Overview of Future Trends

Introduction

Vision 2030

1. In 1999 the "Vision 2030" Project was commissioned to enable the Highways Agency (HA) to look further ahead than the usual 5-10 year planning cycle. The aim of Vision 2030 was "to develop visions for mobility needs of people and goods in thirty years' time". Clearly a spectrum of possible futures exist and it is not possible nor sensible to set out one single vision. So the approach has been to try and identify the key factors that are likely to influence transport over the next 30 years or so and document the main trends and possibilities.

Factsheets

2. Transport is influenced by a range of social, economic and technological factors. It is a large consumer of energy and has profound environmental impacts. The political and legal context will also influence what happens. Collectively these topics are all embracing and intertwined, therefore the approach has been to focus on some of the key drivers affecting transport by preparing a series of "Factsheets" on the main topics. Inevitably this leads to some overlaps but the aim was to provide comprehensive and consistent information for each topic. There are nine Factsheets in total which are cross referenced in this summary.

Transport visions

3. The process of developing the three Vision 2030 scenarios and twelve transport visions of the future of inter-urban transport has drawn heavily on the information gathering phase of the project. Each of the visions reflects an imaginable picture of transport of the future which in turn has important implications for the HA. The relevant transport visions are cross-referenced in this summary.

Validity of information

4. This "evidence" has been collated solely for the purposes of the Vision 2030 project; to shape informed discussions at workshops; to facilitate the development of alternative scenarios, and to reflect on possible disaster scenarios. Inevitably, some trends are more predictable than others, and undoubtedly others will emerge as the future unfolds. Information has largely been drawn from recognised sources and authorities. The Web references are intended to help readers keep up to date with the latest position as much of the material collected is likely to date quickly.

Other visioning work

5. The Highways Agency is not alone in wishing to develop visions of the future – looking at possible future needs, opportunities and threats and deciding what should be done in readiness for these challenges. The UK Government's Foresight Programme[1] is at the forefront of this activity collating information and developing scenarios on social trends across a broad spectrum of activities. The European Commission is sponsoring several relevant projects in the fields of transport, energy, sustainability, and the information society (see *European Projects Factsheet*). The United States Department of Transport also completed a major forward visioning exercise as the 20th Century drew to a close[2,3].

People

Detailed information: *Social Trends Factsheet*

Relevant Visions: *Understanding the Customer*; *The Connected Customer*; *Land Use Planning*

6. Demographic factors are important in shaping the UK's travel patterns. Population growth, the increase in the number of households and their location affect the number of journeys made. Generally, as the population grows, travel tends to rise proportionately due to factors such as increasing car ownership. By 2030 there will be more women drivers and more older drivers on the roads.

Population growth

7. Over the next 30 years, the UK population is expected to increase by over 5 million to 65m[4]. Demographic projections indicate that the age distribution of the

population will continue to change significantly, as a result of increasing life expectancy linked with declining mortality and morbidity.

Ageing population

8. Between 2001 and 2031, the over-60s population will rise significantly - from 20% of the population in 2001 to almost 30% by 2030[4.] The rate of increase is even more dramatic for the over-80s. This "ageing population" will affect transport both directly and indirectly through the make-up of the workforce, consumer preferences for products and services, and the numbers of youthful and ageing drivers, amongst other things.

Land-use

9. Infrastructure development will have to take into account large numbers of elderly people. Because activities have become more dispersed, personal mobility, although clearly a basic right, is sometimes an obligation. This problem, which relates to land-use planning, will become increasingly important as the population ages. If distances to facilities and services increase, people will find it harder to give up their cars. Providing the elderly with home services in isolation is not likely to be sustainable as the elderly will still want to have a social life, including visits to friends, and this will involve travel.

Regional trends

10. There are important regional variations in predicted population growth[5]. The East, South East and South West Regions are projected to show the greatest increases in population (12-13% between 1996 and 2021), followed by London and the East Midlands (9-10%). Population declines are projected for the North East and the North West.

More households

11. Since the 1970s, there has been a steady increase in the number of households in England and Wales reflecting the slight increase in population and a move to more people living alone. More households will tend to require an increased use of transport and will contribute to the growth in car ownership. The number of households is forecast to continue to grow at a faster rate than the population. Between 1996 and 2021 there is a projected increase in the number of households of about 3.8 million (19%) in England[5] . This increase has three basic components: population change, behavioural changes, and greater life expectancy. About three quarters of the total projected growth is likely to be due to one-person households. Household growth will be mainly in the South-West, South-East, Cheshire, East Midlands and Eastern regions, with the lowest increase in Merseyside and in the North-East.

Lifestyles

Detailed information*: Social Trends Factsheet*

12. Over the next 30 years or so, our lifestyles are likely to adjust in response to changing socio-economic, technological and demographic factors.

Housing

13. With more households, there will be a need for more housing. An estimated 3.8m additional homes (comprising new and rehabilitated units) will be required in the next 20 years, mostly in urban areas[6].

Pressure on the Green Belt

14. The increased demand for housing will put pressure on current undeveloped land. Over 1% of England's land area is projected to change from rural to urban land uses between 1991 and 2016. Land shortages will require greater housing densities, which may offer increased opportunities to develop housing styles which reduce travel dependency on private cars.

SMART housing

15. There is likely to be a major technology-led drive towards the SMART house. Advances in ICT (advanced information and telecommunication technologies), construction materials and components will deliver improved living conditions, including better air quality controls, home-based (remotely controlled) health diagnostics, facilities for the elderly, infirm and disabled, intelligent, remote controlled household products for energy saving etc.

Leisure

16. People will spend more time on leisure associated with a larger proportion of people in retirement, flexible working patterns and increased opportunities for being economically active beyond the present retirement age. Tourism continues to grow with faster long distance travel, and travel in non-peak hours may increase at a greater rate relative to commuting travel, as the retired have more leisure time.

Tele-working

17. The potential impact of teleworking is unclear[7], but results from the EU TELDET[8] project suggest that the potential for teleworking in Europe is around one fifth of the labour force. Optimistic views are that teleworkers will ease traffic congestion mainly by saving fuel.

18. An alternative view is that the widespread application of information and communications technologies (ICT) may generate new types of transportation as well as reduce the need for physical transport. ICT facilities provide increasing opportunities to make contacts beyond geographical boundaries which may gradually result in face-to-face meetings.

Travel

Detailed information*: Factsheets: Traffic Growth and User Behaviour; Travel Substitution*

Relevant Visions*: Managing Demand; Managing Supply; Favouring Public Transport*

Travel substitution

19. Increased demand for travel brings increased safety, environmental, energy and congestion concerns. The increase in telecommuting, e-commerce, and other advances that can be a substitute for transport are likely to slow the growth in transportation demand. However, continued growth in demand may need to be restrained through pricing, regulation, and other mechanisms.

Road

More road traffic

20. With increasing prosperity, more people with driving licences and several million new households likely over the next three decades, there is potential for a dramatic increase in traffic.

21. The Department for Transport, Local Government and the Regions (DTLR) publishes traffic forecasts for cars, lorries and other road vehicle usage[9]. Between 1996 and 2031 car traffic could grow by more than a half, according to the central estimate of the latest National Road Traffic Forecasts. Van and lorry traffic is forecast to grow even faster. The forecasts assume no change in policies, the best available evidence of driver behaviour and the capacity of the current road network.

Not everyone will have a car

22. Car ownership is continuing to increase as a result of increasing GDP, falling vehicle purchase costs and changing living arrangements. However, it is worth noting that one fifth of households will still not own a car by 2030.

Driving conditions

23. It is difficult to predict how drivers will respond to increasing congestion and longer journey times. DTLR estimates that journey times will increase considerably, especially on urban motorways, where they will double by 2031. Average journey times on rural motorways are also predicted to increase substantially, especially in the peaks. The estimates imply that few people will decide not to travel as a result of increasing congestion by 2031 – except in the conurbations - where up to 12% of private road travel may be suppressed.

Air

Global air traffic

24. Demand for air travel has been growing rapidly, both globally and in the UK, and the industry is now facing capacity and environmental constraints. Air transport is responsible for 8-12% of transport related carbon emissions and because the carbon is emitted at high altitude, its potential impact on global warming is particularly harmful.

UK air traffic

25. In the UK, air traffic forecasts produced by DTLR[10] show that unconstrained demand for passenger air travel may more than double by 2015. Air traffic at UK airports is expected to grow at an annual average of 4.5% between 1995 and 2020 under the mid-point forecasts (with no capacity constraints). There is already a shortage of capacity at some airports because of runway or terminal constraints.

26. The UK has several important international hub airports. ICAO figures for 1998 show that Heathrow served more international passengers than any other airport in the world, and Gatwick was sixth in the list. During the1990s, regional airports have grown faster than London airports and this trend seems likely to continue[11].

Surface access to airports

27. Major airports have the potential to become efficient transport interchange hubs, although such hubs risk attracting traffic to already congested areas. Many airports have begun to develop good public transport access schemes such as the Heathrow Express.

Rail

Upward trend in rail journeys

28. Rail travel accounts for about 6% of passenger billion kms travelled by all modes[12]. Rail patronage has been steadily increasing over the past five years and at 38 billion in 1999/2000, passenger-kms are at a level last reached over 50 years ago[13].

29. By 2010, in order to meet the growing demand for transport, and to reduce its environmental impact, the Government hopes that large-scale investment in upgrading and expanding the rail network will allow 50% more passengers to travel by train[14]. Since privatisation, demand for rail passenger services has increased substantially and growth is forecast to continue, particularly if capacity can be provided and quality improved. The achievement of these objectives will require significantly higher investment than has been seen previously.

30. Although there is spare track and station capacity in parts of the network, capacity shortages at key bottlenecks restrict the operators' ability to schedule new services with journey times and service quality that would be commercially attractive. Apart from identifying and prioritising measures to deal with these bottlenecks the main inter-regional priorities are to modernise and increase capacity on the West Coast and East Coast Main lines, and the high speed Channel Tunnel Rail Link[15].

Freight

Detailed information*: Freight and Logistics Factsheet*

Relevant Visions*: Freight Foremost; Easy Interchange*

Sustainable distribution

31. The UK freight industry is heavily dependent on road transport. However, increasing congestion and growing environmental concerns are imposing rising costs upon industry and society, so there is a need to develop a more sustainable distribution strategy. In the longer term an essential task is to transfer some freight to other modes but logistics operators are unlikely to use costly and inflexible rail and waterway networks unless they are integrated intelligently and efficiently. This requires the development of advanced intermodal freight chains and logistics technology throughout Europe.

32. In a European context, the particular challenges for freight are our island nature, physically separated from and at the periphery of our major European trading partners, the regional concentration in the south-east with the resulting transport bottleneck, and our favourable location as a gateway to and from the Americas.

Road freight

33. Most freight is transported by road and this share is increasing. Road transport offers the most flexible, rapid, cheapest, and in many cases most efficient service for door-to-door deliveries. 65% of total tonne km[14] and 80% of domestic freight tonnage goes by road[16]. The number of trips has increased by 38% in the last decade[17] and this

trend is likely to continue with rising GDP. The 1997 National Road Traffic Forecasts[9] foresee the number of Light Goods Vehicles doubling by 2031 and HGVs growing by 169% (central forecasts). This assumes a further increase in the share of freight transported by road.

Just-in-time

34. Growth in freight transport has resulted from increases in the physical quantities of goods produced and consumed; increases in the number of links in the supply chain; and increases in the lengths of these links. New patterns of freight transport have emerged, such as long hauls serving the whole of Britain, and “just-in-time” (JIT) logistics which involve precise planning of deliveries to match production or sales needs.

Weight and size

35. Overloading and standardisation are two important problems with regard to truck weights and dimensions. Overloading can damage handling equipment and infrastructure. The lack of standardisation and scale problems are particularly acute for container transport. Vehicle weights are not thought likely to increase much beyond present plans (perhaps 60 tons on 6 axles)[18], although road trains comprising two articulated trailers coupled together, like those currently operated in Sweden, might be permitted by 2020. Vehicles will get taller though, particularly as a result of double deck vehicles.

Air freight

36. Air freight (imports and exports) has grown rapidly over the 1990s. Tonnage carried by air grew by about 7 per cent a year over that period. Increasing use of international just-in-time delivery techniques, particularly in high tech growth sectors of the economy, suggests that demand may continue to grow at a similar level. There are indications that the proportion of freight carried in dedicated all-cargo flights may increase very rapidly - partly due to growth in the small package/express sector, led by major consolidators such as FedEx, UPS and DHL.

Water-borne freight

37. Freight distribution by water accounts for 23% of total tonne km, and 95% of all export trade by weight is carried by sea[14]. Inland waterways carry less than 1% of domestic freight moved at present, but there may be potential to divert about 3.5% of the UK’s road freight to rivers and canals[19]. According to estimates by the World Bank and others[20], expansion of world sea-borne trade is expected at the rate of 4% a year over the next decade, almost doubling current volumes by the year 2010. The UK is well positioned to share in this world-wide trade growth.

38. Shipping is one of the most environmentally sustainable means of transport. It is less environmentally damaging than other modes and has the advantage of being subject to fewer capacity constraints. The UK, as an island nation, therefore has a natural interest in exploiting the potential of shipping on coastal and short-sea routes to relieve pollution and congestion on the roads.

39. Shipping is gradually being brought within the ambit of supply-chain logistics. Short sea links from the British Isles to the continent are recognised as essential to the coherence of the EU internal market. There is scope for introducing improved cargo-handling technologies, integrated distribution hubs, and enhancing basic intermodal transfer activities with storage, processing and manufacturing facilities on the same site.

Rail freight

40. Freight distribution by rail accounts for 7% of total tonne km[14]. A significant (80%) growth in rail freight is planned in the next ten years taking its market share to 10%. Although there will always be many distribution tasks for which road transport is the only alternative, more freight could be moved by rail, particularly over longer distances, with less damage to the environment. Integration of the road network with intermodal rail facilities is necessary to achieve a significant switch of freight from road to rail.

41. The fast rail infrastructure now being developed for passenger transport could be partly usable for freight as well. High speed combined transport trains are now being tested up to speeds of 240km/hr in Germany. High-speed freight trains also increase the

capacity of the rail system, since these trains do not have to be shunted aside to make way for fast passenger trains.

Intermodality

42. In order to cope with growing transport flows, environmental concerns and for reasons of overall efficiency, intermodal freight operations are being advocated throughout Europe and the USA. However, in order to improve its competitiveness, intermodal transport needs to match the service standards of road freight. Thus, freight transport must be considered as a door-to-door operation based on a range of viable transport alternatives – roads, railways, inland waterways, seaports and major airports - with the nodes and links interconnecting them. Given that the UK is an island, interchange facilities at ports and airports are particularly crucial.

Freight interchange

43. Efficient freight interchanges are an essential component of any intermodal transport concept. The management of pre- and end-haulage is a major bottleneck in using intermodal transport, especially for smaller companies. ICT and international standards are prerequisites for achieving intermodal transport, but not all partners share the same interests. The lack of standardisation and scale problems are particularly acute for container transport.

Logistics

44. ‘Seamless’ logistics solutions providing improved reliability and cost-effectiveness are being sought the world over, but in Europe the need for such integrated ‘borderless’ systems is particularly pressing, with Europe increasingly being seen as one market. Increasingly “logistics” are being applied to the whole supply chain in order to improve efficiency across all modes.

45. IT tools applied to the freight logistics chain aim to improve the flow of information and organisation of freight movements, for example, intra-company resource management systems, freight related on-line information systems for cargo terminals, integrated route planning with mobile communications, centralised route planning, electronic Customs procedures and freight capacity exchange systems. Terminal and port information systems aim to strengthen the bottleneck of the door-to-door chain[21].

Safety

Detailed information: *Traffic Growth and User Behaviour Factsheet*

Relevant Visions: *Zero Accidents*; *Co-operative driving on the Automated Highway*

46. The transport system as a whole is the safest it has ever been. Although roads in England have a good safety record, there were still 2,834 people killed in 1998 and over 288,216 injured[22]. Advances in technology, our renewed focus on partnerships changing human factors, and effective legislation offer great hope for progress in reducing transport crashes and fatalities.

New 2010 target

47. The Government’s new 2010 target is a 40% reduction in the number of people killed or seriously injured in road accidents; a 50% reduction in the number of children killed or seriously injured; and a 10% reduction in the slight casualty rate, expressed as the number of people slightly injured per 100 million vehicle kilometres[23].

48. Motorways and trunk roads carry over 30% of traffic generally and over half of lorry traffic. But less than 10% of deaths and serious injuries happen there. Safety is 'mainstreamed' into all trunk road improvements and maintenance systems. In the next 10 years, technology will bring increasing benefits through controlling traffic, mainly to make the flow smoother and to avoid accidents.

49. Most advances in safety have come from improvements in road and motor vehicle design, increased seat-belt use and decreased drunk driving. Public awareness campaigns have also helped to improve safety. Additional improvements in safety are expected to come from advances in motor vehicle road designs, in-vehicle technologies, technology-

enhanced traffic-law enforcement, and improvements in pedestrian / cyclist safety.

Older drivers

50. There will be greater concerns for the safe mobility of older adults who will make up a greater proportion of the population. New technologies will be employed to keep them driving safely for longer, as they continue to use the car as their main mode of transport. Criteria will have to be found to judge a person's ability to drive, and, if the elderly were to be banned from driving, alternative services would have to be provided. Safety will also become a crucial issue for pedestrians, many of whom will be elderly and very elderly.

The Environment

Detailed information*: Environmental Issues Factsheet*

Relevant Visions*: The Green Highway; Favouring Public Transport; Land Use Planning*

Sustainable development

51. The effects of transportation on the environment are complex and widespread. Air, water, land use, and animal habitats, are just a few of the areas affected. Transport is a major contributor to environmental problems at the local, regional and global levels and is now the fastest growing source of greenhouse-gas emissions. The Kyoto agreement exemplifies a growing recognition that globally and locally we have to find a more sustainable development path. Although transport provides many positive benefits for the individual as well as for the economy and society, it is one of the sectors which present the greatest obstacles to sustainable development.

52. People are becoming increasingly concerned about the environmental problems caused by transport. Unrestrained growth in traffic will only make these problems worse and a new transport consensus recognises that the provision of road space in line with the predicted growth in road travel is no longer a primary aim. We need to find ways of making more effective use of the existing infrastructure, including better operational management and publicly acceptable ways to reduce demand and increase capacity. Comprehensive and integrated land use and transport planning and combating the adverse environmental impacts of transport are major features of the new approach but will take many years to develop. Technology will have a key role, but behavioural responses by transport users will also be important.

Global warming

53. There is increasing scientific consensus that global warming is under way, linked at least in part to human economic activity. If atmospheric concentrations of greenhouse gases are to be stabilised, efforts to reduce these will need to be sustained over many decades on a global scale. Since climate change cannot be prevented entirely, it will be necessary to adapt to it. Estimates suggest that a combination of wetter, stormier winters and hotter, drier summers could necessitate remedial investment in roads, railways, flood defences, water supply and coastal protection[24].

CO_2 emissions

54. Transport is responsible for around 23% of the UK's emissions of carbon dioxide (CO_2), the main greenhouse gas, and this share is rising both in relative and absolute terms[25]. The majority of energy use is for road transport (80%), with air travel accounting for a further 13%. The key to reducing greenhouse gases will be reducing the carbon intensity of the transport sector - by encouraging more efficient travel, by making transportation more fuel efficient, or by adopting fuels that will emit less carbon. Technological improvements will be encouraged by the voluntary agreement between the European Commission and European car manufacturers to reduce average CO_2 emissions from new cars.

Air quality

55. Road transport is a major source of air pollutants (CO_2, NO_x and volatile organic compounds) and is the dominant source in many urban areas. Over the past 20 years or so, there has been significant progress in reducing air pollution. For vehicles this success has resulted primarily from improvements in vehicle fuel systems, the use of catalytic converters to treat combustion products, and the development of cleaner burning fuels.

Aircraft emissions also have been reduced, largely through international standards.

56. By 2030 air quality is likely to be better than it is today. The improvements will be driven by the continuing public pressure for a healthier environment. New technologies and fuels will be the mechanisms by which air quality gains are made. Electric hybrid vehicles, fuel cell engines, and new fuels – from reformulated petroleum products and new sources like biomass – will be commonplace through widespread commercialisation and "green marketing".

Noise

57. Despite progress in reducing noise from individual vehicles, as traffic volumes increase, noise pollution, particularly from road and air transport, is expected to rise and become an issue of growing concern.

Energy

Detailed information*: Factsheets: Energy Issues; Emerging concepts and technologies*

Relevant Visions*: Managing Demand; Favouring Public Transport;*

Fossil fuels

58. Fossil fuels are finite, and ultimately exhaustible, energy resources. In 1998, fossil fuels met 90% of global commercial energy demand. Crude oil accounts for over 98% of transport consumption. Energy consumption in transport is growing at a faster rate than for other sectors – people are buying larger cars and car ownership is increasing. Demand for aviation fuel is growing at about 5% per year [26].

59. World oil production will soon peak[27]. Thereafter oil production will continue for many decades, though at a declining rate. Production is unlikely to cease before 2050. After that, coal, tar sands, heavy oil and oil shales could be used to produce liquid or gaseous substitutes for crude oil. As far as natural gas is concerned, by 2020, some 40% of that ultimately recoverable from conventional sources will have been produced.

Non-OECD burden

60. Demand for energy is strongly correlated with GDP and climate. If oil demand was held constant to postpone the decline - the greatest burden would fall on the non-OECD countries where per capita oil use today is only 14% that of the OECD countries.

61. Ultimately we need to find ways of using less fossil fuels especially as the expected growth in traffic volumes is likely to more than offset the expected gains in vehicle performance. Possible ways forward include reducing the demand for travel, particularly society's dependence on the car; promoting non-motorised modes such as walking and cycling; encouraging a switch to more energy efficient modes (for example, collective transport); using fossil fuels more efficiently, developing alternative fuels and alternative vehicle technologies and enhancing public awareness of energy issues through media campaigns etc.

Energy efficiency

62. The development of conventional internal combustion engines (ICEs) is far from fully exploited[28] and there is potential to develop vehicles capable of tripling the fuel efficiency of today's vehicles using technologies such as hybrid-electric propulsion, fuel cells, lightweight materials and regenerative braking.

63. The EC has proposed a Community strategy to reduce CO_2 emissions and improve fuel economy[29]. EC Directive 99/94/EC commits car manufacturers to attain a CO_2 emission target of 120g/km CO_2 on average for newly registered passenger cars by 2005, and at the latest 2010. This Directive is part of a trio of policy approaches, which includes fiscal measures, and an agreement by the motor manufacturers in Europe (ACEA) to reduce emissions of CO_2 by technical improvements to new cars. Pollution emission regulations have speeded up progress in engine design, but have hindered improvements in energy efficiency. Low sulphur petrol is a prerequisite for improving conventional ICEs.

Alternative fuels

64. Many promising prototype technologies exist to use alternative fuels. Most are at an early concept stage. They have strong environmental advantages over conventional fuels – lower emissions and noise. The challenge of developing alternative fuel vehicles lies in making them affordable. Widespread use of any new fuels would require new fuelling infrastructures and better storage facilities at depots.

65. When produced from renewable resources, hydrogen and electricity have the potential to virtually eliminate greenhouse gas emissions when they can be substituted for fossil fuels. However, the infrastructure does not exist to produce, distribute, or deliver alternative fuels on a widespread basis. Ford has built a pilot H_2 refuelling station to analyse the benefits of liquid versus gaseous refuelling and Japan has some H_2 filling stations.

Natural gas and LPG

66. Compressed natural gas (CNG) and LPG are alternative fuels that could have a role in improving air quality, although in 1997 they accounted for only 0.1% of final UK energy consumption. They are attractive for motor vehicle use because they are stored in liquid state and used in gaseous state, making it possible to obtain a high-energy storage density and achieve cleaner and quieter combustion. Some adaptation of existing fuel system technology is required to enable vehicles to run on these gases. In some countries there are networks of local filling stations providing these fuels and these are developing in the UK.

Renewable fuels

67. The EU has set a target of 12% for the contribution of renewable sources to energy consumption by 2010[30]. In 1997 renewable energy only contributed to 0.5% of UK consumption - the lowest in the EU.

68. Renewable energy sources suitable for transport operations include "biofuels" derived from vegetable products, and hydrogen (H_2) which has often has often been called the perfect fuel. Solar power is also attracting a lot of attention. A cheaper alternative is to blend conventional and alternative fuels - in France about 5% RME is added to diesel fuel.

Electric vehicles

69. Electric vehicles (EVs) are the most familiar of the alternative fuel set. Practically all manufacturers are developing electric vehicles whose driving ranges are 2-3 times higher than earlier EVs. These are starting to capture a small part of the passenger and urban car market. Electric propulsion systems have been used for decades in mass transit. The key technological issue regarding EVs is batteries. With the exception of lead and NI-Cad batteries all other systems are prototypes.

70. Electric vehicles are limited by infrastructure; and without breakthroughs in battery performance and cost, pure electric vehicles appear unlikely to significantly penetrate the market. Moreover, despite the promise of these technologies and fuels, the cost and pace of fleet turnover could limit their impact over the next 20 years or so.

Hybrid EVs

71. The most promising type of electric vehicle is the parallel hybrid EV, which employs a combination of battery driven electrical and combustion driven mechanical drives. Toyota's hybrid gas/electric vehicle "Prius" already available in Japan gets 66 mpg in stop-and-go traffic. GM will unveil demonstrator models of full size hybrid pickups this year[31].

Fuel cells

72. Use of fuel cells in cars appears promising and perhaps hold the greatest promise for the clean car of the future. Fuel cells convert the "free" energy of a chemical reaction, typically between hydrogen and oxygen, directly into low voltage direct current electricity and heat. They are similar in principle to batteries. Fuel cells can be designed to run on a variety of fuels.

Prototypes

73. Several prototype hydrogen vehicles using fuel cells are under development. Japan is leading the commercial market with a small fleet of delivery trucks. BMW is developing vehicles which run on solar gathered pure liquid H_2, a process that is

completely neutral to the earth's environment. However, obstacles remain in hydrogen fuel cell technology – at present no major infrastructure exists to deliver H_2, and on-board storage is a problem.

74. Truly commercially competitive fuel cell products are not yet available and widespread uptake is unlikely before 2010[32]. For the transport sector, capital cost projections for volume manufacture of fuel cell systems compare favourably with internal combustion engines.

Vehicle design

Detailed information*: Vehicle Design and Technology Factsheet*

75. World-wide the search is on for vehicle technologies that meet modern expectations for mobility, satisfy strict environmental and safety requirements, and help sustain the competitiveness of manufacturing industry. The challenge to develop technology options that can form the basis of a sustainable transport policy is a formidable one. In the UK, the Foresight Vehicle Initiative[33] aims to stimulate suppliers to develop and implement market driven technologies for future vehicles.

Hypercars

76. Vehicle weight, material composition and aerodynamic shape are important considerations in vehicle design. Weight has a major effect on vehicle fuel consumption. "Lightweighting" can be achieved by using lighter materials –metals such as aluminium and magnesium or composite materials. The latest research is on "Hypercars" with 3-5 times better fuel efficiency, virtually no emissions and technologies that are almost completely recyclable or reusable[34].

77. Other ideas include making vehicles smaller (for example, man-wide car), more versatile during their lifetimes (upgraded to cope with disabled or older users), and dual-mode, enabling them to alternate between guided and unguided transport.

Automated Vehicles

Detailed information*: Vehicle Design and Technology Factsheet*

Relevant Visions*: Co-operative Driving on the Automated Highway*

"Smart" cars

78. The potential benefits of automating the guidance of cars are extensive especially with regard to better utilisation of highway space and safety. Proposals for vehicle automation have been made for at least 50 years but a practical system has not been possible because of technology limitations. Now new advances in technology have brought a practical system within reach. Emerging transport telematics technologies offer many possibilities for improving vehicle control, comfort and safety.

Advanced Vehicle Control Systems

79. Advanced Vehicle Control Systems (AVCS) include any vehicle or road-based systems that provide increased safety and/or control to the driver. The unifying purpose is to improve safety, whether by aiding the driver in controlling the vehicle as with anti-lock braking (ABS), or by actually removing the driver from a hazardous environment, such as with autonomous military vehicles. Ultimately the efficiency gains which AVCS systems can deliver are expected to provide significant growth to road capacity and to allow for more rapid road construction and maintenance operations.

80. AVCS has already touched every major area of vehicle dynamics: braking systems, propulsion systems, suspension systems and steering systems. These systems have provided significant improvements in vehicle safety, as well as comfort, convenience and performance. Most systems require no highway infrastructure modifications. Ultimately an AVCS must activate either the steering, propulsion or braking systems. The latest developments are "drive-by-wire" systems which allow consolidation of idle speed control, cruise control, traction control and manual throttle control to a single actuator.

81. Current autonomous systems rely on vehicle based sensors to “see” the surrounding environment and detect dangerous situations. Adaptive cruise control, forward collision warning, side collision warning, lane departure warning systems are available now. Systems of active control of the vehicle to automatically control vehicles will be available within 5 years, and early collision avoidance systems are being sold in Japan.

82. Commercial vehicles are early adopters of many automated handling aids. In addition anti-rollover devices, electronic braking systems that shorten the stopping distance, reduce skidding and avoid jack-knifing are widely available.

Novel infrastructure

Detailed information*: Emerging Concepts and Technologies Factsheet*

Relevant Visions*: Co-operative Driving on the Automated Highway; Institutional Change*

Automated Highways

83. “Intelligent highways” enable suitably equipped vehicles to receive information from the highway and respond appropriately. Vehicles can also detect and report hazards to the roadway, for dissemination to other travellers. An automated highway system (AHS) is a lane or set of lanes where specially equipped cars, trucks and buses can travel together under computer control. The long range goal of AHS is to significantly improve the safety and efficiency of the transport system[35]. Some estimates show an up to 80% improvement in travel safety and a doubling or tripling of lane capacity. AHS also offers the potential for substantial improvements in trip predictability, level of service, inclement weather operation, mobility and air quality.

Dedicated versus mixed lanes

84. Two distinct types of automated highway are possible. The first is a dedicated lane system, in which certain lanes are reserved for automated vehicles. The second is a mixed traffic system: fully automated vehicles would share the road with partially automated or manually driven cars. Organisation of traffic on automated highways could range from free-agent vehicles to platoons. Free-agent vehicles operate independently and each would drive so that it would be able to stop without mishap even if the vehicle ahead applied maximum braking. Platooned vehicles, at the other extreme, would operate in closely co-ordinated groups to maximise highway capacity.

85. Most experts agree that automation of highways is technically feasible even with existing technology but there are many factors that might prevent such systems from becoming truly practical – cost, liability, societal and institutional issues. The process would probably begin by converting part of existing highway, along with the construction of special ramps, transition lanes and barriers. Most of new technology would be packed into future cars – for example, magnetometers for steering, forward looking sensors and/or video cameras to detect dangerous obstacles and other vehicles ahead, accelerometers to control steering, breaking and throttling and allowing “hands-off, feet off” driving. Lateral and longitudinal crash avoidance technologies may take longer to deploy, because of issues related to taking direct vehicle control.

US Co-operative intelligent vehicle-highway systems

86. The United States and Japan lead the research on automated highways. The key impetus in California is vehicle congestion relief, using vehicle-vehicle and vehicle-infrastructure communications. Key functions are driver alerts that traffic is slowing ahead, hazardous road conditions (ice) and poor visibility. Dedicated Short Range Communications (DSRC) for toll collection is seen as a key enabling technology - thus the toll tag could be the device used for vehicle-infrastructure communications.

SmartCruise in Japan

87. The Japanese “SmartCruise” program focuses on vehicle-highway co-operative systems to maximise safety. In the recent Demo 2000 an extensive array of advanced systems were in operation in a test track environment – pedestrian avoidance, staying safely on the road, and avoiding crashes straight ahead or when changing lanes. Deployment is planned in 3 stages – information/ warning only (ahs-i 2003-2005), active vehicle control (ahs-c 2005-2007), and fully automated vehicles (ahs-a 2007-2015).

Key challenges seen are increasing public acceptance, full system design (reliability etc) and acceleration of the infrastructure-vehicle role sharing system (integrated standards etc).

France

88. In France, the La Route Automatisée program is considering advanced forms of CIVHS for automated guidance and management of traffic over a 20-yr timescale. Public private partnerships between car manufacturers and private road operators offer a way forward here.

Dedicated lanes

89. One way of increasing road capacity is to provide separate lanes for cars and trucks. Because cars are smaller and lighter, cars-only lanes can be double-decks, either above the road surface or in tunnels beneath high value real estate. Special-purpose lorry lanes could permit larger, heavier vehicles than at present and would allow these vehicles to bypass congested all-purpose lanes facilitating just-in-time deliveries.

Dual-mode

90. RUF (Rapid Urban Flexible) consists of electric vehicles that can be operated both on the conventional street system and on a rail facility. They can be privately owned or publicly owned for general use. RUF could be designed as the backbone of high-capacity inter-urban arteries combining the flexibility of an individual car with mass transport capacity. Prototype systems for both passengers and freight are under development in Denmark and the US. Infrastructure costs are substantial. However, flexibility to switch between guided and unguided operation-avoiding change of vehicle and transport mode is a major advantage.

Maglev

91. Maglev systems offer opportunities for improved passenger and freight transport either above or underground. Magnetic forces lift, propel and guide a vehicle over a specially designed guideway and cruising speeds of 300 mph or more are possible. At such high speeds Maglev systems have the potential to change the modal split for inter-urban traffic. Trains are environmentally friendly as they generate little noise and vibration at high speeds. Expectations are high that Maglev will some day replace conventional railways.

US feasibility studies

92. The first Maglev project in the US could be operating in revenue service by 2010 if funds are appropriated[36]. Seven cities are undertaking feasibility studies and one project will be selected for possible deployment in Spring 2001.

High speed trains in Japan

93. Japan has a 1.5km High Speed Surface Transport test track (HSST) for developing Maglev trains. In Aichi it is hoped that the proposed 8.9km Tobukyuryo line will be the first full-scale operation of a Maglev system in time for the 2005 World Expo.

Swissmetro

94. The Swiss are developing a Maglev tube transportation system. The prime motive is to obtain the benefits of a high-speed passenger system in a region where there are major environmental constraints. Construction of the full system is planned for 2010.

Freight-train

95. These concepts are systems for freight transport that do not necessarily make use of a driver. They can be implemented at the urban level or at a long-distance level. The key issue of all container based transport innovations is to use a container of standard size to make the switch between modes easy and efficient. There are prototype systems which use existing infrastructure or dedicated infrastructure.

Tunnels

96. The inherent difficulties in extending infrastructure above ground, raises questions about the greater use of tunnels for increasing network capacity[37]. Significant advances in tunnel technology and inclusion of all costs in scheme appraisal might make tunnels more competitive.

Tube freight

97. There may be increased scope for using "microtunnels" for freight transport beyond traditional pipelines, particularly given advances in microtunnel technology. Tube freight transport is an unmanned system in which close-fitting capsules or trains of capsules carry containerised freight through tubes between terminals. If this system were implemented in congested areas, passenger vehicles could be separated from freight

vehicles with improvements in efficiency and safety for both modes. There are proposals for unmanned tube freight systems in Tokyo and Holland.

Dutch IPOT programme

98. The IPOT programme in the Netherlands is a design for a national Underground Transport and Tube system of about 10,000km with 14 major junctions for both general cargo and liquids and gases. Key concepts include automation of transhipment and standardisation of load units.

Airships

99. Airships could form an integral part of sustainable passenger and freight transport. The majority of new concepts for medium and large airships rely on rigid structures for providing a maximum payload capacity, safety and efficiency. Airships cruise at a low altitude (1000 - 2000m) which helps avoid interference with other modes. They require little ground infrastructure and could link to other transport modes.

"Air crane" concept

100. The Dutch CargoLifter AG "CL160" is an example of a large semi-rigid freight airship for point-to-point delivery of heavy and bulky loads – "air crane" concept. With a payload capacity of 160 tons and a range of 10,000km this offers an option for transport of bulky goods which might otherwise require bridges to be temporarily removed or loads to be disassembled and reassembled. The first full scale prototype is to fly in summer 2001. Larger airships targeting unique market segments like bulky and heavy freight transport will require innovative solutions addressing logistic aspects of this concept. There are other developments in Russia and the US.

Conclusion

101. The future development of transport systems and options will require attention to be paid to regulatory, financial and social measures which an help mitigate the adverse effects of infrastructure stress and infrastructure damage. Whilst market forces will remain the principal drivers of change, Government action to help direct other measures might be needed when market failures occur. Policies aimed at dealing with these problems might include demand management, including road pricing and charging; shifts to smaller, safer, more fuel efficient cars; and improvements to public transport services, including attention to better interchange practices with other modes of transport.

References

[1] Foresight Web-site (www.foresight.gov.uk)

[2] USDOT. "The Changing Face of Transportation".2000

[3] USDOT. "Policy Architecture for the 21st Century". 2001

[4] Government Actuary's Department. "1998 Based Summaries of populations for the UK".

[5] DTLR.. "Projections of Households in England 1991 – 2021".

[6] Foresight Construction Associate Programme. "Building our Future – A Consultation Document of the Built Environment and Transport Panel". 2000

[7] Sirka Heinonen and Matthias Weber. "Recent Experience with Teleworking: Effects on Transport".

[8] CEC. "Status report on European Teleworking". Brussels 1997.

[9] DTLR.. "National Road Traffic Forecasts (Great Britain)". 1997.

[10] DTLR.. "Air Traffic Forecasts for the United Kingdom 2000". June 2000.

[11] DTLR.. "The Future of Aviation. The Government's Consultation Document on Air Transport Policy" . 2000.

[12] DTLR. "National Travel Survey". 2000.

[13] DTLR. "Bulletin of Rail Statistics Qtr 1 2000/2001". 2000

[14] DTLR. "Transport 2010: The 10 Year Plan". 2000

[15] Strategic Rail Authority. "Developing the Strategy. Annual Report 1999-2000".

[16] DTLR. "A New Deal for Transport: Better for Everyone". 1998.

[17] DTLR. "Sustainable Distribution: A Strategy". 1999.

[18] Foresight Retail Logistics Task Force. "Foresight Vehicle Workshop". April 2000.

[19] Jonathon Packer and Associates. "Roads to Water Research Project". 1993.

[20] DTLR. "British Shipping Charting a New Course". Dec 1998.

[21] EC IMPREND Project. "State-of-the-Art Pre- and Endhaulage". 1997

[22] Highways Agency. "Making the Network Safer. Highways Agency Strategic Plan for Safety". 2001.

[23] DTLR. "Tomorrow's Roads: Safer for Everyone. The Government's Road Safety Strategy and Casualty Reduction Targets for 2010". March 2000.

[24] ERM. "Potential UK Adaptation Staregy for Climatic Change". 2000.

[25] DTLR. "Tackling Congestion and Pollution". June 2000.

[26] European Union. "1999 Annual Energy Review".

[27] World Resources Institute. "Plausible scenarios for future global oil production". Washington DC. 2000.

[28] EC UTOPIA Project. "Overview of promising transport modes related to new propulsion systems". 1998

[29] European Commission (EC) Directive 99/94/EC "Consumer Information on fuel economy and CO_2 emissions in respect of the marketing of new passenger cars". April 2000.

[30] European Commission. Community Strategy and Action Plan. "Energy for the Future: Renewable Sources of Energy. COM (97) 599". November 1997.

[31] Environmental News Network. "Touring on Alternative Power". (http://www.enn.com/index/asp)

[32] DTI. (http://www.dti.gov.uk/renewable/cells.html).

[33] Foresight. Foresight Vehicle. "Strategic Plan". Feb 1999. (www.foresightvehicle.org.uk)

[34] Hypercar. (www.hypercar.com)

[35] NAHSC. "AHS Program". (ahs.volpe.dot.gov/aboutahs/aboutahs.html)

[36] US Dept of Transportation. "The Changing Face of Transportation". 2000.

[37] POST Report Summary. "Tunnel Vision". London 1997.