a mixture of franchising of services and the outright sale of assets and operations. This structure has been modified subsequently, but initially involved British Rail being restructured into over 100 separate companies, including 25 passenger Train Operating Companies (TOCs), the infrastructure company Railtrack, six rail freight companies (five of which were purchased by one operator), three rolling stock leasing companies plus companies covering maintenance, engineering and other support services. During 1995-97 the passenger services were franchised to private sector operators, while all other companies were sold outright to the private sector. The process proved to be very messy, has ended up increasing and not reducing state subsidies and has needed further legislation and reorganisation, particularly in the wake of the bankruptcy of Railtrack and the systemic failures that led to the 2000 Hatfield crash.

Overall, when looking at the characteristics of the privatised railway, market strategies are dominated by responses from within the Cost-driven scenario. This perhaps is not surprising. Winning a passenger franchise has required cost cutting and revenue growth packages and some franchises are now in premium rather than subsidy, and there has also been the recent re-letting and consolidation of franchises. Through all of this financial pressure have remained high.

Employment in the railways has been cut largely by stripping out a whole layer of middle management and ancillary staff and by outsourcing. In some areas there has been an increase in staff to develop new products. The latter is related to the expectation in the scenarios that railways would increasingly segment the market. This was a cross-scenario trend and has proved to be a key issue. It has resulted in a plethora of ticketing deals and diverse marketing strategies. Yield management has become very important with an increasing range of ticketing products.

Investment and innovation has concentrated on new and profitable areas, which have been similar to those suggested in the Cost-led scenario and, to some extent, the Quality-driven scenario (with a focus on off-peak leisure and business customers in particular). There have been very few initiatives that have been dominantly quality-driven. An early example was the introduction by Midland Main Line of a 'Premier' Class above First Class. Implementing this proved tricky as demand varies across the day and in the end this market initiative was abandoned. Other TOCs have concentrated on the traditional stance of quality initiatives for business customers. Virgin have added in-train entertainment systems and power sockets for laptops, but in general these are quality add-ons to a core cost-led approach. The only TOC to develop a new overall quality-led strategy was Chiltern Railways. They introduced a 'club class' train, with a hybrid interior design to satisfy a mixture of suburban and long distance markets. Other TOCs seeking to compete with Intercity operators have used a cost-driven approach, simply cutting prices and using their existing suburban trains in the off-peak, assuming passengers would accept such 'basic' trains if the price was low. More recently quality has been viewed in terms of the basics of railway operations (punctuality and reducing cancellations) rather than services and technologies to enhance the travelling experience for those willing to pay for it. Quality initiatives have not really been a core privatisation strategy.

Passenger information and use of IT was identified as a key cross-scenario issue, but progress has been patchy. Initially it largely involved conventional, rather than innovative approaches (e.g. reorganising the national telephone enquiry line). Web-based information and booking systems have emerged and real time information is now available. However the driver for this seems less to do with customer care than the need for market segmentation ticketing products. Delivering this remains problematic as the information systems try to keep up with more complex pricing structure. For the passenger (and certainly anyone new to rail travel or a particular route), a web booking can remain a lengthy and confusing process, given all the price and availability options for a particular journey. Some through-ticketing arrangements have been made with bus services (partly spurred on by the fact that bus companies won several rail franchises). This now takes the form of the 'Plusbus' add on to railway tickets, providing a bus pass for the day either at the start or end of a rail journey, but it is not extensively used or promoted.

For less lucrative markets, such as peak-hour commuter flows, the suggested trend towards innovative refurbishment has not materialised, despite some radical approaches being offered (e.g. in the mid 1990s the Adtranz *Classic* concept of a low cost commuter train which involves putting a new body on the underframe, wheelset and engines of an existing electric train). Refurbishment has actually been more important in moving upmarket or developing market segmentation, rather than in serving the established commuter markets. Some refurbishment of old locomotives has featured (e.g. IC125 and Class 59).

One thing we did not pick up in the scenario exercise was the way in which the railways have developed cost and risk shifting. With so many companies now involved, with contracts and conditions to provide services to each other, issues of risk management, standards and penalty payments have produced a risk adverse culture that has constrained innovation.

Signalling and rail capacity was identified as a key, cross-scenario, issue, and this has indeed proved to be the case. With cost cutting limited by franchise conditions and a scheduled decline in subsidy, revenue generation has been key to all TOC strategies (Potter and Enoch, 1997). Up to 1996 there had been a steady, but gradual growth, in rail passengers. In 1996 39 billion passenger kilometres were undertaken by rail in Great Britain. By 2005, this had risen to 52 billion passenger kilometres (DfT, 2006). Market expansion is needed for the franchises to be profitable. This key structural situation has led probably one of the most important trends in the privatised railway and has put heavy pressure on the infrastructure. For the upgrade of the West Coast Main Line, the franchise holder, Virgin, and Railtrack initially adopted an ambitious technology-led approach. This was to introduce the tilting Pendolino trains at 140mph (225km/h). In practice cost estimates were continually increased and the specification cut back. Thus, having initially planned to enhance capacity using innovative transmission based signalling, as anticipated in our 1995 Technology-

driven scenario, Railtrack retrenched to using conventional signalling. From being a technology-led approach, this became a cost-led one. When they entered service (late) at 200 km/h the tilting Pendolino trains did cut journey times, but despite the hype, they are really a subsidiary technology add-on to a core cost-centred approach.

There have, however, been more modest moves towards innovative signalling systems, but this has been cost-driven, particularly for rural lines to cut operating costs (e.g. axle counting signalling on the Marston Vale line and transmission-based signalling for Scottish rural lines). For the busy lines nearing capacity, rather than innovative signalling, service simplification and withdrawal of 'complex' services has emerged in the last few years.

The debacle of Railtrack's bankruptcy and its replacement by Network Rail as the track owner/operator highlighted an element of the cost-driven scenario, the seriousness of which we did not appreciate. The cost-led scenario identified that resources would be diverted into areas of higher profitability, but the implication that this might result in a disastrous withdrawal of resource from basic engineering was not picked up.

Overall, only hints of the technology-led scenario have emerged, and it does seem that the structuring of franchises has resulted in the use of rolling stock designs have utilising safe, established technologies. The risk adverse nature of today's rail industry and the fact that most franchises are for only seven years, helps explain the use of quickly-introduced and non-innovative technologies. This element of rail privatisation was not appreciated in our scenario exercise and helps to explain the disjuncture between the railways developing markets as we anticipated in the scenarios, but with little development of the technologies needed to serve these market developments. The exceptions were in the longer (15 years) Virgin franchises.

The Environmentally-driven scenario is one that might have been expected to correlate with actual action in the last five years. Particularly following the change of government in 1997, the publication in 1998 of the Transport Policy White Paper (DETR, 1998), and subsequent 2000 and 2004 Transport Acts, environment and transport have become leading policy topics. Yet, in reality, any actions that even vaguely map on to the Environmentally-driven scenario are little more than side effects of the other three scenarios. Indeed none of the features that are unique to this scenario appear to have been given even a passing consideration.

Indeed, the railways stance towards environmental issues has essentially been one of minimum compliance to regulation with the occasional development of an urban service due to local authority initiative (e.g. the Edinburgh cross city service to Newcraighall). As noted in Fergusson et al (2005) UK railways have been particularly resistant to environmental improvements, and any introduced are only a by-product of a cost reduction or revenue enhancing approach. This is typified by the resistance to introducing cleaner diesel for trains.

It seems that policymakers viewed the general growth of rail passengers as fulfilling an environmental brief - a widespread simplistic assumption that any increase in rail use must inevitably somehow reduce car dependence and is therefore good for the environment. This reveals a key flaw in understanding of the nature of the transport crisis. The vast growth in car use that is predominantly at the core of the transport crisis has not been generated by trips shifting from bus and rail to the private car. It is a process of the car permitting new economic and social behaviour leading to our whole society becoming increasingly transport dependent (Potter, 1997). In Britain, we undertake no more trips than 20 years ago, but now trips are much longer and dispersed, and our lifestyles have adjusted to become increasingly mobility dependent.

If rail is simply part of this travel generating system, then the expansion of rail will not contribute to solving the transport crisis. Indeed, just like the car, rail would simply be part of the problem. An examination of the commercial strategies of the railways, despite their rhetoric about competing with the car and air, is essentially about generating additional leisure, social and business trips in the same way that road developments have generated more travel by car. For example, the current plans to introduce high speed commuter trains on the new Channel Tunnel line through Kent seem likely to reinforce the existing trend to metropolitan decentralisation and the development of more car and transport dependent lifestyles. Indeed the OECD now considers high-speed commuter rail lines as environmentally degrading as building motorways (OECD, 1998).

The 1995 scenario was based upon a more thorough understanding of the environmental impacts of transport, and the absence of any effective developments (and consequent technologies) to address transport's core environmental problems is perhaps the most startling conclusion of this retrospective analysis.

5. Scenarios in transport research

Overall this examination of the 1995 scenarios, five years after they were written, has proved most enlightening. A scenario approach has proved to be a robust, enlightening and useful approach to market and technology forecasting. The four scenarios represented strategically different ways in which the post-privatisation railway could develop. In practice, the privatised players in the new rail industry have adopted market strategies that were identified in three of the scenarios, largely concentrating on variations of the cost-driven scenario. The necessary policy initiatives to effect the Environmentally-driven scenario have not progressed at a sufficient rate for this to be an important driver.

In retrospect, in constructing the scenarios we should have paid more attention to the ways in which the organisational and regulatory structure of the rail industry would constrain them. In retrospect it might have been anticipated that the privatised railway would be finance-driven and a series of scenarios around alternative financial strategies and risk management might have been more useful (e.g. cost reduction, revenue generation, high and low risk). We could also have paid more attention to the timescales involved. We tended to look at what was possible in 15 years, and not so much the pathing towards longer-term technologies. Could, for example the technologies stimulated by the pressures of a short-term franchise provide incremental innovations that would lay the foundations of a more radical approach? Alternatively, would this simply close-off these more radical approaches altogether?

As noted already, one factor that should be incorporated in any future scenario exercise are the risks associated with different technological approaches. This has particularly affected the choice of signalling and capacity enhancement technologies, where risk has been a key factor in the choice of a less technologically-advanced, yet more expensive approach. Where serious financial penalties are involved, risk assessment associated with technology choice is clearly a major consideration.

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