

INTRODUCTION

A historical overview of the development of the road

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Everybody travels, whether it be to work, play, shop, do business, or simply visit people. All foodstuffs and raw materials must be carried from their place of origin to that of their consumption or adaptation, and manufactured goods must be transported to the marketplace and the consumer. Historically, people have travelled and goods have been moved: (1) by road, i.e. by walking and riding, using humans and various beasts to carry goods or to pull sleds, carts, carriages and wagons, and (since the late 19th century) using cycles and motor vehicles such as cars, buses and lorries; (2) by water, i.e. using (since early times) ships and boats on seas, rivers and canals; (3) by rail, i.e. initially using animals (in the early 19th century) and then steam-, oil- or electric-powered locomotives to pull passenger carriages and goods wagons; and (4) by air, i.e. using airships and aeroplanes (in the 20th century).

Whilst the birth of the road is lost in the mists of antiquity, there is no doubt but that the trails deliberately chosen by early man and his pack animals were the forerunners of today's road. As civilization developed and people's desire for communication increased, the early trails became pathways and the pathways evolved into recognized travelways. Many of these early travelways – termed *ridgeways* – were located high on hillsides where the underbrush was less dense and walking was easier; they were also above soft ground in wet valleys and avoided unsafe wooded areas.

The invention of the wheel in Mesopotamia in ca 5000 BC and the subsequent development of an axle that joined two wheels and enabled heavy loads to be carried more easily, gave rise to wider travelways with firmer surfacings capable of carrying concentrated loads, but with less steep connecting routes down to/up from valleys and fordable streams. Thus *trackways* evolved/were created along the contours of lower slopes, i.e. they were sufficiently above the bottoms of valleys to ensure good drainage but low enough to obviate unnecessary climbing. The trackways eventually became well-established trade routes along which settlements developed, and these gave rise to hamlets and villages – some of which, eventually, became towns and cities.

Early manufactured¹ roads were the stone-paved streets of Ur in the Middle East (ca 4000 BC), the corduroy-log paths near Glastonbury, England (ca 3300 BC), and brick pavings in India (ca 3000 BC). The oldest extant wooden pathway in Europe, the 2 km long Sweet Track, was built across (and parts subsequently preserved in)

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marshy ground near Glastonbury. The oldest extant stone road in Europe was built in Crete ca 2000 BC.

Notwithstanding the many examples of early man-made roads that are found in various parts of the world, it is the Romans who must be given credit for being the first 'professional' road-makers. At its peak the Roman road system, which was based on 29 major roads radiating from Rome to the outermost fringes of the Empire, totalled 52 964 Roman miles (ca 78 000 km) in length². Started in 312 BC, the roads were built with conscripted labour; their purpose was to hold together the 113 provinces of the Empire by aiding the imperial administration and quelling rebellions after a region was conquered. The roads were commonly constructed at least 4.25 m wide to enable two chariots to pass with ease and legions to march six abreast. It was common practice to reduce gradients by cutting tunnels, and one such tunnel on the Via Appia was 0.75 km long. Most of the great Roman roads were built on embankments 1 m to 2 m high so as to give troops a commanding view of the countryside and make them less vulnerable to surprise attack; this had the engineering by-product of helping to keep the carriageway dry. The roads mainly comprised straight sections as they provided the most direct routes to the administrative areas; however, deviations from the straight line were tolerated in hilly regions or if suitable established trackways were available.

In the 150 years following their occupation of Britain in 55 BC the Romans built around 5000 km of major road radiating out from their capital, London, and extending into Wales and Scotland. However, the withdrawal of the legions from Britain in AD 407 foreshadowed the breakdown of the only organized road system in Europe until the advent of the 17th century.

Whilst the Roman roads in Britain continued to be the main highways of internal communication for a very long time, they inevitably began to decay and disintegrate under the actions of weather, traffic and human resourcefulness. Eventually, their condition became so deplorable that, when sections became impassable, they were simply abandoned and new trackways created about them. Most 'new roads' consisted of trackways made according to need, with care being taken to avoid obstructions, private property and cultivated land. These practices largely account for the winding character of many present-day secondary roads and lanes.

Throughout the Middle Ages through-roads in Britain were nothing more than miry tracks so that, where practicable, the rivers and seas were relied upon as the major trade arteries. During these same times, however, lengths of stone-paved streets were also built in some of the more prosperous towns, usually to facilitate their provisioning from rural hinterlands, i.e. good access roads were needed to withstand the high wheel stresses imposed by the wheels of the carts and wagons of the day.

It might be noted that the terms *road* and *street* began to come into wide usage in England in the 16th and 17th centuries¹, with the word 'road' possibly coming from the verb 'to ride' and implying a route along which one could progress by riding, whilst 'street' likely came from a latin word meaning constructed (as applied to some Roman roads, e.g. Watling Street).

Even though most roads were in a dreadful state the opportunities for overland passenger travel continued to increase, e.g. the first non-ceremonial coach was seen in London in 1555 and the first British stagecoach service to change horses at regularly-spaced posthouses was initiated between Edinburgh and Leith in 1610.

The development (in Austria in the 1660s) of the Berliner coach's iron-spring suspension system resulted in such an expansion of travel by coach that, by 1750, four-wheeled coaches and two-wheeled chaises (introduced from France) had superseded horseback-riding as the main mode of intertown travel by Britain's wealthy and its growing middle class.

The onset of the 18th century also saw foreign trade become more important to Great Britain's steadily-developing manufacturing industries, and soon long trains of carts and wagons were common sights as they laboriously dragged coal from mines to ironworks, glassworks and potteries, and manufactured goods to harbours and ports, along very inadequate ways.

Confronted by the above pressures and the terrible state of the roads Parliament passed, in 1706, the first of many statutes that eventually created over 1100 Turnpike Trusts. These Trusts, which administered some 36 800 km of road, were each empowered to construct and maintain a specified road length and to levy tolls upon certain types of traffic. The development of the toll road system, especially in the century following 1750, was important for many reasons, not least of which were: (i) it promoted the development of road-making techniques in Britain, and allowed the emergence of skilled road-makers, e.g. Thomas Telford and John Loudon McAdam; (ii) it established that road-users should pay some road costs; and (iii) it determined the framework of the 20th century's pre-motorway trunk road network.

The opening of the first steam-powered railway service (between Stockton and Darlington) in 1825 marked the beginning of the end for the Turnpike Trusts as the transfer of long-distance passengers from road to rail was almost instantaneous once towns were accessed by a railway. So many Trusts became insolvent that, in 1864, the government decided to gradually abolish them; as a consequence the final Trust (on the Anglesey portion of the London–Holyhead road) collected its last toll on 1 November 1895.

The abolition of the Trusts resulted in their roads reverting to the old system of parish maintenance. Thus, at the turn of the latter half of the 19th century, there were some 15 000 independent road boards in England and Wales alone, most of which resented having to pay for the upkeep of 'main' through roads from local funds. The situation became so chaotic that, in 1882, Parliament agreed *for the first time* to accept financial responsibility for aiding road construction and maintenance. This and subsequent governmental financial-cum-administrative reforms were very timely for, by the turn of the 20th century, the bicycle and motor vehicle had well and truly arrived. Then, the end of World War 1 resulted in a major impetus being given to commercial road transport, when a myriad of motor trucks became available for non-military uses and thousands of trained lorry drivers were returned from the army to the civilian workforce.

Overall, the first 40 years of the 20th century were years of evolutionary development rather than revolutionary change for roads. Initially, the emphasis was on 'laying the dust' using, mainly, tar and bitumen surfacings, and then on reconstructing existing roads. Organized road research that was directly applicable to United Kingdom conditions was initiated in 1930 with the establishment of a small experimental station at Harmondsworth, Middlesex at which research was carried out into 'highway engineering, soil mechanics, and bituminous and concrete technology'; this was the start of the Transport Research Laboratory (TRL).

After World War 2, road technology took a giant step forward with the passing in the USA of the Federal Aid Highway Act of 1944 which authorized the development of the *Interstate and Defence Highway System* to connect 90 per cent of American cities with populations above 50 000, by means of some 70 000 km of motorway. Momentous research programmes, which included the development of special test tracks to study pavement materials, design and construction, were initiated in the USA as a consequence of this decision. The outcomes of these research programmes, and the development of associated road-making and traffic-management techniques, were major influences for road development on the international scene, especially in the 1950s.

In 1958, the first motorway (the 13 km Preston bypass) to open in Great Britain presaged the development of a strategic inter-urban trunk road network of over 15 000 km (including the construction of some 3100 km of new motorway and over 3500 km of dual carriageway). This also was the catalyst for the initiation of major pavement technology and traffic management research programmes by, in particular, the Transport Research Laboratory. Unlike in the USA, the TRL tended to rely upon test sections incorporated into existing main roads, rather than upon controlled test tracks, when evaluating pavement materials and design and construction criteria.

Notwithstanding the great numbers of motor cars on the road the research work clearly demonstrated that most damage to road pavements is caused by heavy goods vehicles and not by cars and, therefore, that pavement design should mainly be concerned with resisting the stresses and strains caused by commercial vehicles. Figure I.1 indicates that the demands placed upon existing and new pavements by heavy goods vehicles in Great Britain will increase substantially in future years.

The motorway and trunk road network is now the backbone of Great Britain's transport infrastructure, and the country's economic health and quality of life depend upon the system being well built, well managed, and well maintained. Increasingly, it can be expected that the governmental focus in the well-developed crowded island of Great Britain will be to maximize the use of the existing road network,

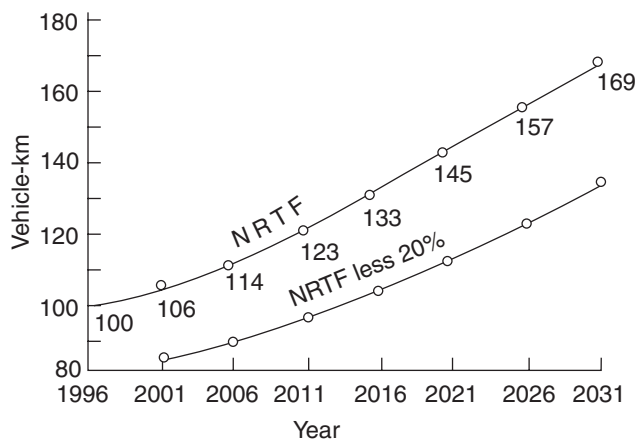


Figure I.1 National Road Transport Forecasts (NRTF) of travel by heavy (>3.5t) goods vehicles for the years 2001 to 2031. (Note: Index for 1996=100)

and most improvements will be in the form of the upgrading of existing roads, the building of bypasses about towns and villages suffering the noise, dangers and severance of inappropriate through traffic, and the widening of the most heavily trafficked and congested motorways.

Overseas, in countries that are only now experiencing the pleasures and problems associated with the motor age, the opportunities and challenges for road designers and builders are very great.

I.1 References

1. Lay, M.G., *Ways of the World*. Sydney: Primavera Press, 1993.
2. Pannell, J.P.M., *An Illustrated History of Civil Engineering*. London: Thames and Hudson, 1964.