Fifty years of motorways: how did we get there and where do we go to next?

Joint lecture of the Institution of Civil Engineers and the Transport Research Foundation

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David Bayliss started his career in Manchester, where he studied both civil engineering and town planning and worked for five years for the city. He then moved to the Greater London Council (GLC), where he ended up as Chief Transport Planner responsible for transport research and policy. In 1984, he moved to London Transport as Director of Planning, with responsibility for a range of policies and projects including the Docklands Light Railway, the Jubilee Line extension and the Croydon Tramlink. Since retiring from London Transport, David has been a Director of Halcrow Consulting, a Visiting Professor at Imperial College London, and is involved in a range of transport and planning activities both in the UK and internationally. Recently, he has jointly authored the RAC Foundation study of *Roads and Reality*, which has provided much of the material on which this lecture is based.

**Abstract**

The development of the main road system in Britain from the appearance of motor vehicles through the pre-motorway period and over the last half century is outlined. The changing patterns of responsibility for planning and managing the main road network are described, along with changes in political attitudes to road construction. Britain's current motorway network is compared with those of other European countries and the challenges of providing a fit-for-purpose national road network spelled out. Finally, it is concluded that a combination of more efficient pricing of road use, along with a programme of new and expanded motorways and trunk roads, should be a vital and central component of national transport policy.
Peter Hansford, Vice President of ICE

It is my great pleasure to welcome all of you to the Institution of Civil Engineers (ICE) this evening and to tonight’s joint ICE and Transport Research Foundation (TRF) Fellows Lecture. Tonight, we are delighted to welcome Professor David Bayliss as our speaker. David is certainly no stranger to ICE, or indeed to TRF, where he is a Fellow of TRF. Also, a welcome this evening to Professor Rod Kimber, Chairman of the TRF Fellowship, and to Alan Stilwell, who’s the Chair of ICE’s Transport Board.

So I am delighted to invite Professor Rod Kimber to the lectern. Rod joined TRF and TRL 11 years ago to lead corporate research and the development of TRL’s scientific and engineering capability. He is a Visiting Professor at Imperial College London, and has extensive experience in transport research, research management and national policy formulation.

Rod Kimber, Chairman of the TRF Fellowship

I am pleased to be able to introduce David Bayliss to everyone this evening. It is an introduction that, in a sense, scarcely needs to be made. We all know him and we are delighted that he can give us our lecture this evening. As Peter said, it’s the second in the series. TRF and ICE are very pleased to be working together – there is a great deal of commonality of interest and we want to go forward with these events because we feel that we get mutual benefit from them.

I will just say a few words about David before we get to his lecture and ensuing discussion. David began his career in Manchester where he studied civil engineering and town planning. He then went to the City of Manchester for five years before moving on to the Greater London Council (GLC), as it then was, where he subsequently became Chief Transport Planner, responsible for transport research and policy. In the mid-1980s, he moved to London Transport as Director of Planning where, among a significant portfolio of policies and projects, he was responsible for the Docklands Light Railway, the Jubilee Line extension and the Croydon Tramlink, to mention just three projects which I think we would all be proud to be associated with. Of course, there are many other achievements, but let me mention just one or two. First of all, he chaired the Science Research Council’s Transport Committee and the European Commission’s research programme on sustainable mobility and intermodality; and he has served as adviser to many august bodies including the World Bank, the World Health Organisation, the OECD and the European Conference of Ministers of Transport.

More lately, David has taken up his role as Director of Halcrow Consulting and is also Visiting Professor at Imperial College London. He was awarded the OBE in 1992. His recent joint authorship of the RAC Foundation study of Roads and Reality has provided what I understand is the inspiration for what promises to be a very lively and wide-ranging talk. It is entitled “Fifty years of motorways: how did we get there and where do we go to next?”

David Bayliss

Introduction

Thank you for that very kind introduction. As the fiftieth anniversary of the opening of Britain’s first motorway approaches, I would like to thank the TRF Fellowship and ICE for inviting me to give this lecture. I would also like to thank those colleagues who have helped me to put its contents together and, in particular, the RAC Foundation, which has kindly allowed me to use material from its recent report, Roads and Reality. However, what I say this evening reflects my personal views and not necessarily any of those of the organisations with which I am connected.

Pre-industrial road developments

I will start by briefly referring to two attempts to provide a national main road network before the onset of the Industrial Revolution, and then outline the subsequent efforts by central and local government to create a public national road system before the dawn of the motorway era. I will then outline the history of the development of the national motorway network and the growing antipathy that came to dog it. I shall compare our motorway and main road systems with those of our continental peers and go on to describe the findings of a recent study carried out for the RAC Foundation on what is needed to establish a strategic road system that is fit for purpose (Figure 1).

Figure 1

The first efforts to create a national road network were between 43 AD and 180 AD when the Romans required a good communication system to facilitate government and trade, and to provide for the movement of troops and supplies. The main road network they built, which was about 3,000 kilometres in length, covered most of what is now England and reached into Wales and southern Scotland (Figure 2). This was maintained until about 400 AD, but when the Romans left Britain at the beginning of the fifth century it fell into disrepair and much of it disappeared. Following the departure of the Romans, what responsibilities there were for highways fell to adjacent property owners, but with town councils gradually taking an interest in the larger settlements. Then in the mid-sixteenth century, local parishes were given a statutory responsibility for the upkeep of roads in their area (Figure 3).
For over 1,000 years after the departure of the Romans, little effort was made into providing a national road network – not surprising because we were hardly a nation. But by the second half of the eighteenth century, the onset of the Industrial Revolution and the consequent growth and diversification of the economy were leading to a rapid expansion in transport needs. Gross domestic product (GDP) growth had been very slow for hundreds of years prior to the late eighteenth century, but then it doubled between 1760 and 1810, doubled again by 1830, and doubled again by 1865 (Figure 4). This must have led to a surge in travel, much of which had to go by road as the canals and the railways had yet to be built.

The turnpike system started in the middle years of the seventeenth century to carry the burgeoning stagecoach traffic and, financed through user tolls, was expanded to accommodate this. It soon came under threat from the canals, which could carry much heavier loads than road transport, and later the railways, which, with their higher speeds and heavy load capacity, were attractive for both passengers and freight.

The turnpikes were not particularly efficiently managed and the competition from canals and railways soon sent them into rapid decline. From their peak length of about 32,500 kilometres in the middle of the nineteenth century, they had virtually disappeared by its end, with most being wound up in the 1870s (Figure 5). Responsibilities for main roads then fell back on local parishes, which had little interest in their upkeep; then to local boroughs; and then in 1888 they were transferred to the newly created county councils, whose performance, sadly, was little better. Whilst most main roads were paved after a fashion, they were not properly sealed, so frontages and pedestrians were subject to road dust in summer and mud in winter, and wheel traffic had a slow and bumpy ride. This was a situation that prevailed into the early years of the motor transport era.

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Central and local government efforts before World War II

The failure of county councils under the jurisdiction of the Local Government Board to do much to improve main roads prompted central government to set up a national Road Board, which was formed in 1910 with revenues earmarked from motor taxes; against the wishes of the Treasury I might add (Figure 6). This was successful in funding the reconstruction of many road surfaces with tarmacadam and providing some limited improvements to alignments, but to standards that would prove inadequate for the forthcoming deluge of motor traffic. This board was wound up in 1919 when the Ministry of Transport (MoT) was created, but the hypothecation of road user taxes remained, at least for the time being. However, at this time the ministry did not have direct responsibility for any roads, so it relied entirely on local authorities for the maintenance and improvement of main roads.

The rise and fall of motorway construction

Whilst during the inter-war period the MoT did accomplish quite a lot – for example, by introducing national classification and signage systems, and a compulsory driving test – it achieved rather less in dealing with the road system’s physical shortcomings. Whilst the MoT recognised the need for national road improvements and started to implement them, this did not amount to a coherent and continuous effort. Early in the 1920s, a number of road construction schemes were carried out, mainly to help relieve unemployment. These suffered from not being part of a general and properly thought-through plan: they usually had few and simple land acquisition needs because of the delays these would bring; they tended to be located in or close to areas of high unemployment; and they typically relied on much unskilled labour, with only limited use of machinery. Nevertheless, a number of bypasses, such as that around Derby and new inter-urban roads such as the East Lancashire road, were built before the financial problems of the early 1930s brought these efforts to a halt. When the financial situation improved in the mid-1930s, central government started at last to get to grips with the roads problem, with the initiation of a five-year improvement programme costing about £1.75 billion at today’s prices.

In 1937, by which time the much raided and then vestigial road fund was wound up, recognising that sufficient progress could not be made by relying solely on the efforts of county councils central government established a 7,175-kilometre trunk road network, for which the MoT was directly responsible. Whilst some progress was made with this mid-1930s programme, a slow start and the outbreak of World War II meant that it was never completed.

Meanwhile, the number of motor vehicles had grown from one third of a million at the end of the First World War to over three million by the outbreak of World War II (Figure 7). Vehicle ownership and traffic forecasting were very crude at that time, and in his 1937 proposals for roads in London, Sir Charles Bressey foresaw an increase in traffic of a little over four-fold. In the event, the 1937 motorised traffic level of 45 billion vehicle kilometres had increased four-fold by 1966, and today is 11 times that level.

These traffic levels meant that at the end of the 1930s, flows on the busier main roads were up to 20,000 a day – not much by current standards, but much heavier than ever seen previously (Figure 8).

Figure 6

Growing Government Involvement

- 1878: Government provide grants to Districts for main roads
- 1900 -1919: The Road Board
- 1919: Formation of the Ministry of Transport
- 1937: Creation of a trunk road network
- 1948: The post War roads plan
- 1949: The Special Roads Act
- 1958: The Preston By Pass opens

Figure 7

Pre War Growth of Road Vehicles

Figure 8

Main Road Traffic Volumes in 1938

Not only were traffic volumes becoming a problem, but casualty rates were rocketing (Figure 9). With road deaths approaching 9,000 a year (that is more than 30 times today’s rate in relation to traffic levels) and casualties a quarter of
a million, the poor layout of many main roads was seen as an important, although by no means the only, factor in this sorry state of affairs.

There had been interest in motorways by British engineers long before World War II and in 1926, William Rees Jeffreys, who amongst other roles had been a secretary of the Road Board, organised a delegation of engineers to attend a roads congress in Milan and visited the recently opened autostrada between Milan and Varese. Visits were subsequently made to Germany and several proposals were drawn up for a British motorway system, the most notable of which was the County Surveyors’ Society scheme published in 1938, in which most but not all the main corridors it identified now contain motorways (Figure 10).

However, the Second World War saw most engineering activity devoted to military purposes – which included, amongst other things, placing enough airfield concrete to form the carriageway of today’s motorway network – and little progress was made with conventional road improvements. But preparations were laid for post-war reconstruction, including new roads, and in 1946 a basic motorway plan was produced by the Ministry of War Transport (Figure 11).

Priorities for housing and industrial reconstruction & renewal following the war meant that little was done to the road system for ten years or so, although the passing of the Special Roads Act in 1949 provided for the first time specific powers to construct motor roads. As the immediate needs for post-war housing and industrial reconstruction eased, attention turned to the road network and work started on Britain’s first Motorway, the M6 Preston Bypass, in June 1956 (Figure 12). This was opened to traffic in December 1958, to be followed in November 1959 by the opening of the first section of the M1 (Figure 13). Britain’s motorway era had dawned.
At this time, there was general political support for new motorways, although there were occasional protests about individual schemes. This situation continued into the 1970s (Figure 14), by which time the Labour Party, initially in London and subsequently nationally, became increasingly hostile to major road schemes. Also around then, we saw the emergence of professional road protestors and anti-road lobby groups. Whilst the Conservatives continued to support road construction and the predecessors to the Liberal Democrats supported bypasses, in the 1980s deregulation and privatisation were the main passions of the Thatcher Government in public-sector reform, including transport. The publication of *Roads for Prosperity* by the Conservative Government in 1989 saw a brief swing back towards central government support for new road construction, but the consequences on the ground were modest and hard won. The most notable was the Midland Expressway, which was originally proposed by the MoT in 1985 but did not eventually open until 2003.

The decline in the growth of the motorway network started in the mid-1970s and has continued since. However, this is only part of the picture, as the strategic road network includes other trunk roads and physical capacity expansion has more recently focused on the widening of existing roads. Nevertheless, here again the picture is one of a reduction of activity over the last two decades (Figure 15). Since the early 1990s, central government has reduced its direct involvement in main roads, with (1) the length of the trunk road network being reduced by over 18% since 1993, (2) an arm’s length relationship created through the establishment of the Highways Agency in 1994, and (3) improvement to some sections of the trunk road network now being subject to regional rather than national priorities.

The decline in expansion in motorways and all-purpose trunk roads means that we have some of the busiest main roads in Europe. Of the ten largest Western European countries, the UK – indicated by red vertical arrows in Figure 17 – comes bottom of the league for motorway provision in relation to population, GDP and traffic volumes. It comes eighth in respect of surface area, with only Greece and Sweden ranking lower; their population densities are one-third and one-twelfth of those in the UK, respectively.
Looking at state roads, a similar picture emerges (Figure 18), although there are some definition problems with what state roads exactly are. And even taking road networks as a whole we score badly again, only escaping bottom or next-to-bottom ranking on provisions in relation to surface area (Figure 19).

We were late in starting our motorway programme, around 30 years behind the Italians, Germans and Americans. By 1970 in Europe, the Germans, French, Italians, Dutch and Austrians already had more generous motorway provision than we did; the UK is again represented by the bold red line in Figure 20. By 2000, all the ten largest Western European countries had more motorways per head, and despite being the third-largest country in the European Union, we have just over 6% of the motorway network.

If we had much more generous provision of rail our lowly position in the European roads league might be more understandable, but this is not the case (Figure 21). Whilst our overall rail provision on a population basis is only slightly below average, we are next to the bottom in terms of electrification and, although we have recently joined the high-speed rail club, we are right at the bottom of that league and, it seems, destined to fall further behind.

This is all consistent with generally inferior transport infrastructure provision in comparison with our European peers. Our principal airports are in much the same position as our main roads, with the runways at Heathrow and Gatwick having twice the passenger throughput of any of those in Europe’s busiest 11 airports (Figure 22). Moreover, this phenomenon is not confined to transport. If we look at power generation and flood and coastal defences, similar messages are to be heard.

We are clearly in a position where high-quality road capacity is miserly and over-subscribed by the standards of our continental peers. So what is being done about it? There are no signs of government having any appetite for providing a motorway system comparable with that of other major European countries. In its
2004 statement on the future of transport, the government’s policy was to improve safety, add capacity where justified, improve management, get people to make smarter choices and develop new ways of paying for new roads (Figure 23).

Improving safety and traffic management are long-established and extensively applied practices. Hoping for people to travel less, especially on congested roads, is a worthy aim, but will not amount to much without new incentives and is likely to make only a limited contribution to easing trunk road congestion. Whilst road pricing has substantial potential for reducing congestion, progress has been painfully slow, being left to local government initiatives and focusing on urban areas, not the strategic road network for which central government is responsible. In the meantime, targets for congestion reduction on the strategic road network have been progressively watered down, have failed to be met and, reflecting this, in the 2007 spending review, the congestion-reduction target for the trunk road network was essentially abandoned (Figure 24).

Turning now to the question of increasing strategic road capacity, expansion of the English trunk road network is through the Highways Agency’s Targeted Programme of Improvements, the TPI (now termed the Programme of Major Schemes, or PoMS), which contains a few major schemes, principally the widening of sections of the M1, M25 and M6. Overall, it provides for about a dozen motorway-widening schemes, about twice as many substantial A-road improvements, one new motorway link and one new motorway junction. Whilst this avoids the painful problem of seeking new routes, it focuses traffic growth on existing corridors, making for complex operations and no broadening of high-quality road accessibility. Even this limited programme seems to be in doubt, with the Highways Agency now looking at hard shoulder running as an alternative to conventional widening on sections of the M1, M6 and M25.

£1.4 billion was invested in the British strategic road network in 2006/2007, less than half that invested in rail infrastructure. In the analysis for the Eddington study, the TPI was estimated to add physical capacity at a rate of about 130 lane kilometres a year between 2003 and 2015 to its stock of 33,000 lane kilometres, less than 0.5% a year.

The Eddington review made many recommendations in its report, *Transport’s Role in Sustaining the UK’s Productivity and Competitiveness*, and in respect of the strategic road network it proposed that a combination of road pricing and capacity expansion should be pursued to improve the network’s efficiency. This has been, rightly, widely welcomed. However, there has been little discussion of the detail in the proposals. The Eddington study concluded that with pricing, even the limited expansion in the targeted programme of improvements should be reduced after 2015, and that without pricing it needs to be broadly doubled but to a rate lower than seen in the 1980s and early-1990s (Figure 25). These recommendations are difficult to credit on two counts. Firstly, traffic growth is expected to continue for many years to come; and secondly, appraisal of current road schemes shows a generally healthy rate of return.
Looking first at traffic growth, Eddington used a traffic growth forecast of 31% overall for England between 2003 and 2025 and 40% for strategic roads. With the physical capacity additions proposed, traffic densities would increase by 16% with pricing or 22% without (Figure 26). It would seem rather improbable that congestion on the strategic network could be satisfactorily dealt with at these significantly higher traffic densities, and indeed Eddington estimated delays to grow by 28% between 2003 and 2025.

Secondly, looking at the benefit-to-cost (B/C) ratio as a strategic road scheme assembled for the Eddington study, it is clear that there is a substantial stock of projects that have healthy B/C ratios (Figure 27), well in excess of the 1.3:1 benchmark that the Eddington study used for worthwhile projects. So on the face of it, Eddington’s conclusions appear to have significantly underestimated the case for additional strategic road capacity. In response to the Eddington review, and Sir Nicholas Stern’s assessment of the economics of climate change, the government proposed that for the strategic road network we should continue investing at about current levels until 2014, make better use of existing roads by expanding active traffic management, and continue exploring the scope for direct road pricing. Beyond 2014, it proposed the preparation of a longer-term plan by 2012 (Figure 28). In the same document, it acknowledged that most road projects take up to ten years to approve. So if this logic is to be followed, there would be no new major road projects implemented beyond those in the current programme until 2022 at the earliest.

The need for capacity and demand management

The rundown of the strategic road programme and the prospects of worsening congestion prompted the RAC Foundation to carry out its own investigation into the long-term road transport problems and how these could be addressed; and this was published in 2002 in Motoring Towards 2050 (Figure 29). Essentially, this recommended that substantial and sustained investment in roads and public transport are needed; the move towards low-carbon vehicles should be accelerated; land use policy and urban design which reduce travel needs should be employed; railway investment should be accelerated and focused on commuting and intercity travel; better bus services, traffic restraint and some major schemes are needed in urban areas; strategic road capacity should be increased by traffic management and new construction; and road pricing should be developed with some of the proceeds used to fund congestion-reducing schemes.

Progress had been made to these in several key areas. Rail investment has averaged £4.66 billion a year over the last five years, Crossrail had been given the go-ahead, and a further £15 billion of public funds for the railways over the next five years was promised in last year’s Comprehensive Spending Review.
Land use policies have been increasingly focused on “brownfield” higher-density development, although the recent announcement to build ten new eco-towns seems to run counter to this. But in other areas, progress has been poor. Reforms to local bus operations have not materialised and ridership on local buses outside London has fallen. A limited road-pricing scheme has been introduced in London, but outside the prospects remain uncertain, and investment on strategic roads has recovered only a little after the substantial fall during the 1990s. The only recent significant initiative on strategic road capacity has been the decision to extend hard shoulder running to possibly 800 lane kilometres of motorways. These 800 lane kilometres will increase the area of motorway capacity available for running traffic by about 4% during the time they’re in operation. The M42 experiment shows that whilst journey time variability is reduced by this, and accident and emission levels fall, flows increased – but by only 2% or so – and overall journey times appear to have changed little.

It is against this background that the RAC Foundation commissioned a study by Nick Banks, Stephen Glaister and myself into the long-term need for the development and management of the strategic road network. We examined the relationship between pricing and capacity that had been postulated in Motoring Towards 2050 (Figure 30).

The slightly complicated diagram in Figure 31 shows that the then prevailing level of congestion could be contained beyond the provisions of the ten-year plan if motoring charges were increased by 6% annually (vertical axis), or by a substantial increase in capacity (horizontal axis), or by some combination of pricing and additional capacity (diagonal line). In Roads and Reality, we examined the balance of adding new capacity to the strategic road network and efficient pricing, taking a planning horizon of 2041. The reason for taking such a distant horizon was that the inertia of major infrastructure programmes is such that only over such an extended period could real alternatives to simply tinkering with the existing system be realistically considered.

I will not try and explain the modelling methods we used, as these were quite complex and are described in the technical report of the study on the RAC Foundation website. However, we did, as far as reasonable, use nationally accepted forecasts of population, employment and income growth, and generally accepted relationships and values of key parameters. However, our analysis differed in these key respects: our assumption on fuel costs were higher than those used in the national transport model; our price for carbon emissions was about twice as high as the officially recommended figure for 2007; and in the evaluation, we used the costs and benefits to the community as a whole rather than the social opportunity costs of Exchequer funds – which is the official Treasury method.

As you can see (Figure 32), our traffic estimates fell within the national transport model range, although we projected them forward to 2040.

Our base case comprised no additional capacity beyond that resulting from the TPI, and taxes and duties were as they were in 2005. Our efficient pricing regime included the costs of congestion, accidents, environmental damage, climate change and road track costs, and we examined capacity additions from 200 lane kilometres a year to 800 lane kilometres a year between 2010 and 2041 (Figure 33).
We concluded that pricing, without increasing capacity, reduces strategic road traffic levels by just over 10% below what they would be with the existing charges. Adding capacity gradually restores this difference, until by about 700 lane kilometres a year traffic will be brought up to base case levels. In the absence of efficient pricing, additional capacity increased traffic flows, but at a slower rate – as the choking effects of congestion were greater than with pricing (Figure 34). With pricing, average speeds on the strategic road network were 14% higher, and this increased to almost 20% with the maximum additional capacities that were tested. Adding capacity without pricing also increased speeds, but at a slower rate, with a maximum increase of 4% (Figure 35).

A simple interpretation of these findings is that the main impact of pricing is to reduce congestion and the main impact of additional capacity is to increase mobility. Adding capacity at a rate of 600 lane kilometres a year with pricing, mobility would be little different from in the base case but travel times would be about 18% lower. In the absence of pricing, at this build rate, journey times would be about 4% lower and mobility about 6% higher. So a combination of new capacity and efficient pricing would significantly reduce congestion whilst maintaining mobility. But would this be cost effective? And could it be afforded?

A programme of 600 lane kilometres a year would generate benefits of about £12 billion annually in 2041, and if efficient pricing were deployed this would increase to £27 billion (Figure 36). However, it can be seen that the growth of benefits falls off as additional capacity is added. So at what point does additional capacity cease to be worthwhile? Benefits diminish with each increment of additional capacity, but even at a rate of 800 lane kilometres a year a B/C ratio of 2:1 is achieved with efficient pricing and a slightly higher rate in its absence (Figure 37). Our analysis has also indicated that we probably did not have the optimum pattern of road improvements and refinements could increase these benefits further.

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Financial affordability is not really an issue if efficient pricing is introduced, as this will generate substantial receipts even allowing for the costs of operating a sophisticated road-pricing system. Income from the pricing of strategic road travel in 2041 would amount to about £28 billion annually, and adding 600 lane kilometres a year would give an additional cost of about £4.5 billion (Figure 38). Allowing for collection costs of half a billion a year in respect of trunk road pricing, and maintenance, operations and policing costs of £2.5 billion, there would be a surplus of over £20 billion, well in excess of the cost of sectoral externalities. By this I mean those costs, such as noise, imposed by road users on the rest of the community. The additional financial costs to motorists above those that would be paid in conventional taxes would, to some extent, be offset by reduced resource cost from less congestion. However, trunk road users as a whole would only get their money back from reduced congestion and improved mobility with a programme in excess of 400 lane kilometres a year.

A programme of 600 lane kilometres a year of new strategic road capacity up until 2041 would be economically well worthwhile and have an annual cost of £4.5 billion. If this were coupled with efficient pricing, the economic benefits would be greatly increased, environmental and accident costs would fall, the additional revenues would handsomely cover the cost of the programme and road users would still come out ahead, despite the higher charges of using the strategic road network. But what might such a programme result in? If this capacity were to be added simply by widening existing routes, the average width of motorways could increase by about 50% and other trunk roads by about 20%. Given that the case for capacity expansion is strongest where congestion is worse, this could involve expanding the M25 up to dual eight lanes on the busiest sections and sections of the M1 and M6 to dual six lanes. Although roads of this width have been built in North America, the scale of junctions and loads on feeder roads would be beyond anything seen to date in this country. As I mentioned earlier, apart from the operational problems and the disruption that this would cause, such a policy would be to concentrate improvements in accessibility and safety in existing corridors rather than spreading these more widely.

Today, any debate about transport policy must include consideration of carbon emissions, and we looked at the potential impacts of efficient pricing and additional capacity on these. Using the high cost of carbon charged as a fuel duty, we found that, without pricing, a 600-lane-kilometres-a-year programme would result in carbon emissions from road transport increasing by just under 5% – but with pricing they would fall by 9% (Figure 39).

Whilst widening existing roads avoids the problems of finding new routes and the disruption this causes, new routes can have the advantage of causing less disruption to existing flows during construction, they have lower costs, they can reduce the need for multi-level intersections on roads, they are operationally simpler, they generate lower loads on feeder routes, they extend improved accessibility to new areas, they provide opportunities for the best design and construction methods (including tunnelling) and they provide greater network resilience, which is particularly important (Figure 40). In practice, a combination of widened and new routes would be the best way forward, developed in the light of the needs, constraints and opportunities of individual corridors.

Our modelling analysis did not permit us to evaluate alternative network configurations, so any notion of new network patterns has to be based on more subjective assessments. Figure 41 shows a possible network form drawn up by my colleague Nick Banks, and compares this with the stresses on the strategic road network that a straight 40% increase in traffic would
create. Clearly, a definitive network would require much more sophisticated analysis to design, but this attempt to strike a balance between maximising congestion relief and improving connectivity between major settlements and different parts of the country.

**Relative Advantages of New Routes & Widening of Existing**

**Widening**
- No need to seek new routes
- Contains environmental disruption

**New Routes**
- Less disruption to existing traffic flows
- Lower costs
- Reducing the need for multi-level interactions on existing roads
- Operational simpler (fewer lanes)
- Lower loads on feeder routes
- Extends improved accessibility to new areas
- Opportunities for the best design and construction methods &
- Greater network resilience

**The need for reform of responsibilities**

If we look back at the history of highway planning in Britain, the problem has not been a lack of ideas, but the frequent absence of ways and means of implementing them. In the time of the Romans, an authoritarian regime created a national road network to maintain its military power. The development of the turnpike system was a result of private commercial initiatives subject to approval by parliament. During the 1960s and 1970s, there was sufficient political commitment to support a modest national motorway programme, but this, it seems, has now disappeared and the administrative processes for infrastructure development have become more complex.

So what are the ingredients of a successful national road building effort? I suggest there are five essentials: a robust legal basis; a political will; an expeditious administrative process; a capable organisation; and an adequate source of funds (Figure 42).

**Ingredients of an Effective Highway Programme**
- A legal basis
- A political will
- An expeditious administrative process
- A capable organization and
- An adequate source of funds

**The 1919 US Army Transcontinental Motor Convoy**
- Washington to San Francisco in 67 days
- Average speed 58 miles per day
- Lt Colonel Dwight D Eisenhower – tank corps observer
- Current journey – 5 days @ 8 hours/day

Fourteen years later, the newly elected Chancellor of Germany, Adolf Hitler, set out his first four-year plan in which the construction of a substantial motorway system and the development of the German automobile industry were paramount objectives. To implement this, in 1933 a law was passed setting up the German Motorways Company, the *Reichsautobahnen*, as a subsidiary of the German railways, with its head directly responsible to Hitler himself, who held the ministerial portfolio for the national road and rail systems. The motorway company was given working capital and funded through grants reflecting reductions in unemployment relief, growth in industrial development and a 9% fuel tax (Figure 44). Within four years, over 2,000 kilometres of *autobahn* had been opened and a network of over 11,000 kilometres planned, which can be compared with the present network length of 12,500 kilometres (Figure 45).
Dwight Eisenhower became the Allied Commander during World War II and was mightily impressed by the German autobahn system; this caused him to rethink his approach to a high-quality federal road network. Although President Truman had designated a national system of interstate highways in 1944, it was not until 1956, after the now President Eisenhower made the development of the national interstate and defence highway system a matter of national priority, that the development of a comprehensive US freeway system was embarked upon. Although President Eisenhower did not get the Federal Highways Corporation that he wanted, Congress authorised a Highways Trust Fund, financed through a motor fuel tax, to pay 90% of the costs of the system (Figure 46). Today, the network extends over 75,000 kilometres out of a total expressway system of about 95,000 kilometres.

In different ways, the US and Germany both achieved these five key ingredients for a successful national roads programme, and although they appeared to exist in Britain during the 1960s and 1970s, in the 1980s and 1990s the political will faded and the complexities of appraisal and implementation grew to the point where the vestigial roads programme has almost ground to a halt. There seems little prospect of a political champion for Britain’s national roads, so is there any hope of developing a system to make it fit for the needs of the twenty-first century in Britain? The business community has argued strongly for better transport infrastructure, but it seems, as far as the strategic road network goes, to little effect.

My conclusion is that the only champions to be found are the users themselves – but how could their needs be realised? This could be done by taking a leaf out of the history book and creating a National Roads Corporation, an NRC, responsible for the entire national strategic road network, rather like a modern-day national turnpike trust (Figure 47). This would be responsible to parliament for the maintenance, management and development of the strategic road network to make it fit for purpose. It would be funded by a share of the proceeds from direct charging for use of the network and it could be responsible for the collection of user charges. Charges for wear and tear, network management and congestion would be retained by the NRC in respect of the national network, which would probably be something closer to the current primary route network, and the local authorities’ share passed on to the relevant local transport authorities. Charges for intra-sectoral externalities like noise and noxious emissions, and services funded by the Exchequer such as policing, would be passed on to the Treasury, which would also receive the proceeds from the tax on fuel in respect of greenhouse gas emissions. The prices charged would indicate where and how much additional capacity was cost effective and generate the funds to provide this. A regulator would ensure that the NRC was not charging motorists more than the economic rate, that it operated efficiently and that the right amounts were...
spend on maintenance, management and investment. Where the most cost-effective way of dealing with the congestion problem would be by improving public transport, then the NRC would be duty bound to fund appropriate public transport schemes. In any period before full user charging, or in its absence, an equivalent sum could be allocated from conventional road user taxes, with cost-benefit analysis used to indicate where additional capacity is needed.

This might appear to be a radical departure from the way our strategic road network is managed and developed, but the present arrangements are not serving users well and change is badly needed. Chairman, I have a short and long conclusion. I think time suggests I should go to the short conclusion as my time is running out, and rather than attempt to summarise what I have already said, I would like to thank you for listening so patiently and I would be happy to take any comments or questions that you have.

Thank you.

Discussion

Alan Stilwell, Chair of ICE’s Transport Board
Thank you very much David. I think there is much food for thought there and I am sure we will have a lively question and discussion session.

Question
How do you envisage road pricing to be implemented practically?

David Bayliss
There are a variety of systems whereby a national road-pricing system could be implemented. An obvious possibility is to develop the sort of technology which is currently used by Norwich Union for car insurance purposes; and as well as paying an appropriate insurance charge according to when and where you are driving, you could pay the road user charge as well. I do not think the technological problems are particularly difficult; it is the lack of political will to implement it that is the problem.

Question
My primary interest is in road safety and I want to make one comment and add it on to a question. Firstly, in terms of road safety, when we compare the UK with European countries, and I have in particular recently looked at The Netherlands and Sweden, we do indeed see what David has described in terms of the proportions of motorways, and that has quite a substantial effect on the safety outcome in terms of fatalities in those countries. However, if you then look at the dual-carriageway network, the non-motorway but dual-carriageway trunk network, and bring that into play, then that brings Britain a lot nearer to some of these other countries in terms of the level of capacity, but obviously not at the same level of quality as motorways. What you see is the quality of the dual carriageway limited by levels of access, by junctions, by quality of the roads. At the same time, through things like hard shoulder running, we are beginning to see an eroding of the potential quality of motorways. The question for your road-pricing modelling then becomes: What do you actually price? Do you price motorways? Do you price the trunk road network? Do you price an even larger network? My final point is that you then have to assess diversion away from the network that you have priced. The quality of the next network down is then critical as to how much diversion would take place. And I would suggest that you need to look towards a much bigger differential between the quality of the network that you are going to define as your main road network and that you might price and the network below it, and that the differential may include the speed limit policies as well as simply the quality of the roads.

David Bayliss
We have assumed that the efficient pricing regime would apply to all roads in the network, for two main reasons. Firstly, if you start to price only part of the network then you have a problem of diverting traffic from one type of road to another; to price only the motorway network would be perverse because you would be driving traffic from safe roads to less safe roads. The other reason for pricing all roads is that I believe that we need to replace the existing taxation system, which is inefficient and, in
some senses, perverse, with a new efficient regime. You cannot do that by simply pricing part of the network; you have got to get rid of the existing taxation system lock, stock and barrel and put in a new pricing system that covers the whole network. This first consideration was why John McGregor abandoned motorway pricing back in the 1990s, was simply because it would have pushed people from motorways onto unsafe roads that the motorways were built to relieve.

**Question**

I would first like to congratulate Professor Bayliss on a masterly presentation. I think that the problems about the vision we have are a combination of three things: the Treasury not being willing to provide the money; environmentalists; and a weakness of political will. One of the problems concerns environmentalists. I think there is no doubt that the early motorway programmes were rather brutal in their design and I think that the building of the section of the M3 over Twyford Down did not help. It seems to me one could make a great deal of progress if one could defuse the environmental criticism of inter-urban roads, and any thoughts you have on that would be very interesting.

**David Bayliss**

I am not sure there is an easy answer to that. We talk about the environmentalists but we are all environmentalists to some extent. It is the irrational end of the spectrum which is the particular problem and, at one extreme, there is this almost paranoid belief that constructing roads is somehow the work of the devil. And I do not think there is any way that that passion against road construction can be placated; it is there, it is a kind of priesthood rather than thinking. As for the more rational environmental concerns, in our analysis we included all the environmental costs and the charges that should be made. We were generous with our capital costs to allow for tunnelling, for landscaping and for treatment of new routes in a way which would make the local impact more acceptable. And it seems to me part of the problem is the juxtaposition between a new road and a sensitive environment; Westway is perhaps the starkest example. We have got to get away from that concern and I think high-quality design can help that.

As I say, the pricing provides a rationale for dealing with the environmental concerns, but at the far extreme we just have to be brave. The government has to be brave and say "Look, we have got to treat roads, rail and other modes of transport on an equal footing".

**Question**

I want to come back to this issue about funding and costs. Looking at the statistics you showed about comparators with other European countries, I thought that the effect on the trunk road network would not be quite beneficial. I am not denying that for one moment, but we thought that on the trunk road network there would be some effect, but we thought that on the trunk road network it would be quite small. Many of the measures that you refer to have more powerful effects at the local level and, indeed, can be quite beneficial. I am not denying that for one moment, but we thought that the effect on the trunk road network would not materially affect the conclusions that we came to.

**David Bayliss**

That was not specifically included in the model, simply because nobody quite knows how to model these things: the different types of measures, the different scales of effects and the real problem of knowing what the uptake of these travel demand measures will be in the future. We did recognise that there would be some effect, but we thought that on the trunk road network it would be quite small. Many of the measures that you refer to have more powerful effects at the local level and, indeed, can be quite beneficial. I am not denying that for one moment, but we thought that the effect on the trunk road network would not materially affect the conclusions that we came to.

**Question**

I am picking up the later point you made about the fact that change is needed and implementation is a problem. I take it from the early slides that in terms of the availability of highways the UK is way below comparable countries. So one would assume that
there is something fundamentally wrong with what Britain has. Secondly, you are saying that there are plenty of ideas, but you are also saying that the difficulty is engaging with change and getting implementation and you do indicate a possible route by identifying a champion. My question is: Would the next stage be to focus on how you can engage somehow with all the various stakeholders and do a study to see how the participants could enable a change to take place?

**David Bayliss**

That is an interesting idea. I think one knows pretty well where each of the stakeholders stand and there is no shortage of dialogue or ideas. Maybe there is some crock of gold hidden somewhere that we have not yet unearthed, but I doubt it. I would not deny that this might be worth doing, but the only conclusion I could come to, short of a radical shift in political attitudes, is that the only champion we can really identify is the individual stuck in the traffic jam on the M25.

**Question**

What assumptions have you made about future trends in oil price?

**David Bayliss**

I thought this question might come up, given recent events. We assumed fuel prices to be higher than they are today. At 2008 price levels, we used 75p a litre ex-tax for road transport fuel, which with taxes comes out at about £1.48 per litre, which is substantially higher than the present amounts that we are paying at the pump. So I suppose it is equivalent on that analysis to oil prices in the region of $150 or $150-plus a barrel. We did not make a specific assumption about fuel prices but we allowed for much higher fuel prices than we foresaw in 2006. Looking at the International Transport Forum’s recent forecasts for road fuel costs, none of the scenarios that they consider for the next 20 years envisage price levels being maintained at the present level of $130 a barrel. Who knows what the answer is going to be? But our assumptions on fuel were for very expensive fuel in future.

**Question**

You made the point that over two millennia there has been the continuing disaggregation of political will, from being centralist in Roman times to lots and lots of much smaller-scale entities, which is where we are now – not only with regards to highways, but also about the connection between the main trunk routes and the networks of all the other different modes. It strikes me that one of the issues that we are facing is how to claw some of that back and for certain aspects of planning to be done centrally against local needs and local optimisation. How do you articulate that argument when the political will is actually going in the opposite direction? The political will is to make planning less joined up and yet the economy is demanding it is more joined up. How do we generate the argument for the political will? We can bewail the fact it is not there, but it will respond to rational argument. It seems to me that political scientists, and those on the boundary between the economics and the political science, are not being engaged about the value of infrastructure. Eddington started on it, Stern started on it, but that is only the start of the journey. We need to get our act together across a number of disciplines in order to generate the political backbone that you rightly point out is not there, not I think for lack of trying but for lack of understanding.

**David Bayliss**

Who in the Department of Transport is doing this kind of analysis? Nobody? That sort of analysis has not been done within the Department of Transport for many years, if ever. It seems to me there is a real technical gap in ability to do this analysis and confront ministers. At the moment, I think ministers are too prepared to be let off the hook. Road pricing is a classic case; it is too hard. Here is a good idea: let us get local government to do it – but that is the last thing that should be happening for road pricing. I think there is a real issue there about confronting politicians with the reality of these sorts of issues.

**Question**

Can I just come back on that issue? It seems to me that we have somehow got to present large-scale systems and complexity in a way which is approachable and understandable and becomes part of the political argument. We all have to work together on that, in this institution and in other institutions. It is engineering, it is science, it is mathematics, it is technology – it’s all joined up. We have been fragmented in lots of different ways and we have to get back to basics. We need to work together to get the arguments marshalled and acceptable, and get the media on our side in order to deliver an agenda which the politicians can feel is good for the country but is not risky for them.

**David Bayliss**

Can I just add one thought? In transport, it is possible to introduce user charging. When you do that, you bring the power of the consumer into the debate and it seems to me that is the only way we are going to move forward. It is more difficult in areas like urban planning, but in transport we can employ the power of the consumer in order to get the kind of service that the nation requires.

**Question**

I am involved with the production of a paper on the financing aspects of road pricing, and indeed taxation, and to engage with others to try to define a route map through this very controversial area. I am very conscious of the key elements that you identified as essential for getting this sort of thing through. I am also aware that as we need strategic capacity improvements in our motorway network – I do not think there is any denying that – we also need high-speed rail investment. We also need to be fully aware of the environmental implications of this, and also the need for rather a lot of cash, which I suspect the Treasury has not got and may be looking to the private sector to provide. So why not try to bring these things together? There is a certain commonality between the strategic transport networks, both road and rail, in this country. We see examples on the continent. We see examples in Kent, where motorways and high-speed rail can run together in the same corridor. We could expand a strategic motorway corridor by locking in the benefits of partly charging for certain lanes and have other lanes free, which remove the risks of diversion, but we could also include a rail system. Any thoughts on that?
David Bayliss
We did not look at the rail network but clearly, as I illustrated very briefly, our rail network is pretty poor compared with that of our continental neighbours and yes, there is plenty of scope for improvement there. Whether it’s worth spending £30 billion on a high-speed line up to Glasgow, I do not know, but if you did that it would probably be worthwhile having a joint corridor – road and rail.

Question
Is there anything that you and your colleagues did in the study which two years later you would like to rethink as a result of anything that has happened in the interim? Or do you believe, as you implied when you addressed the question about oil price and cost of emissions, that you wisely took into account everything that was not only conceivable in the year 2006 but is still conceivable in the year 2008?

David Bayliss
I think the areas where we differed from the conventional assumptions about how things would go were the right ones and subsequent events have shown that to be the case: growing concern about carbon costs, higher fuel prices.

Stephen Glaister (co-author of the report)
I think for myself one of the many things we did not do perfectly in the work, which in a future world I would like to improve on, is our modelling of reliability because, of course, what really matters when the networks get congested is the unpredictability of journey times. Our work was entirely in terms of average speeds.

Going back to the discussion about how we might get the general public more involved in this debate, I am very struck by how badly informed the public is about the reliability and the quality of service they get from the road network. Thinking about other utilities, there has been enormous change over the last 20 years or so in telecoms, gas, water and railways, where people insist on knowing what quality of service they are getting in return for what they are paying. There just is not that kind of information in the case of our continental neighbours and yes, there is plenty of scope for improvement there. Whether it’s worth spending £30 billion on a high-speed line up to Glasgow, I do not know, but if you did that it would probably be worthwhile having a joint corridor – road and rail.

David Bayliss
Can I add one further thought? In shaping the capacity increases that we tested in the model, we relied on work done by the department for Rod Eddington on the benefit-to-cost ratios for different types of schemes; we know that it was not optimal. The model we used is not ideally suited for testing different types of network patterns, but I think I would like to see some different mixtures of different types of capacity in different regions, and see what the effect of that would be. And I am pretty sure we could get a better, a more efficient pattern of capacity improvement, but that is the kind of thing which the department itself is best equipped to deal with.

Peter Hansford
Thank you all very much. I would now like to ask Rod Kimber to sum up this evening’s contributions.

Rod Kimber
I think David has given us an extremely refreshing run through our history, which in itself is pretty absorbing, and a possible future. That possible future marks out some pretty firm constraints. It is a future which is rather clear in the possible consequences. We are, of course, at the moment in the midst of economic turbulence at world level and Britain is no less at risk than any other developed economy, so government is hardly likely to be in a position to indulge what might seem speculative investment – but roads simply do not fall in that category. Firstly, road systems are essential to a sound economy and, secondly, they need to be carefully financed and run as a matter of national supply for movement. The scale of the asset and its operation is very large, as David has pointed out. So decisions have long-term consequences and they cannot really be fudged. Fudging, of course, is a sort of time-dependent thing; it somehow gets caught up in time rolling forward and the formulation of longer-term plans which really grasp the issues somehow seems elusive.

David has argued that for a sound long-term economy we need freedom of movement within an efficient pricing regime. He is not arguing for radical demand management but rather for marginal pricing with respect to trips on a reasonably expanded network, and that sounds a very well balanced argument. Everything, of course, turns on the word “reasonably”, and the argument here seems to arrive at, for “reasonably”, something like 600 lane kilometres building per year, and that is really quite a difference to what we’ve become used to in these latter years of attrition.

The key to it all though seems to be how we move from analysis and aspiration, of which there’s been quite a lot in the past. I must say that David has put before us a very interesting, crisp and attractive analysis, to move from that to action. Overall, I think David’s approach is: Let us not now distract ourselves too much with over-elaborate arguments, let us focus on specifically what we can do. I think we really need take some steps forward towards strategic planning, but there are no signs of any political way in. A lot of the discussion is really centred around that point, it turns on that axis. We, as professionals, may well feel that we see what is necessary, but the task of actually finding political routes through it is a formidable one; it confronts politicians on a day-to-day basis and somehow or another they need to be helped into it. The recent public reactions to fuel price increases illustrate just what they actually confront.

So how do we go forward? There are groups for and groups against. David described some of the extreme environmentalists as seeing roads as the work of the devil and his answer to that is: Be brave, go for high-quality design. And it seems to me that that is two sides of a coin, in a sense: the professional side, the side
of presenting schemes which are attractive and do not produce quite the alienation that some of the past schemes have; and the task of actually arousing public support in a way that will actually provide a political force. Stephen Glaister said that we may well have to look to a lot more discussion and presentation of the performance of the network to bring home to people just what they actually face in terms of reliability.

But the question is: Where does the bravery come from? Where does the political will come from? And how can we actually get into it? I was much heartened by the discussion about large-scale systems arguments. What has come out from David’s talk is that there is a bridge to be built in understanding between the arguments acceptable in a professional sense and the arguments that need to be absorbed politically in order to provide a change in political outlook.

So there is a lot of work to be done there and I think David has given us a very stimulating ride through what is very difficult territory. It does not get any easier and I for one found it extremely interesting.
Fifty years of motorways: how did we get there and where do we go to next?

The development of the main road system in Britain from the appearance of motor vehicles through the pre-motorway period and over the last half century is outlined. The changing patterns of responsibility for planning and managing the main road network are described, along with changes in political attitudes to road construction. Britain’s current motorway network is compared with those of other European countries and the challenges of providing a fit-for-purpose national road network spelled out. Finally, it is concluded that a combination of more efficient pricing of road use, along with a programme of new and expanded motorways and trunk roads, should be a vital and central component of national transport policy.

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