Making roads safe for pedestrians or keeping them out of the way?

An historical perspective on pedestrian policies in Britain

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Transport policy in many countries has sought ways to decrease reliance on cars and increase the use of other modes of travel. One focus of these policies has been to enhance urban livability by increasing pedestrian activity in cities and walking as a mode of utilitarian travel. The motivation for these changes is derived from efforts to reduce the environmental consequences of car use, especially in urban areas. Increased walking is also seen as a way to improve the physical activity of the population, as obesity levels have increased in most developed nations.

The UK government has in recent years redirected transport policy to focus on non-car modes of travel. Beginning with the Integrated Transport Policy, published in 1998,[1] there has been an effort to improve local planning to consider other modes. Walking is a key feature of these policies and was re-emphasised in the publication of *Walking and Cycling: an Action Plan* in 2004.[2] These policies are being implemented via the promulgation of local transport plans and documents such as the *London Walking Plan*.[3]

Many successful projects have been implemented. For example, in London they include the opening up of Trafalgar Square in 2003 and the linking of routes to the south bank of the Thames via the construction of pedestrian-only bridges at the start of the new millennium. These projects have sought to increase opportunities for walking in the city and have generally been seen as successful.

The actual implementation of policies to promote walking is often stymied by the existing infrastructure. This includes wide streets with large flows of motor traffic, inadequate opportunities for pedestrians to cross the streets safely, inadequate sidewalk space in some areas, and overall concern that any walking facilities will exacerbate congestion on existing road networks. These controversies are not new and, as our historical review reveals, have often been of primary concern in the debates over providing facilities for pedestrians.

This review seeks to understand how pedestrian infrastructure in Britain developed over time and how increases in road traffic influenced the design and planning of pedestrian facilities. An initial goal was to understand the basis of various engineering standards and the development of the techniques

used to control the flow of pedestrians, thereby providing a perspective on how many cities ended up neglecting pedestrians. The sources of many current practices are often shrouded in mystery, with no historical research underpinning their relative effectiveness. Much of the debate over the years has often sought to balance the need for pedestrian safety while maintaining the flow of vehicular traffic, based on explicit guidance provided in government documents, without much knowledge of how long-standing practices were originally devised.

Our focus is on British history and policy. However, these issues are relevant to other countries as many will likely resonate internationally. In particular, the lack of evidence-based policy for many decisions in this area is likely common. This strikes us as a rich area for historical research that is informed by knowledge of new techniques; however, a broad international survey is beyond the scope of this article.

The historical perspective of many of the larger issues in pedestrian–motor traffic interaction in Britain (and some other Western countries), has been discussed by Hass-Klau.[4] She has focused primarily on traffic calming and the 'pedestrianisation' (as it is called in planners' jargon) of shopping areas. This and other work on pedestrian issues have tended to make only passing reference to the micro-traffic engineering issues involved, such as the evolution and development of various techniques aimed at making it safer to cross the road. Most of the recent literature, primarily in urban planning, deals with contemporary issues without reference to the historical roots of these problems. The present work is an attempt to trace the roots of modern-day pedestrian issues and hopefully bridge some of the gaps in the literature of pedestrian policy developments.

The basic methodological approach taken was to survey and review a large selection of historical sources. These included nineteenth-century newspapers (primarily the London *Times*), medical journals such as *The Lancet,* which were an early source of information on what was seen as a new public health issue, engineering journals and engineering trade journals, and published parliamentary papers of the House of Commons and House of Lords. In addition the files of police records, various government Ministries and local bodies were consulted at the National Archives. Information was also obtained from the London Metropolitan Police service. While we make no claim that all relevant sources were identified, we do feel that this search of late nineteenth and early twentieth-century sources was comprehensive. More recent mid-twentieth-century sources included reports from the Ministry of Transport and the Road Research Laboratory (now the Transport Research Laboratory).

Our review begins with a discussion of road safety in the nineteenth century and the response of the existing agencies to the problem of pedestrian safety. We trace this through the development of sidewalks and footpaths to methods developed for making street crossings safer for pedestrians. In a subsequent section we discuss the development and history of methods designed to control pedestrian flow and channel traffic, specifically median refuges and

guard rails. Thus the organisation of the article is partly chronological, partly thematic. Following this structure allows the individual policies to be highlighted while noting their interaction and extracting the relevant lessons for current policy in modern cities, which are brought together in the conclusion.

Road safety policy in the nineteenth century

Most major cities experienced tremendous growth in the nineteenth century. The population of London grew from 818,129 in 1801 to 5,328,855 in 1901.[5] This growth was accompanied by increasing vehicular and pedestrian traffic on the streets. While the former is common knowledge in the historiography of transport, the latter is often forgotten. Although road vehicles using steam engines were in use as early as the 1830s, and bicycles as early as the 1850s, their use was not significant until the last decade of the century. Traffic on city roads was overwhelmingly horse-drawn vehicles, trams and pedestrians. The absence of motor vehicles by no means meant that pedestrians did not face any problems in using the road infrastructure. These problems were mainly the result of poor or no pedestrian facilities and the lack of effective traffic control policies.

The earliest comprehensive report of the Registrar General indicated that in 1840 there were nearly 1,000 deaths that could be attributed to road traffic in England and Wales, giving a fatality rate from traffic accidents of about sixty per million persons living per annum, or 60 pMa). Between 1840 and 1900 accidents involving horses produced a mortality rate on average of about 50 pMa—probably higher in the earlier decades, lower in the latter.[6] Greenwood *et al.* have shown that road transport fatalities fluctuated between 53 pMa and 59 pMa between 1878 and 1900 in England.[7] Their figures show an almost static traffic death rate in the nineteenth century, which, taking into account the rapid population rise, means an ever greater number of people being killed in traffic accidents. For comparison, the traffic fatality rate for England and Wales in 2002 was 60 pMa, similar to the nineteenth century. However, overall travel frequencies and travel distances have increased manifold in comparison with the nineteenth century.

As for separation of data on traffic deaths to ascertain the risk faced by pedestrians, it can be assumed that the overwhelming majority of the road fatalities were pedestrians, although it is not possible to find the exact proportion. Only since 1863 have road traffic fatalities been listed as a separate cause of death in the reports of the Registrar General and even then a considerable proportion of accidental deaths (some of which were apparently caused by traffic accidents) were classified as 'not stated how'. After 1873 deaths on the street were further classified by the types of road vehicles involved.[8] Even then it remained unclear as to what the proportion of pedestrian deaths was to those of vehicle occupants.

Before 1846 the law of deodands had acted as an insurer of traffic safety for many centuries in England. The law stated 'if a horse or ox or other

animal, of his own motion, kill as well an infant as an adult, or if a cart run over him, they shall in either case be forfeited as deodands'.[9] This policy of forfeiture of any vehicle or animal involved in a fatal accident with a pedestrian assumed that such accidents resulted from partial or total negligence of the owner of the animal or vehicle. Forfeiture was seen as a punishment. For some time before the abolition of this law in 1846 its use had become redundant. The reasons were described by William Farr in his analysis of the causes of deaths in the report of the Registrar General in 1870.[10] Farr writes that the confiscated vehicles and animals would end up with lords and churches instead of with the family of the deceased. For this reason, jurors (who were generally vehicle owners themselves) would seldom find the vehicle owner guilty. Hence the law was abolished.

Farr severely criticised the laws that existed to prevent accidents after the abolition of the law of deodand, including the Police Act, which imposed a trivial penalty even for accidents involving a fatality. He maintained that:

> these laws do not meet the case, one of our oldest laws did meet it, and instead of being abrogated should have been adapted to the present state of things . . . there can be no doubt that if every van or carriage that killed a man in London were forfeited it would lead to an immediate diminishing of the 200 annual deaths in the streets.'[11]

The abolition of forfeiture was to some extent a response of the more mobile classes to diminish the penalties potentially associated with mobility. While this law was abolished prior to the age of widespread personal mobility, it foreshadows the relative leniency still shown to drunk drivers and the current leniency towards speeding. It may also represent an early attempt to place blame on pedestrians, regardless of the fault of the motorist (or carriage driver). An indirect result of the lenient penalties imposed for traffic violations was that drivers (of omnibuses) developed certain attitudes towards other road users. An eminent judge, Mr Mellor, explained this phenomenon in 1869:[12] 'Accidents happen because the drivers do not believe, or at any rate will not admit, that foot passengers had as much right to cross a street or thoroughfare as persons driving have to pass along it.'

This sort of attitude to pedestrians, whether expressed by nineteenth-century omnibus drivers or by current drivers, remains a barrier to implementing rational policies that both protect the pedestrian and provide them with a safe environment. The tension between providing free and unobstructed traffic while allowing pedestrians to engage in their own activities is a recurrent theme in the history of pedestrian policies, as will be seen in our discussion of specific engineering policies.

In another report of the Registrar General, Farr, again expressing concern about traffic accidents, wrote that the problem was so serious that a commission needed to be established to enquire into the rising number of them. He proposed that until this was done some immediate steps should be taken:[13]

- The creation of more pedestrian refuges to facilitate street crossing.
- The licensing of all drivers of heavy waggons and vans to ensure that they

possessed the necessary driving skills. All carriages to be issued with number plates.
- A police regulation to ensure the use of brakes to enable the driver to stop the carriage instantly at any speed.
- A system of variable fines on the drivers and owners of carriages involved in serious accidents in the streets according to the nature of the case.
- Educating the masses so that those who witnessed street accidents would be ready to arrest, take notes and give evidence against offenders in the public interest.
- Educating the masses in how to cross the street safely; how to be at once cool, attentive and alert. Disabled people needed to take extra precautions.
- The provision of more playgrounds in schools and in neighbourhoods to keep children out of danger.

Not much action was taken on these recommendations and, as the figures above indicate, the number of traffic deaths kept pace with the increase in population throughout the nineteenth century. Various engineering measures, however, were implemented, as will be shown. A key feature of these was the inherent tension between protecting pedestrians and enabling the flow of traffic.

Early regulation of road and footpath space

Any visitor to the ancient Roman town of Pompeii will immediately notice the footpaths and the large stones for crossing the streets, the latter in many ways resembling the zebra crossings of today. These were mainly because of poor drainage, not necessarily a progressive approach to pedestrian safety. In London the new roads constructed after the Great Fire of 1666 were provided with footpaths,[14] but hygiene and drainage were the primary motivation for their development, as opposed to the separation of pedestrians from horse-drawn traffic.

At the dawn of the nineteenth century a number of authorities were in charge of managing the streets of London: turnpike trusts, the commissioners of the sewers of different districts, various vestries (the governing councils) of the parishes, among others.[15] These authorities worked to a conglomeration of regulations regarding the paving, cleansing and lighting of the streets which had been enacted from time to time after the Great Fire. The first major consolidation of the regulations came in the form of the Metropolitan Paving Act of 1817 (commonly known as Michael Angelo Taylor's Act). Some of its salient features concerning pedestrians were:[16]

- Companies working on the public streets were required to provide the necessary protection and lighting to ensure public safety.
- During frost and snow the occupiers of premises must sweep the footway in front of them every morning before ten o'clock.
- Any person throwing filth or causing any obstruction of the footpath

could be taken into custody and brought before a magistrate by anyone witnessing the offence.
- Cellar entrances, area windows, coal plates, etc., must be properly secured to the satisfaction of the Commissioners of Sewers.

The powers under this Act were exercised by vestrymen, various public committees, the courts and all other persons having control over pavements. The Act, however, did not extend to turnpike roads, to some parishes or to private estates. Footpaths on roads managed by turnpike trusts were poorly maintained. One important issue was establishing responsibility for the upkeep and maintenance of footpaths. Turnpike trusts profited by charging tolls for road traffic and tended not to maintain footpaths, as they were unable to charge pedestrians (other than at bridges). The trusts suggested that each house or shop should maintain that part of the footpath in front of and adjacent to it. An editorial in the *Times* in 1837 stated that 'the footpath is an essential part of the road itself and you [the trusts] must not begin the exercise of your power by shifting upon other shoulders the responsibility inseparable from it'.[17] Turnpike trusts were eventually abolished as the development of railways resulted in reduced revenue and rising debts for the trusts. As the roads fell into disrepair the State increasingly assumed responsibility for the development and maintenance of roads.[18]

The poor maintenance of footpaths would result in the surface turning into mud in the rain and dust in the dry season. The situation in the neighbourhoods of the lowest strata of society, comprising working and artisan classes, was even worse. The same editorial in the *Times* continues: 'the most reprehensible negligence has been exhibited, not merely to the extreme fatigue and oppression of the middling and humbler orders of people but in many places to the actual peril of their lives'.[19] Clearly this situation continues in some respect to this day, as recent research has shown that those living in more deprived wards, especially children, are at greater risk of becoming a pedestrian casualty than those in less deprived areas,[20] although the risk is from very different causes, as paving surfaces have improved enormously.

Clauses in Michael Angelo Taylor's Act of 1817 were elaborated and extended and clauses concerning traffic control were included for the first time in the Police Act of 1839. The Commissioners of Police were empowered to regulate the route and the conduct of persons driving vehicles such as stage carriages or herding cattle through the streets. They were also made responsible for preventing obstruction of the streets. The power of arrest was granted to any constable or any person injured by a violation of the Act (as the law of deodands was being abolished). Among the offences related to pedestrian safety or the regulation of pedestrian activity were listed:[21]

- Driving or being in possession of or responsible for any horse, cattle or dog that attacked or frightened or caused mischief to any person, horse or other animal.
- Driving or riding any cart or carriage or horse without holding the reins, or leaving it unattended.

- Riding or driving furiously, or in such a manner so as to endanger any person or passengers.
- Flying a kite or playing any games in any street or thoroughfare causing annoyance to the inhabitants or passengers, or using any slides on ice or snow causing danger to the passengers.
- Disobeying the directions in force for regulating the route of horse, carts, carriages, and persons and for preventing obstructions during public processions and on other occasions.

There were in total seventeen clauses under Article 54 and eight clauses under Article 60 of this Act relating to nuisance in public places and streets. The clauses are informative in themselves, as they demonstrate an early attempt to protect pedestrians by regulating traffic behaviour but also to regulate pedestrian behaviour so as to maintain the flow of traffic. Balancing the control of traffic for both pedestrian safety and traffic flow remains a relevant issue as new pedestrian policies are implemented.

The Acts of 1817 and 1839 were revised repeatedly to take account of changing hazards and at times were imposed harshly, but even so, walking on a footpath remained dangerous for a long time to come. Even in the 1890s various obstructions such as trap doors, coal cellar plates, telegraph or telephone wires, crane chains hanging in front of warehouses[22] and even fruit peel thrown away carelessly were a source of danger to pedestrians.

Large parts of London in the nineteenth century consisted of slums and there was no organised management of the roads in such areas, as already hinted in the *Times* editorial. A select committee on the health of towns reported in 1840 on these conditions and bemoaned the lack of regulations to enforce sanitary drainage and proper building construction.[24]

In 1844 the Royal Commission on the Sanitary State of Large Towns called for a central Inspector of Housing and for one administrative body for drainage, paving, cleaning and water supply. On the recommendation of the commission the Sewers Act was passed in 1848 and the Metropolitan Commission of Sewers was established.[25] The commission was the forerunner of the Metropolitan Board of Works, created in 1855. This again suggests that one of the key drivers of improved roads and footpaths was the desire to improve sanitary conditions.

The establishment of the Metropolitan Board of Works was an important step in the centralisation of responsibility for the construction and maintenance of roads and pavements in London. One of the first decisions the board took was to define standards for the minimum width of streets. The minimum width of streets along which carriages could pass was defined as 40 ft and of those used only by pedestrians as 20 ft (6 m). However, the width was conditional on the height of the adjacent buildings being less than the width of the street, otherwise the width of the street should be at least equal to the height of the highest adjacent building.[26] Later the power of the board to regulate the width of streets was extended to include private estates by the Metropolitan Management Act of 1862.[27]

There was no compulsory provision of walkways on all streets and no rule for the division of the minimum street width into some proportion of footway and carriageway. During the proceedings of a committee of the House of Commons a question was put to George Vulliamy, the Superintendent of the Architect's Department of the Metropolitan Board of Works, as to how the board determined the required size of street and footpath. He replied, 'There is no positive rule, it is merely the opinion of the Board.'[28] This provides some of the first evidence of the lack of basic engineering research to determine crucial elements of urban form and pedestrian facilities.

The size of the footpaths that existed became increasingly insufficient by the 1870s, when the Metropolitan Board of Works started major road developments. For example, when a question was asked of Joseph William Bazalgette, the Chief Engineer of the board, as to the narrowness of the existing footpaths, he replied, 'Yes, so narrow as to be quite dangerous. When a heavy cart comes heavily loaded, with a part of the load overhanging, a person can hardly save himself by standing up against the wall.'[29] Giving evidence before another select committee in 1877, John Richardson, a resident of Great College Street, said:

> At Monte Video Place the pathway (footpath) is so narrow that the vehicles brush against you as you pass on the pathway. There is only about twenty inches, or just under two feet [60 cm], in one portion of the pathway, so that often vehicles have brushed against me and touched my shoulder as I have passed.[30]

It was in 1877 that the minimum width of footways was defined by the Local Government Board in its model bye-laws issued for the use of sanitary authorities. It declared that the carriageway of every new street should be a minimum 24 ft (7.3 m) in width, with footpaths on each side of the street of a width no less than one-sixth of the entire width of the street.[31] That meant a footpath at least 4 ft (1.2 m) wide on each side of the road. The bye-laws of 1877 were very forward-thinking for their time, as, for example, they recommended a drop in the kerb at street intersections for the convenience of pedestrians.[32] There is, however, no evidence of any analysis of the pedestrian footpath capacity needed under different circumstances.

The state of pedestrian facilities in the countryside was different from that in cities. Footpaths were considered a luxury, hence the state of affairs by the end of the nineteenth century:

> in towns, the authorities are compelled to attend to the footways, especially in those residential districts and pleasure resorts to the prosperity of which the convenience of pedestrians is essential. In many rural and semi-rural districts, the authorities consider that economy is effected by constructing narrow footpaths which frequently oblige pedestrians to use the carriageway.[33]

In fact the situation became more severe by the dawn of the twentieth century when the use of motor vehicles started to increase rapidly. A letter in the

Minutes of the Proceedings of the Institution of Civil Engineers in 1906 stated,[34] 'It is unfair to the motor car driver, as well as to the pedestrian, to allow any important road to be without a footpath . . . There were important roads within twenty-five miles of the metropolis which had no footpath.'

This highlights one of the driving forces for the development of footpaths (in both town and country). While an initial consideration was to improve the sanitary condition of cities, they were also deemed necessary for the unobstructed flow of vehicular traffic and not just for the convenience and safety of pedestrians. In a sense it was a recognition that increased motor traffic required the regulation of pedestrian traffic. It is this same issue that challenges current planners seeking to safely deregulate pedestrian flows to enliven city centres. The specific standards established on footpath widths, as well as road widths, appear to be somewhat *ad hoc*. It is unclear whether any structured research was undertaken to establish them; more likely they were based on the judgement of the various boards involved, as the quotations above indicate.

One technique currently under active consideration by planners and traffic engineers is the elimination of footpaths in some areas. This is exemplified by the Dutch concept of *woonerfs* (known as Home Zones in the UK),[35] whereby residential neighbourhoods are designed to blur the distinction between street space and pedestrian space. The design sends a message to drivers that they are in a shared space and must drive at a lower speed. Thus we see new policies which question the historical approach but also represent a shift from the presumption that street space is solely dedicated to vehicular movement.

Making streets safe for pedestrians to cross

With the large-scale redevelopment of existing streets and the construction of new ones under the Metropolitan Board of Works in the latter half of the nineteenth century roads were becoming wider to cater to the rise in horse and carriage traffic. The rise was due mainly to the rapid increase in London's population but also to the rise in commercial activity resulting from the development of railways.[36]

Wide streets with heavy traffic flows must have been difficult to cross, and combined with continuously rising traffic fatalities, started to raise concern in Parliament. Responding for the government to a question in the House of Lords regarding pedestrian safety in 1866, Earl Granville, Lord President of the Council, expressed his opinion on proposals for footbridges and subways as a means of accommodating pedestrians. He was sceptical whether people would use them and seemed inclined to the idea of controlling traffic with the technology developed in railway engineering. He said that a gentleman (J. P. Knight, traffic superintendent of the South Eastern Railway) he had met

> suggested that there should be brought into use in the streets something like the semaphore signal now used on the railways. The idea was that the speed

> might be regulated by means of this signal and there might be an indication to vehicles to stop in order to allow foot passengers to cross.[37]

The first traffic signal was installed in December 1868 on a road junction near the Houses of Parliament. It was established there not so much to protect the public as to safeguard members of Parliament, who had to negotiate the streams of traffic.[38] The system was described in *The Times:*[39]

> The design of [the signal] is the application of semaphore principle to the public streets at points where foot passengers have hitherto depended for their protection on the arms and gesticulations of a policeman—often a very inadequate defence against accident. . . . Of course suitable regulations will be issued for the guidance of the police by whom the signals will be worked, and also by the public.

As this was the first experiment of its kind on the roads, the public, especially carriage drivers, needed to be instructed in the use of the signals, hence the police notice (Figure 1) posted at various mews and cab yards on 10 December 1869, the day the signal started functioning.[40] However, the regulations to which *The Times* had referred in its editorial were never enacted. This resulted in low driver compliance, and the degree of traffic control at the junction hardly improved. The signal also suffered operational problems and a few days later it was reported in *The Times* that:

> Gas explosions have occurred more than once in connection with the street signal post at the intersection of the great thoroughfares in front of Palace Yard, Westminster. The last of these occurred when the constable opened the box near the base of the pillar to turn off the gas for the night . . .[41]

The time available to pedestrians to cross the road was thirty seconds in a cycle of five minutes,[42] which meant that pedestrians would have incurred greater delay than in the absence of the semaphore and probably would have resulted in low rates of pedestrian compliance.

Members of Parliament, who were supposed to benefit most from this signalling system, started voicing their opposition to the arrangement. During proceedings in the Commons, Colonel Dawson Damer challenged the government on the usefulness of the semaphore signal and asked when it was likely to be removed.[43] The reply of the Home Secretary was:[44]

> The signal was obeyed by the drivers of omnibuses and cabs who were familiar with it and it was beginning to be obeyed by the intelligent drivers of other vehicles. The general result was that although the signal has not been completely successful, yet in the opinion of the district superintendent it conduced considerably to the convenience and safety of the general public.

The Home Secretary was clearly defending a weak position. The semaphore did not improve pedestrian safety and it was obvious that not all traffic was obeying it. There were other accidents at the junction as well.[45]


POLICE NOTICE.

STREET CROSSING SIGNALS.

BRIDGE STREET, NEW PALACE YARD.

CAUTION.

The Semaphore Arms lowered, and by Night with a Green Light.

STOP.

The Semaphore Arms extended, and by Night with a Red Light.

By the Signal "CAUTION," all persons in charge of Vehicles and Horses are warned to pass over the Crossing with care, and due regard to the safety of Foot Passengers.

The Signal "STOP," will only be displayed when it is necessary that Vehicles and Horses shall be actually stopped on each side of the Crossing, to allow the passage of Persons on Foot; notice being thus given to all persons in charge of Vehicles and Horses to stop clear of the Crossing.

RICHARD MAYNE,

Figure 1 The police note issued on 10 December 1868 on the eve of the opening of the first traffic signal.
Source Archives of the Metropolitan Police Museum

The failure of this experiment meant that no signals were provided at any other busy junction. In February 1870 a subway[46] tunnel was opened under Bridge Street, near the semaphore-controlled street junction. Although at first its use was restricted to members and officers of Parliament, it was opened to the general public within a few weeks.[47] The police lost interest in the semaphore signal and it stood idle. Thus came to an end the first attempt at signalling a pedestrian crossing. No further experiments were carried out in Britain for more than half a century.[48] At the same time, an age of pedestrian subways seemed to be at hand, something that current UK transport policy aims to avoid. In fact the aim is to remove those that exist,[49] as most are perceived as dirty, dangerous and unpleasant. Many suffer from water leaks, are not adequately cleaned and may be occupied by vagrants. Most pedestrians prefer to avoid them when above-ground alternatives are available.

The difficulty of crossing the street became an even greater problem in the last decades of the century. The role of policemen in helping pedestrians across increased to such an extent that James Monro, Metropolitan Police Commissioner, observed *c.* 1889, 'few crossings in crowded thoroughfares can be got over by the nervous and the timid without an appeal for the courteous help of the policeman'.[50] The demand for some sort of intervention to assist pedestrians across busy roads persisted. A report of 1890 in *The Lancet* suggested the building of bridges and subways to help pedestrians but also expressed doubt that they would be used by many people, but expressed confidence that those more vulnerable would be able to cross safely.[51]

It is ironic that those most in need of a direct crossing, the old and infirm, should have been expected to use a subway or footbridge, either of which requires much greater effort to negotiate and increases the distance to cross the road. The authorities responsible for the streets were unsure of the best way to overcome the problem of crossings and, despite substantial debate, no decision was taken. In 1898 Edwards, who was clerk of the improvements committee of the London County Council, describes in some detail the reasons why no decision had been taken regarding grade-separated pedestrian crossings:[52]

- Footbridges were unsightly.
- Their construction would necessitate the expensive acquisition of property for the approaches to a bridge.
- Few pedestrians would use a bridge and most people would probably still take the risk of crossing the street directly.
- Special police supervision would be necessary in the case of pedestrian tunnels.

There is no evidence of further consideration being given to solutions that would actually stop vehicular traffic to let pedestrians cross safely. This suggests that uninterrupted traffic flow was considered too important to allow any repetition of the semaphore experiment, at a period well before the advent of the automobile. It again highlights the desire to keep traffic moving without consideration of how to minimise delay for pedestrians while providing them with safe options. The situation changed little in the early twentieth century. In 1938, in a statement before a select committee of the House of Lords, a representative of the Pedestrian Association testified, 'We do feel that if subways and bridges were put into general operation it would only confirm the view of the motorist that the public highway was a motor speed track and would lead to further accidents.'[53]

Much of the debate surrounding solutions focused on the cost of either tunnels or footbridges. The latter were viewed as also potentially unsightly. The argument over costs, however, ignored the fact that many street widenings that benefited traffic throughput were also costly. Pedestrian facilities, then as now, received far lower funding than vehicle facilities. (Walking was allocated £7.6 million in the Transport for London budget of 2004-05, against £337.5 million allocated to surface transport, out of a total Transport for London budget of £2,618 million.)[54]

Another argument put forward was that few pedestrians would use the facilities, preferring to take the risk of crossing at street level. However as the editor of *The Lancet* pointed out, this was only an assumption that needed to be tested, although clearly it was a reasonable assumption that, given the choice, pedestrians would prefer the shortest path. This debate is still topical today, but not in heavily urban areas. Rather, in some suburban districts (especially in the United States) there are active debates about how to enable safe crossing of broad arterial roads, typically between lower-income neighbourhoods and large shopping centres.

In 1927 some London boroughs experimented with road markings for pedestrian crossings. 'Please cross here' signs were erected but they were not sufficiently conspicuous and were replaced by upright signs with the letter C. These were not successful either, and they were replaced by the amber globes popularly called Belisha beacons in 1934. The 1930s also saw trials of different surface markings for pedestrian crossings. Eventually two lines of studs became the authorised surface marking. By the end of the 1940s there were over 30,000 crossings in the whole of Britain.[55] Driver observance was poor and pedestrians seldom used them. The beacons and studs were still not sufficiently conspicuous and were increasingly thought of as ineffective in affording a safe crossing for pedestrians.

In 1946 the Ministry of Transport asked the Road Research Laboratory to recommend a pedestrian crossing that was more visible to all road users. In June 1951 the Ministry issued a circular (No. 668) to local authorities telling them to reduce the number of uncontrolled pedestrian crossings by two-thirds. On the recommendation of the Laboratory new traffic regulations were introduced on 31 October 1951. The main provisions were: the road surface was to be striped (hence the name zebra crossing), other road users were to give precedence to pedestrians and vehicles were not allowed to wait at the kerbside within about 45 ft (13.7 m) of the crossing. (In 1958 parking within 75 ft (22.9 m) of a pedestrian crossing was prohibited.) The Belisha beacon was retained but in 1953 was replaced by a flashing beacon for better visibility at night. The introduction of zebra crossings was reported to have resulted in a noticeable reduction in pedestrian casualties: 8 per cent in the first ten months of 1952 in comparison with the first ten months of 1951 in urban areas of England and Wales.[56]

Pedestrian signals for crossing were first prescribed in 1933, with a red light illuminating the words 'Don't cross' and a green light for 'Cross now'.[57] The Road Research Laboratory carried out experiments with signals activated by a push-button on the beacon pole in 1950 and 1956.[58] The experiments resulted in the introduction of various push-button devices in the early 1960s. They led in 1968 to 'pelican' crossings (with a push-button-controlled signal) after a variety of less successful crossing types had been tried out, variously named Panda, Pin-man and X-way.[59]

Many zebra crossings were converted to pelican crossings after the introduction of the latter. One important reason was to make drivers give way to pedestrians without the need for a police presence to ensure compliance. In

the minutes of a meeting held between the officials of the royal parks, the Ministry of Transport, Scotland Yard and the Metropolitan Police on the control of traffic in and around the London parks in 1967 it was observed that:[60]

> This [Marlborough Gate] is a very difficult place to control manually as motorists find it hard to pick out the Policeman on point duty. He [the policeman on duty] also has to change position constantly and is unable to give much assistance to pedestrians. Traffic lights would remedy these difficulties. However, the basic reason for the traffic light proposal is to save manpower and to enable the Police to deploy a seriously undermanned force to better advantage.

The crossing time for pedestrians had always been difficult to determine, with differing groups of pedestrians having equally differing needs. Some pelican crossings became unpopular with drivers as pedestrians were often able to cross the carriageway before the green man was displayed, leaving vehicles waiting unnecessarily at a red light. This led to puffin ('pedestrian user-friendly intelligent') crossings in the early 1990s. Puffins incorporated pedestrian and vehicle detectors and a variable cycle time that could increase the pedestrian phase if pedestrians were still on the crossing or cancel it if they had already crossed.[61] Although puffin crossings were meant to replace pelican crossings as standard,[62] they are still not widespread, probably owing to the cost of replacing the pelican crossings and the limited budgets available for pedestrian projects in general.

Of interest from a policy perspective, the introduction of pedestrian crossings was guided by experimentation and research, led by the Road Research Laboratory (at the time a government research lab). This coincided with the recognition that highway engineering was a distinct discipline with a need for research to underpin the many policy decisions that affect the transport system. The advent of the zebra crossing also was a recognition that, for the safety of the pedestrian, traffic must sometimes come to a complete halt, regardless of the desire to increase throughput.

Controlling the pedestrian: refuges and guard rails

While the discussion so far has highlighted the development of techniques for making streets safer for pedestrians to cross, other developments also protected traffic from pedestrians crossing. This was often couched in terms of pedestrian safety but the primary objective was usually maintaining and channelling both pedestrian movement and vehicle flow. This was achieved by two engineering developments: the median and the pedestrian guard rail. (The latter refers to railings along sidewalks in British terminology.)

One of the unique elements of roads in Britain is the pervasiveness of small medians and mid-block crossing points as well as guard rails that control and channel pedestrian traffic. Pedestrian refuges were initially installed not to control pedestrian movement but to make crossing safer. In some

cases, particularly on busy roads, they developed into controlled 'cattle pen' crossings, facilitated by the advent of guard rails. Guard rails have served the purpose of channelling pedestrians in many ways, ostensibly protecting them from traffic but in reality allowing faster vehicle flow.

Pedestrian refuges have a long history. The first mention we have come across is in a letter to the editor of *The Civil Engineer and Architecture Journal* in 1841 which states, *inter alia*:[63]

> Far more essential is it to the public that they should be enabled to cross . . . exceedingly wide carriageways . . . with less inconvenience and danger then they now incur. What objection there can possibly be to directing a lamp post here and there with short posts around it so as to form a secure spot midway of the crossing where foot passengers might stand in security, it is difficult to conceive. It is true that something of this sort has been done already but not effectively; for the crossings are still left dangerously wide.

This suggests that refuge islands for pedestrians were present on some urban roads in the early nineteenth century. Pedestrian refuges in the nineteenth century consisted of an open space of about 8 ft^2 (0.74 m^2) within which pedestrians were protected on either side by semicircular spaces formed by an open balustrade about 90 cm high.[64]

This typical design is still in use with slight variations on British roads. Layout diagrams of street improvements show that the pedestrian refuges were mostly provided near junctions and in conjunction with islands created to channel the traffic.[65] The police were probably more interested in separating opposing streams of traffic for easier control, as a statement by Sir Richard Mayne, Commissioner of the Metropolitan Police, before a select committee in 1865 shows: 'what I am obliged to do in all crowded thoroughfares, by placing policemen who divide the traffic . . . I am sure that every policeman would agree that two streets are better than one of the same width as the two'.[66] The need to separate opposing traffic likely resulted in the installation of mid-block islands that served the additional purpose of pedestrian refuges. This need ultimately resulted in the introduction of one-way street systems in the 1920s.

In the early twentieth century, when motor traffic became widespread, the need to provide more pedestrian refuges became an important issue in accident control. A select committee appointed in 1912 to inquire into the rise in traffic accidents made specific recommendations related to how the pedestrian was considered in traffic planning. The committee noted:[67]

- There is no doubt that the pedestrian has a clear right to the use of the road.
- The pedestrian has the right to be treated not less formally than if they were another traffic unit.
- They [the committee] are impressed by the value of the refuge in keeping traffic in line, and in view of the general speeding up of vehicles, they do not think the slight delay of being unable to pass a slow vehicle with the

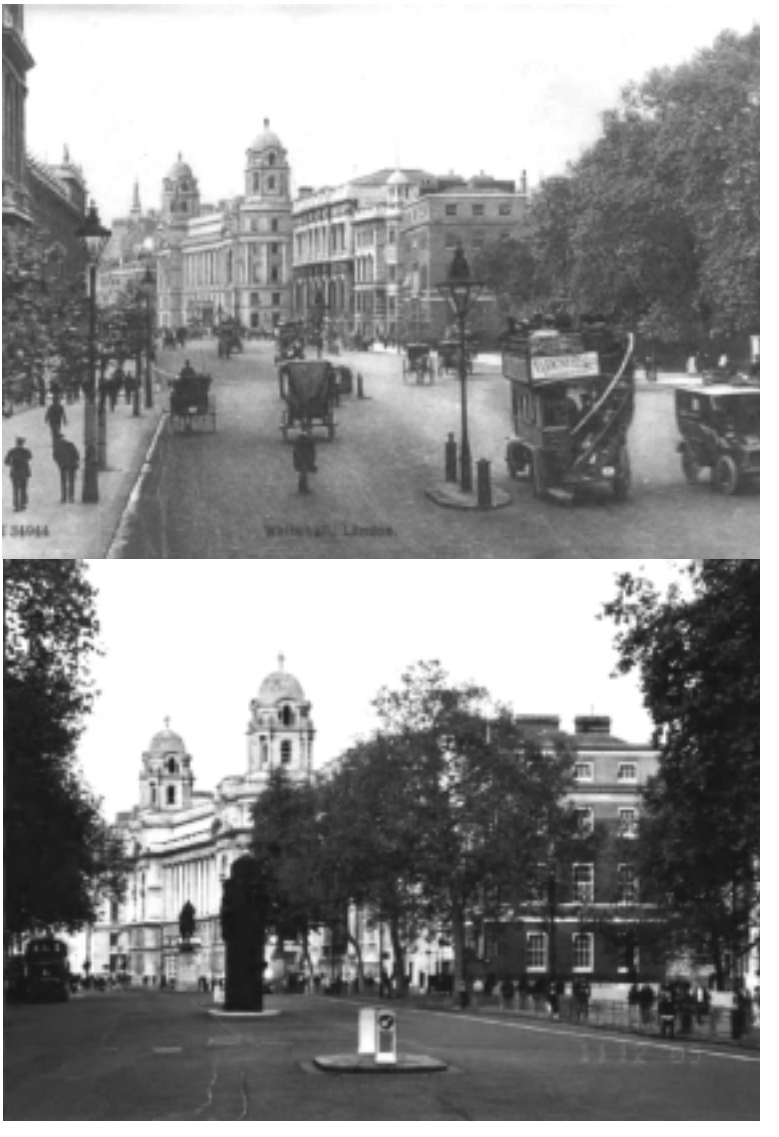

Figure 2 Pedestrian refuges in Whitehall, London. *Above* From a postcard *c.* 1915. *Lower* The pedestrian refuge still there in 2005

same facility as if the road were quite open should be allowed to weigh against the safety and convenience of pedestrians. A refuge may be looked upon as a permanent automatic traffic point performing the duty of a policeman. But when the traffic reaches a certain density the refuge is no longer efficient, and the Committee thinks that there is also necessity for the establishment of further traffic points positioned where constables are stationed in the street to direct the traffic.

Thus we see in the last statement again the tension between providing for pedestrians and the 'slight delay' that refuges pose to traffic. In government plans on the future of roads published in 1937 the role of the street refuge was recognised as an important pedestrian safety measure and traffic division technique.[68] It was also recognised as a cost-saving measure that reduced the need for policing traffic streams. In current usage this type of mid-block crossing is frequently mentioned as a traffic calming technique,[69] primarily it makes it easier for pedestrians to cross. But they likewise have some impact on slowing traffic, as recognised above, when traffic is heavy but also by preventing needless passing and by some reduction in speed caused by the perception of the road as narrow.

Pedestrian refuges underwent further development in the 1960s with the introduction of 'cattle pen'-type pedestrian refuges. First came the introduction of guard rails as an additional safety measure on pedestrian refuges, the other was the introduction of staggered crossings on wide roads. The purpose of these measures, proposed first in the United States in the 1940s, was 'not only to keep motor vehicles off the island but also to keep streetcar [tram] and bus riders within the island and discourage crossing between island and sidewalk at other than designated points'.[70] Similar measures were adopted in the UK and the government recommendations cited similar reasons for providing guard rails on central refuges. The guidance on pedestrian safety issued by the Department of the Environment in 1973 stated, 'staggered crossings provide extra waiting space on the island. Guard rails are then necessary on the central island to channel pedestrians from one part of the crossing to the other.'[71] The provision of guard rails on staggered crossings was made more explicit in 1981: 'Guard rails should always be provided on large islands where staggered pedestrian movements are allowed.'[72]

Pedestrian refuges are a timely consideration in many aspects of traffic calming policies, but have long been used in the UK. Staggered, in particular cattle-pen, crossings are less in vogue. These are often seen as adding significant delay to pedestrians.[73]

Guard rails were not just used on median refuges. The Ministry of Transport, in 1935, proposed putting guard rails around most of the roads surrounding Trafalgar Square in London. Spaces would be left at crossing points and at bus stops. This scheme was opposed by Westminster City Council and was not adopted.[74] The proposal was clearly based on a different perspective compared with the opening up of Trafalgar square in 2002 to increase pedestrian access, including the closing off of one street to vehicular traffic in the area on the north side.[75]

Some guardrail proposals in the 1930s included schemes to fence off significant lengths of road. One example was a three-mile stretch in Stepney and Poplar.[76] *The Times* reported that the Pedestrian Association questioned the objectives of this scheme. 'Is the object of the scheme as alleged in certain quarters to enable traffic to proceed with greater smoothness and speed, or to promote safety?' It was recognised by the Pedestrian Association that traffic speed was the prime reason for much of the discomfort and danger

experienced by pedestrians, and thus the Association would oppose any scheme that was aimed at increasing speeds. An assessment by the Ministry of Transport in its report on the administration of the Road Fund for 1936–37 stated that 'in East London . . . guard rails which have been erected on the three miles along Commercial Road and East India Dock Road have not resulted up to the present in any material reduction in the number of accidents'.[77] However, the Association remained sympathetic to any scheme whose object was the reduction of accidents and supported the placing of guard rails that channelled pedestrians at road crossing points.[78]

Political reluctance to fund traffic policemen as a means of controlling traffic was one factor that led to the erection of guard rails to protect pedestrians. Median refuges, as mentioned, were also seen as saving costs and labour. (We see the same efforts at reducing police labour costs in the current UK policy of large-scale deployment of automated speed cameras.)

The Road Research Laboratory found that pedestrians were much more at risk if they crossed the road near a designated pedestrian crossing than if they did so on the crossing itself. 'Near' was defined as within 150 ft (45.7 m) of the crossing.[79] The provision of guard rails was and remains the solution provided in government policy recommendations to overcome the problem of near-crossing pedestrian accidents. However, no conclusive research evidence could be found to support the safety arguments for the introduction of guard rails. Based on a before-and-after study, published in 1988, of the effect of erecting pedestrian guard rails on accidents in London, it was found that no statistically significant reduction took place and the reduction that was achieved was no greater than would be expected from background trends.[80] Another analysis from 1989, looking at pedestrian safety around pelican crossings, found that having them on one side of the road increased the number of people crossing diagonally.[81] Even when they were on both sides of the road, some people crossed diagonally, overall leading to increased exposure to traffic and potentially increased risk. Guard rails are also seen as a prominent source of irritation to pedestrians because their effects are local and immediately obvious to all.[82]

More recent theoretical research supports the finding that measures of this type are unlikely to have an effect on the overall risk. The risk compensation hypothesis, as initially formulated by Peltzman,[83] posits that people make trade-offs between risk taking and other benefits. Applied to street crossing situations, pedestrians will trade the perceived risk of crossing against the benefit of saving time. Risk compensation also suggests that motorists would compensate for the reduced likelihood of pedestrians crossing (due to guard rails) by increasing their own speed (i.e. taking more risks). These effects were clearly discussed in the early debates on the erection of guard rails.

The governmental guidance regarding the provision of railings is based on the following reasoning:[84]

- To restrict pedestrians' crossing to certain approaches at an intersection so as to prevent them crossing at dangerous places.

Figure 3 Guard rails at a road junction in Dagenham Heathway in London. *Above* From a postcard *c.* 1950. *Lower* The same place in 2005. Although the guard rails are of a different design they still run the entire length of the street on both sides

- To channel pedestrians through the central island of staggered pedestrian crossings.
- To provide useful guidance for blind and partially sighted pedestrians.

In addition the Highways Act[85] allows highway authorities to erect barriers at footpaths for the purpose of safeguarding persons using the highway. This provision is sometimes used to discourage roadside and pavement parking[86] and to mark the controlled area near designated pedestrian crossing points.

Pedestrian guard rails and staggered crossings have come under severe criticism and a select committee of the House of Commons recommended in 2001 that staggered crossings with 'cattle pen'-type railings and other railings restricting pedestrian movement should be scrapped and that Local Transport Notes 1/95 and 2/95 should be withdrawn and replaced.[87] These recommendations are in line with current policy to improve conditions for pedestrians and, given that guard rails offer no clear safety benefit, are likely to benefit pedestrians. At least one London borough has already started the experimental removal of guard rails on a busy high street.[88] It remains to be seen how removing guard rails may reduce traffic speeds because of the perception that pedestrians are more likely to cross at unmarked crossing points.

Conclusion

The development of policies affecting pedestrians has a long history. As this review suggests, the development of policy and regulations was guided by attempts to balance the desire to maintain traffic flow with the need for pedestrian safety. In many cases the former appears to have won out over the latter. This is best illustrated by the channelling of pedestrian movement with guard rails, and the placement of designated crossing points and subways such that disruption of motor traffic flow is minimised. The introduction of footpaths can be seen as a way to get pedestrians off the street, though it clearly provided safety benefits also. The balance shifted somewhat when it was accepted that in some cases vehicles should be required to stop, exemplified by the introduction of zebra crossings, which were highly effective at reducing pedestrian casualties. It is less clear whether other policies, such as the placement of guard rails and subways, have always been of benefit to pedestrians.

In initiating this review it was hoped that research evidence for many of the pedestrian policies in use today could be found. There does seem to be evidence for the effectiveness of zebra and other modern crossing designs, which were based upon experiment and research. With regard to other policies research evidence appears to be lacking, especially with regard to the use of guard rails. The introduction of pedestrian refuges, initially a cost-reducing way of making it easier for pedestrians to cross wide roads, is unique to British roads. Median refuges are now seen as a traffic calming technique in many other countries, for the benefit not only of channelling and slowing vehicle traffic but also of making it easier for pedestrians to cross.

Much of the historical record demonstrates the emotional debates over the competing goals of pedestrian mobility and safety versus maintaining traffic flow. This is an issue that reverberates to the present and can easily be seen in fierce debates over speed limit policies such as the use of speed cameras and the criticism of traffic calming measures, especially speed humps.

These issues are important to understand as the UK government and other governments in Europe and elsewhere try to encourage walking and attempt to reinvigorate urban street life. To achieve the goal of increasing pedestrian

activity it is not only necessary to make streets safer for pedestrians but also essential not to inhibit pedestrian activity with a singleminded focus on facilitating traffic flow. Striking the right balance, while maintaining safety, should clearly be a goal of transport policy. It is transport history that can (and, to our mind, should) support that goal considerably.

Notes

1 Department of the Environment, Transport and the Regions, *A New Deal for Transport: Better for Everyone*, http://www.dft.gov.uk/stellent/groups/dft_about/documents/page/dft_about_021588.hcsp (1998). All URLs provided in the notes were accessed and checked on 27 September 2005.
2 Department for Transport, *Walking and Cycling: an Action Plan*, http://www.dft.gov.uk/stellent/groups/dft_susttravel/documents/page/dft_susttravel_029200.hcsp (2004).
3 Transport for London, *Making London a Walkable City: the Walking Plan for London*, http://www.tfl.gov.uk/streets/downloads/pdf/walking-plan-2004.pdf (2004).
4 C. Hass-Klau, *The Pedestrian and City Traffic* (London, 1990).
5 Office for National Statistics, *200 years of the Census in London and Middlesex*, http://www.statistics.gov.uk/census2001/bicentenary/pdfs/middlesex.pdf (2001).
6 P. E. H. Hair, 'Deaths from violence in Britain: a tentative secular survey', *Population Studies* 25, 1 (1971), 5-24.
7 L. Greenwood, W. J. Martin and W. T. Russell, 'Deaths by violence, 1837–1937', *Journal of the Royal Statistical Society*, 104, 2 (1941), 146–71.
8 Departments of State and Official Bodies, *Annual Report of the Registrar General of Births, Deaths and Marriages in England (England and Wales)* (London, 1839–1920).
9 W. Farr, 'Persons killed in the streets of London', thirty-first *Annual Report of the Registrar General of Births, Deaths and Marriages in England (England and Wales)* (London, 1870), p. 210.
10 *Ibid*., p. 211.
11 *Ibid*., pp. 211–12.
12 *The Times* (London), editorial, 11 June 1869, p. 6c.
13 Farr, 'Persons killed in the streets of London', p. 212.
14 J. F. Arcades Geist, *The History of a Building Type* (Cambridge MA, 1983).
15 J. A. Fletcher, 'Statistical account of the municipal provisions for paving, lighting and cleaning the streets and public places of the metropolis, and for protecting them from nuisances', *Journal of the Statistical Society of London* 9, 3 (1846), 204–22.
16 *Ibid*., pp. 214–16.
17 *The Times* (London), editorial, 5 February 1827, p. 2c.
18 Highways Agency, *History of Roads: Where did all the Roads come from?* http://www.highways.gov.uk/knowledge/brief_history.htm (*c*. 2005).
19 *The Times*, 5 February 1827, p. 2c.
20 D. Graham, S. Glaister and R. Anderson, 'Child pedestrian casualties in England: the effect of area deprivation', *Accident Analysis and Prevention* (forthcoming).
21 J. Fletcher, 'Statistical account of the police of the metropolis', *Journal of the Statistical Society of London* 13, 3 (1850), 221–67.
22 'Dangers of the streets', *The Lancet*, 140 (1892), 786.
23 'A street danger', *The Lancet*, 135 (1890), 40.
24 A. S. Wohl, *The Eternal Slum: Housing and Social Policy in Victorian London* (New Brunswick NJ, 2002), p. 14.
25 *Ibid*., pp. 14–17.
26 'Public safety and convenience', *Civil Engineer and Architecture Journal*, 19 (1856), 188.
27 P. J. Edwards, *History of London Street Improvements, 1855–1897* (London, 1898), p. 21.
28 Printed Parliamentary Papers, House of Commons, 8 (1865), 647.
29 National Archives London, Minutes of Proceedings of House of Commons Select Committee on Metropolitan Streets Improvement Bill, MEPO 2/154, 3 May 1872.
30 *Ibid.*, MEPO 2/157, 12 July 1877.
31 H. P. Boulnois, 'Footpaths', *Minutes of Proceedings of the Institution of Civil Engineers* 85 (1885–86), 348.
32 D. S. Warren, *Canonical Road* (London, 1992), p. 10.

33 C. H. Cooper, 'Footways', *Minutes of Proceedings of the Institution of Civil Engineers* 122 (1894–95), 208.
34 C. Lindsay, 'Correspondence on country roads', *Minutes of Proceedings of the Institution of Civil Engineers* 165 (1905–06), 67.
35 Home Zones website, http://www.homezones.org/index.html.
36 Farr, 'Persons killed in the streets of London', p. 211.
37 'House of Lords', *The Times* (London), 23 March 1866, p. 5e.
38 L. E. Wells, 'The story of stop and go', *The BP Shield* (London), May 1966, p. 8.
39 'Street traffic signalling', *The Times* (London), 9 December 1868, pp. 5 f.
40 National Archives, London, 'Police Orders', MEPO 7/30 (1868).
41 'Explosion at Westminster Street semaphore', *The Times* (London), 6 January 1869, p. 10d.
42 J. Winter, *London's Teeming Streets, 1814–1914* (London, 1993), p. 35.
43 'The semaphore near Palace Yard', *The Times* (London), 6 March 1869, p. 6b.
44 'The semaphore near Palace Yard', *The Times* (London), 12 March 1869, p. 6a.
45 Wells, 'The story of stop and go', p. 9.
46 Subways in British terminology refer to pedestrian tunnels beneath the street.
47 National Archives, London, 'Bridge Street subway', MEPO 3/7 (1870).
48 Department of the Environment, Transport and the Regions, *The History of British Traffic Signs*, 2nd edn (London, 1999), p. 45.
49 Transport for London, *Making London a Walkable City*, p. 32.
50 H. Shpayer-Makov, *The Making of a Policeman: a Social History of a Labour Force, Metropolitan London, 1829–1914* (Aldershot, 2002), p. 123.
51 'The dangers of London street crossings', *The Lancet* 136 (1890), 685.
52 Edwards, *History of London Street Improvements*, p. 167.
53 House of Lords Sessional Papers, 'Minutes of Evidence taken before the Select Committee on Prevention of Accidents' (London, 1938) IV, p. 276.
54 Transport for London, *Budget Expenditure 2004/2005*, http://www.tfl.gov.uk/tfl/about/report-library/budget/index.shtml (2005).
55 DETR, *The History of British Traffic Signs*, p. 61.
56 Road Research Laboratory, *Research on Road Safety* (London, 1963), p. 63.
57 DETR, *The History of British Traffic Signs*, p. 63.
58 RRL, *Research on Road Safety*, p. 86.
59 'Pelicans join zebras', *The Times* (London), 26 July 1968, p. 2c; DETR, *The History of British Traffic Signs*, p. 65.
60 National Archives, London, 'Traffic Lights at Marlborough Gate', WORKS 16/2151, 22 September 1967.
61 DETR, *The History of British Traffic Signs*, p. 65.
62 Department of Transport, *The Assessment of Pedestrian Crossings*, Local Transport Note 2/95 (1995), p. 5.
63 Anonymous letter to the editor, 'Width of streets and alleys in the metropolis', *Civil Engineer and Architecture Journal* 4 (1841), 120.
64 'The Houses of Parliament', *The Times* (London), 28 January 1870, p. 6c.
65 See various street layouts in Edwards's *History of London Street Improvements*, e.g. plan 7a, 35 and plate 7b.
66 Printed Parliamentary Papers, House of Commons 8 (1865), p. 647.
67 'The London traffic problem: report of the Select Committee on Motor Traffic', *The Times* (London), 15 August 1913, p. 7g; 'The control of motor traffic', *The Lancet* 182 (1913), p. 176.
68 'Roads of the future', *The Times* (London), 10 February 1937, p. 9a.
69 US Federal Highway Administration, *Traffic Calming*, http://www.fhwa.dot.gov/environment/tcalm/part2.htm.
70 American Association of State Highway Officials, *Manual on Uniform Traffic Control Devices for Streets and Highways* (Washington DC, 1948), p. 180.
71 Department of the Environment, *Pedestrian Safety* (London, 1973), p. 40.
72 Highways Agency, *Pedestrian Facilities at Traffic Signal Installations*, Technical Advice Notes TA 15/81 (1981), p. 6/2.
73 Muhammad M. Ishaque and Robert B. Noland, 'Trade-offs between Vehicular and Pedestrian Traffic using Micro-simulation Methods', presented at the sixteenth International Symposium on Transportation and Traffic Theory, College Park MD, 2005.
74 'Pedestrian guard rails', *The Times* (London), 14 November 1935, pp. 11 f.

75 Transport for London, *Making London a Walkable City*, p. 6.
76 'Road safety measures', *The Times* (London), 26 November 1935, p. 11c.
77 House of Lords Sessional Papers, p. 276.
78 *Ibid*.
79 RRL, *Research on Road Safety*, p. 79; G. D. Jacobs and D. G. Wilson, *A Study of Pedestrian Risk in Crossing Busy Roads in Four Towns* (Harpenden, 1967), pp. 18, 97.
80 D. Stewart, 'Pedestrian guard rails and accidents', *Traffic Engineering and Control* 29, 9 (1988), 451.
81 B. Preston, 'Behaviour and safety of pedestrians at pelican crossings in Greater Manchester', *Traffic Engineering and Control* 30, 12 (1989), 597.
82 C. C. Wright, 'Geometric delay to pedestrians', *Transportation Research* A, *General* 19 (1985), 225.
83 S. Peltzman, 'The effects of automobile safety regulation', *Journal of Political Economy* 83 (1975), 677–725..
84 Highways Agency, *Pedestrian Facilities at Traffic Signal Installations*, p. 6/2; Department of Transport, *The Design of Pedestrian Crossings*, Local Transport Note 2/95 (1995), p.3.
85 HM Government, Highways Act 1980, Section 66, http://www.glass-uk.org/publibrary/acts/ha80/s066.html.
86 Essex County Council, *Draft Best Practice Guide to Walking*, http://194.129.26.30/vip8/ecc/ECCWebsite/content/binaries/documents/walking.pdf (2001), p. 19.
87 House of Commons, *Walking in Towns and Cities*, eleventh report of the Environment, Transport and Regional Affairs Committee, http://www.parliament.the-stationery-office.co.uk/pa/cm200001/cmselect/cmenvtra/167/16702.htm (2001), para. 70.
88 Royal Borough of Kensington and Chelsea, *Kensington High Street Improvements: Crossings and Guard Railings*, http://www.rbkc.gov.uk/EnvironmentalServices/general/hsk_crossings.asp (2004).

Acknowledgements

We acknowledge support from the Rees Jeffreys Road Foundation for which we are grateful. Thanks are also due to Mrs Maggie Bird and Mr Paul Dew of the Metropolitan Police service for their invaluable assistance and to the anonymous referees and both the current and former editors of this journal for their very helpful comments. Any errors or omissions are the sole responsibility of the authors.

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