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Transportation Engineering

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Preface

Transport of people, goods and information is essential to everyday life. Over the centuries, engineering and science has shaped these three essential elements of living. From the Roman roads to transport goods and people, the systems of semaphore and beacons to convey information, to the cars, buses, trains and aircraft of today, coupled with the global information technology that is now taken for granted.

Over time, invention and ingenuity has created new forms of transport, both for people and goods, leading to the decline or redirection of older forms of transport. The canals are a case in point. Originally engineered to provide a network of routes to transport goods from the place of manufacture to the point of consumption as an alternative to a dangerous and unpredictable road system, these now have become a place for leisure activity, while the bulk of goods, having first moved from the canals to the railways, are now carried by lorry on the current road network.

Engineering advances have driven the changes in transport and communications through the centuries and the great engineers such as Stephenson, Telford, Brunel and Macadam have all played their part in creating the world we take for granted today. However, the engineering developments that shape our transportation networks could not have taken place without the investment and confidence of finance and the City.

Transport needs are based on the concept of supply and demand. Viewed as a product, the transport mode can be viewed as having a life-cycle. When a new means of transport is developed, travellers need to be made aware of the benefits. The coming of the railways was by no means greeted with universal approval and there were press stories of the dangers to human health in travelling at speed on the new steam trains. It took significant advertising of the benefits of rail travel and the enthusiasm of, first, Prince Albert and then Queen Victoria to bring acceptance and later enthusiasm for this new form of transport. Once the travelling public accepted the use of railways, and the comfort over existing alternatives became apparent, then demand grew and rail expansion occurred. Investors were prepared to put money into developing and expanding the rail system. The new means of transport was behaving as a commodity, with travellers considering price, convenience and safety and judging this against the alternative of coach travel.

A modern parallel of this example would be the introduction of the electric vehicle. This is an attractive proposition in terms of zero pollutant emission with no reliance on fossil fuels. However, take up of electric vehicles has been relatively modest, despite government subsidy on many of these vehicles. The reasons for the low take up are complex. Partly it is due to the high cost of acquiring an electric vehicle and the uncertainty over the life of the battery. There is also concern as to the range of travel available on a battery charge. Until there is a developed network of charging points or battery exchange facilities, the main role of the electric vehicle seems destined to be a means of transport to and from work in cases where the employer will provide charging facilities or as a short-distance delivery vehicle working out of a depot.

Economics also plays a key role in the popularity of a transport mode. The recent recession, amongst other factors, has revitalised an interest in cycling, both as a means of travel to work and as a leisure activity. Innovations such as short-term bike-hire schemes have opened the opportunity for cycle journeys to those who do not have a bicycle available in a city but wish to take advantage of the flexibility that cycling provides.

This book examines the impact of transportation engineering in the UK, looking at some of the current issues affecting our daily lives. It is a time of great change in transport terms. Developments in the area of electronic communications mean that some of the journeys that were necessary to transact business may now be conducted via the internet, reducing the need to travel. Research is also in progress to create safe driverless vehicles and road trains. These developments are aimed at increasing the safety and capacity of existing road networks.

While this book deals mainly with transportation engineering in the UK, wider issues cannot be ignored.

The increasing congestion at UK airports and the decision whether to expand Heathrow or other airports in south-east England or to build a new airport in the Thames Estuary is ongoing, as is the construction of the proposed high-speed rail link, HS2.

Changes in engineering and technology will have a great impact on the transport of both goods and people.

List of abbreviations

AADT	Average annual daily traffic
ABP	Association of British Ports
ACTRA	Advising Committee on Trunk Road Assessment
ATC	Air Traffic Control Services
BAA	British Airports Authority
BAC	British Aircraft Corporation
CAA	Civil Aviation Authority
CAS	Controlled airspace
CBI	Confederation of British Industries
CIHT	Chartered Institution of Highways and Transportation
COBA	Cost Benefits Analysis
CTRL	Channel Tunnel Rail Link
DDA	Disability Discrimination Act 1995
DETR	Department for Environment, Transport and the Regions
DfT	Department for Transport
DMRB	*Design Manual for Roads and Bridges*
DPDs	Development Plan Documents
DTLR	Department for Transport, Local Government and the Regions
ECTS	European Train Control System
EIA	Environmental Impact Assessment
ERTMS	European Rail Traffic Management System
FAA	Federal Aviation Administration
FOSD	Full overtaking sight distance
FTA	Freight Transport Association
GHG	Greenhouse Gas
GIP	Global Infrastructure Partners
HS1	High Speed 1
HS2	High Speed 2
ICAO	International Civil Aviation Organization
ITAs	Integrated Transport Authorities
LDDs	Local Development Documents
LDF	Local Development Framework
LEZ	Low Emission Zone
LHA	Local Highway Authority
LPA	Local Planning Authority
LRT	Light rapid transit
LTA	Local Transport Authority
MARPOL	International Convention for the Prevention of Pollution from Ships
MEA	*Manual of Environmental Assessment*
MIT	Massachusetts Institute of Technology
MPG	Minerals Planning Guidance
MPS	Minerals Policy Statement
NASA	National Aeronautics and Space Administration
NATA	New Approach to Appraisal
NATS	National Air Traffic Control Services
NCN	National Cycle Network
NIP	National Infrastructure Plan
NMD	Network management duty

NPPF	National Planning Policy Framework
NPV	Net present value
P&R	Park and Ride
PPG	Planning Policy Guidance
PPS	Planning Policy Statements
PRN	Primary route network
PTAs	Passenger transport authorities
PTEs	Passenger transport executives
QUADRO	Queues and Delays at Roadworks
ROSPA	Royal Society for the Prevention of Accidents
RSS	Regional Spatial Strategy
SACTRA	Standing Advisory Committee on Trunk Road Assessment
SDS	Special Development Strategy
SEA	Strategic Environmental Assessment
SPDs	Supplementary Planning Documents
SRN	Strategic road network
SSD	Stopping sight distance
TA	Transport Assessment
TEL	Tetraethyl lead
TEN-T	Trans European Transport Network
TEU	Twenty foot equivalent unit
TRL	Transport Research Laboratory
TS	Transport statements
ULEZ	Ultra Low Emission Zone
WCED	World Commission on Environment and Development

Contents

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1
Introduction

Learning aims

After studying this chapter you should be able to:

- put current transportation engineering into a historical context
- understand the role of engineering in the development of transportation.

1.1. A brief history of transport in the UK

By the first century AD a network of roads was established across the Roman Empire. In the UK this network was used to transport troops and goods to administrative and military centres, while messages were relayed through a system of semaphores and beacons. This relatively sophisticated system of communication was abandoned once the Romans withdrew from the country. By the twelfth century the roads had fallen into decay and were often impassable in winter. Transport of goods was by animal, and people either walked or rode on horseback. Carrying goods around the coast or by river was often the only means of winter transport. Up until the sixteenth century goods were transported by packhorse or cart, while rivers were used both for goods and for personal transport, particularly in London. A small amount of canal building took place to improve winter transport and by 1670 the Stamford Canal was in use between Stamford and Market Deeping. The seventeenth century saw private investment in road building. Toll roads were created and users were charged to travel or transport goods on the new facilities. Charles 1 allowed the public to pay his messengers to carry letters, the beginnings of the Royal Mail. In towns and cities the wealthy were carried in sedan chairs. Most other local journeys were by foot, on horseback or by carriage. Toll road expansion continued in the eighteenth century and by 1874 mail was carried by stage coach leading to a scheduled coach service between towns and cities. The eighteenth century was also the age of canal building with the majority of non-perishable goods being transported by water.

The Industrial Revolution triggered an expansion of transportation engineering. By 1815, steamships were crossing the English Channel on a regular basis and 1825 saw the Stockton and Darlington Railway open. The great age of railway expansion began in 1840 and by the First World War railway use had reached a peak. In London, the first underground line opened in 1863. The first trains were steam powered, but these were later replaced by electric traction trains to the health benefit of travellers and safety of the system.

The invention of the bicycle in the 1880s allowed many people to enjoy the freedom to explore beyond walking distance and opened opportunities for more leisure travel. The development of the pneumatic

tyre in 1888 improved bicycle comfort and soon a bicycle industry developed. The car followed from the development of the bicycle, many bicycle repair shops developing into the first garages. On a wider horizon, steamships developed and gradually challenged sail for supremacy. In 1847 *HMS* Driver became the first steamship to sail around the world and by 1897 steam turbines were making steamships more efficient.

Electronic communications were also expanding. The electric telegraph was developed in the 1830s and the invention of the electro-magnetic relay in 1835 enabled long-distance telegraphy to become a reliable means of communication. Submarine cables were laid between England and the USA in 1866 after several unsuccessful attempts previously. Voice communication followed in 1867 with the invention of the telephone by Graham Bell. These developments reduced the time for the delivery of long-distance communications from weeks to less than a day.

The beginning of the twentieth century saw an accelerating development in transport engineering. In towns and cities electric tramways were built. The railways were by now the major transporter of passengers and freight. Motor vehicles were still a rarity, but some hauliers used steam lorries to move goods and motorised charabancs were appearing on UK roads.

The First World War produced a need for transportation of munitions, men and horses to the battle fields of Europe. The railways were brought under government control and used for this task. The emerging motor industry was diverted to war work and did not expand until peace was restored. After the war the railways were returned to private ownership, but many of the small companies were amalgamated to leave just four major operators.

After hostilities ceased, the internal combustion engine became a major provider of transport propulsion. Aircraft started to become more robust and the first planes carried passengers between London and Paris in 1919. By the 1930s electric trams were being replaced by buses as the fixed tracks were inconveniencing the growing numbers of cars, buses and lorries in cities. By 1934 cars were more numerous and the first driving test was introduced in 1934. When the Second World War started in 1939, about 10% of families in the UK owned a car. By 1950, the figure was roughly 30%.

After the war a new Labour government nationalised many forms of transport. The railways were already experiencing a reduction in freight carriage, partly due to the reduced demand to transport coal following the introduction of the national power grid, which balanced the load on power stations. Rail passenger numbers also declined in the 1950s as more families owned cars. Lord Beeching was commissioned by the government to report on reshaping British Railways and this resulted in the closing of many branch lines in the 1960s.

At the same time (1959) the first inter-urban motorway, the M1, began construction. This was followed by a programme of motorway construction that continued into the late 1970s.

Air transport too was expanding. The first passenger jet service from the UK started in 1952 and air was soon challenging shipping for passenger traffic.

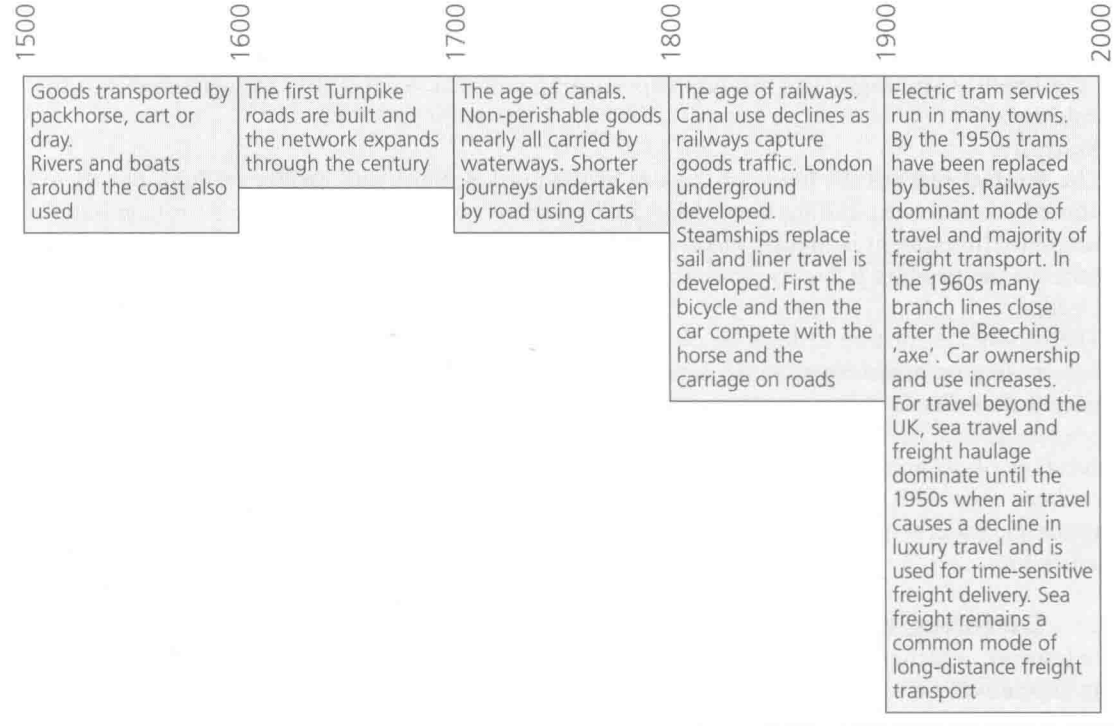
The Channel Tunnel opened to traffic in 1994, creating a permanent link between the UK and Europe. The Tunnel provided a link for road freight vehicles and made it feasible to deliver goods from across Europe to the UK. Passenger services were initially hampered by the highspeed trains sharing the local

service tracks but in 2007 the Channel Tunnel Rail Link (CTRL) opened, allowing a journey time from London to Paris of two hours fifteen minutes.

As the post-war economy improved, travel horizons expanded. More families owned cars and were using air transport for holidays outside the UK. Congestion in towns and cities worsened and by the end of the century the delays, congestion and environmental impacts of transportation were causing concern. In 1963 Sir Colin Buchanan produced an influential report, *Traffic in Towns*, for the Conservative government of the day and this report was a milestone in transportation engineering (Ministry of Transport, 1963). The report recognised that unrestrained traffic growth was not feasible and that restraint of car use in city centres was inevitable. *Traffic in Towns* formed the foundation of modern planning for urban transport.

By the end of the twentieth century technology was a large factor in transportation engineering. The computer, the widespread adoption of the internet for communication and video conferencing has reduced the need for some face-to-face meetings, but has had little impact on congestion, particularly during peak hours. Satellite navigation and improved in-vehicle communications has helped freight operators plan and schedule deliveries as well as track the location of loads in real time. Retail and manufacturing companies have taken advantage of the technological developments to adopt just-in-time delivery, reducing the need to hold stock and minimising storage space. The timeline of transportation development is shown in Figure 1.1.

Figure 1.1 Timeline of transport development in the UK



1.2. Transportation engineering development

The development of transport has been led by engineering innovation, but has depended on the vision and investment of entrepreneurs and investors for finance. Up until the twentieth century investment was from the private sector, although today in the UK most infrastructure projects are at least partially government funded.

As a transport mode develops profit is generated for investors and may also be used to improve the facility. New engineering development may render an established transport mode obsolete and lead to its decline and eventual displacement. In the case of canal transport, the invention and development of the steam train led to the transfer of most goods from barge to train. Ultimately the invention of the automobile and the lorry led to the transfer of the majority of freight haulage moving to the road network.

To some extent, transport may be seen as a commodity, to which the rules of supply and demand apply. Price, speed of journey, comfort and availability will all factor in the decision as to which mode of journey is used.

Using the commodity analogy, transport development and decline may be seen as a life-cycle:

- Introduction
  The product appears on the market. Customers are not aware of the potential benefits, so advertising is necessary. Investment is needed to cover capital costs and build up a market. Risk is high because it is not clear whether the project will succeed. Profit is negative, owing to high cost and low sales. The level of competition is low.
- Growth
  The product has been successful and there is a rapid spread of awareness and use of the product. Sales are growing quickly, unit costs are decreasing and profits start to be generated. Investment is still high. The product is promising and new competitors are attracted into the industry.
- Maturity
  The product reaches the limits of the size of the market. Sales and profits are high but there is limited scope for expanding them. Marginal sales are growing slowly or are even beginning to stagnate. Investment is mainly directed at improvements. Competition is intense in the market, because the product is highly profitable.
- Decline
  The product is starting to become obsolete. Customers are being attracted to other products. Advertising or brand loyalty may slow things down, but not for long. Sales are falling and as output falls. Profit is low or negative and competitors leave the market.

At the stage of decline, the product may disappear from the market, or may experience a resurgence, as has been seen with rail passenger travel. In the case of the canals, conservation groups, working alongside the waterways authority, have adopted them and have fostered the leisure use of the existing infrastructure.

1.3. Distance, modal choice and transport cost

For a journey, whether to transport freight or for passenger travel, cost will be a significant consideration. There will be optimum costs for a journey based on distance. Figure 1.2 shows a simplified scheme for a journey using road, rail and air.