Occasional Papers for the
World Heritage Convention

RAILWAYS AS WORLD HERITAGE SITES

Anthony Coulls

with contributions by Colin Divall and Robert Lee

International Council on Monuments and Sites (ICOMOS)

1999

Notes

- Anthony Coulls was employed at the Institute of Railway Studies, National Railway Museum, York YO26 4XJ, UK, to prepare this study.

- ICOMOS is deeply grateful to the Government of Austria for the generous grant that made this study possible.

Published by: ICOMOS (International Council on Monuments and Sites)
49-51 Rue de la Fédération
F-75015 Paris
France

Telephone + 33 1 45 67 67 70

Fax + 33 1 45 66 06 22

e-mail icomos@cicrp.jussieu.fr

Contents

Railways – an historical introduction

The possibility of designating industrial places as World Heritage Sites has always been implicit in the World Heritage Convention but it is only recently that systematic attention has been given to the task of identifying worthy locations. Any such site must, of course, meet the fundamental criteria specified in the Convention. Yet the particular and peculiar characteristics of industrial sites mean that these criteria need to be developed and refined before they can be of practical use to the World Heritage Committee in the exercise of its powers. This study develops such criteria and illustrates their applicability with regard to just one kind of industrial site, the railway.

What is a railway? According to Dr Michael J T Lewis, the eminent scholar of early railways, it is 'a prepared track which so guides the wheels of the vehicles running on it that they cannot leave the track' (Lewis 1974). This definition has the merit of technical simplicity and thus embraces many kinds of transport systems apart from those conventionally known as railways; wheels need not be a feature. But for our purposes the real advantage of the definition is that in referring to a *prepared* track it draws attention to the fact that railways are built with a specific purpose in mind. That purpose may vary from system to system, but the principle remains the same – a railway is a linear transport feature, the rest is detail.

By the standards of most modern industries railways have unusually deep historical roots. Railways that fit Lewis's definition existed as far back as the 6th century BC; the Greek *Diolkos* was a railway with a track made from stone, 6km in length across the Peloponnese, used for transporting ships until the 9th century AD – an extraordinarily long period. Works such as Agricola's *De Re Metallica* date the extensive use of railways with wooden rails and vehicles to around the 15th century. Although of great technical interest, individual systems had short lives and were of no significance as anything other than adjuncts to the mining industries. By the 18th century, however, wooden railways began to be used for larger loads and more diverse purposes. Railways developed from mine tracks where people pushed four-wheel trucks of coal, stone, or ore into longer and more complex lines with large wagons and horse haulage. Late in the same century, the change was made in many places to iron rails and wheels. Wooden and stone railways did not immediately disappear, however; indeed, in Britain, the Hay Tor Tramroad was built with stone 'rails' at the late date of 1820.

Leaving aside these very early lines, we can date the mechanically worked railway to the first two decades of 19th century England and Wales. These short isolated routes, just a few miles (or kilometres) long, were still usually conceived, financed, built, and operated with the needs of a small number of extractive and primary industries in mind. They shared little beyond a very basic technical similarity with today's railways. However, they rapidly developed in length, volume of traffic, technical sophistication, and financial and managerial requirements. Most historians agree that with the opening in 1830 of the Liverpool & Manchester Railway in the north-west of England, the prototype of the 'modern railway' had arrived: a combination of specialized track, the accommodation of public traffic, the conveyance of passengers as well as freight, mechanical traction, and some measure of public control (Robbins 1998). Conceived principally as a competitor to the carriage of goods by canal, the line tapped a hitherto unsuspected demand for passenger travel. Profits were very considerable and in the generally vibrant economic conditions of the world's first industrial nation, the railway swept all before it as a means of inland transport over distances of any length. By 1850, Britain enjoyed the benefits of a national network linking most of the centres of population and industry. British engineers rapidly gained employment across Europe, building many of the continent's earliest and most important railways (Gourvish

1996; Channon 1996; Ambler 1999). By 1907 there were about 200,000 miles (320,000km) of railways in Europe (Robbins 1998).

The British monopoly on railways was to be short-lived. Even as the Liverpool & Manchester was being built, entrepreneurs in the United States were planning the Baltimore & Ohio Railroad, an enterprise on quite a different scale (Stover 1997; Vance 1995; Dilts 1993). Nearly 400 miles (640km) long, the line was promoted by mercantile interests as a way of maintaining the Maryland port's trade with the mid west, a particular instance of a more general motivation that was to drive much of the early railroad development on the eastern seaboard of the USA. Mercantile rivalries produced a 'system' that was far from perfect; breaks of gauge, deliberately engineered to prevent through-running from the lines of one port on to those of another, survived until at least 1900. By 1907, however, there were about 237,000 miles (379,000km) of route in the USA, making it by far the largest single network of railways in the world (Robbins 1998).

The place of the railway in the history of industrialization is assured. Economic historians might disagree over the precise contribution that railways made to economic growth in the industrializing nations of the 19th century, but all recognize the steam railways' critical role as the dominant form of inland transport for any but the shortest of journeys (eg Szostak 1991; Ville 1990). Railways rapidly developed as the largest and most complex examples of socio-technical systems that the world had known: the political, financial, business, and managerial structures that developed to meet their novel requirements later influenced the growth of large-scale corporate business, particularly – but by no means exclusively – in the USA (Dobbin 1994; Chandler 1990) The railways' advantages of speed, capacity, and economy made them more than mere instruments of industrial and business development, however. Culturally their impact was huge. In particular the sensibilities of societies that had never known travel at speeds above that of a galloping horse were irrevocably changed by the coming of steam locomotion. In Europe and the USA, the railway came rapidly to stand at the very focus of that mixed feeling of awe, wonderment and apprehension that historians have called the 'technological sublime' (Nye 1994; Wosk 1992; Danley & Marx 1990; Schivelbusch 1986).

The railways' influence was not only felt in those countries that industrialized first. By the 1850s the cutting edge had spread well beyond Europe and even the USA. Railway construction began in the colonies of the European powers and the South American republics, with the first lines opening in Brazil and Chile (1852), Argentina (1857), India (1853), Java (1864), and Australia (1854). The Canadian Grand Trunk Railway, started in 1852 and intended to link the Atlantic seaboard with the Great Lakes, was at the time the longest railway planned in the world. Its promoters combined politics and economics in their reckoning: the line was built with the combined intention of binding the eastern Canadian provinces together economically and of reducing the influence of the USA (Lee 1998; Legget 1973). The construction of the Trans-Siberian Railway at the end of the 19th century provided a similar national link for Russia. By 1907, there were 168,000 miles (268,800km) of railway outside Europe and the USA, built at a cost of nearly GB£1.5 billion (Robbins 1998).

All of these railways were part of a wider, and much larger and more complex phenomenon, namely the spread, prior to World War I, of European imperialism around much of the world. Railways were not the only technology to further the process of imperialism: the steamship, the telegraph, and new medicines such as quinine were also important. However, railway building and imperialism were, quite simply, interdependent. Railways often transformed the way in which an imperial power exploited the resources of a colony – for instance, by opening up a hinterland – and even, according to some historians, permitted the development of a new kind of 'informal' or 'railway' imperialism in which the struggle for explicit political control was relinquished in favour of more subtle kinds of influence (Davis and Wilburn 1991). Even those countries which escaped direct rule from Europe – Latin America, the Ottoman Empire, China, Japan, and Thailand – fell in varying degrees under the economic and political domination of the occidental powers. The projection of the trans-Siberian railway to the Pacific, for instance, combined with that of the Berlin-Constantinople line to Baghdad, led the European powers to partition the Chinese and Ottoman empires in terms of exclusive railways rights. Imperial strategy in Asia was directly connected with the military, political, and economic balance of power in Europe (Lee 1998).

Imperial penetration had always begun from ports, but until the coming of the railway the influence of the European powers rarely extended far inland. The railway permitted comparatively easy access to the hinterland; imperialists used railways to integrate and annex territory, and to exploit the resources of the regions surrounding the ports they controlled. The obstacles that had to be overcome were varied and often considerable. They might be political – the resistance of traditional élites or the populace, or that of another rival European power, such as the chimerical French threat to British control over the Suez route to the East that led to the construction of the Uganda Railway. Once these challenges had been met, geography often forced civil engineers to scale ever greater heights, both metaphorically and – sometimes – literally. Their engineering feats became all the more impressive as physical and political boundaries were pushed farther back. Tunnels, bridges, viaducts, cuttings, and embankments, all were developed to take the railway into places which previously had been inaccessible to any but the most determined. Whatever the difficulties, or for that matter the degree of success, the aim remained more or less constant: from Manchuria to Argentinian pampas, from the Great Lakes to the African veldt, from Yunnan to the Australian bush, the creation of a hinterland was the chief motivation (Lee 1998).

Colonial railways were thus an essential part of the spread around the world of the economic processes, ideas, and institutions of the European powers: the production of new foodstuffs and raw materials to feed the industries and peoples of the West, new populations to produce them, new patterns of land ownership, and new legal codes to make the conquered lands safe for investment and exploitation. In European-settled parts of the world, most communities desired the coming of railways as the key to prosperity, while every government wanted them for national development. However, railways were expensive, and the direct financial returns in most parts of the world uncertain, even in the longer term. Typically, railways outside Europe and the USA were joint ventures between European private investors and the governments of the host countries which guaranteed a fixed rate of interest on the borrowed capital. Thus many states fell into financial dependence on the European banks and stock exchanges, mortgaging lands and taxes to pay for railways that were costly both to build and to operate. Nor did contemporaries often draw attention to the social and environmental downside of the technological triumph of the world-wide spread of railways: the exploitation of humans and resources to an unprecedented degree. More commonplace was an almost missionary fervour, emphasizing the role of the railway and (European) engineers as harbingers of 'civilization' (Lee 1998). Whatever the social and economic benefits that later accrued – and we should not forget those that were difficult, if not impossible, to reckon within the conventional accountancy of the day, such as the provision of the infrastructure of public utilities – the initial cost in human life and misery was all too often appalling high (eg Kerr 1995).

The 'great' or 'golden' age of railways – in the sense that they virtually monopolized inland transport – was over in most countries by World War I. Certainly by the middle of the 20th century most of the world's railway network was in place and on the whole the story since then has been one of slow decline, at least in terms of route mileage. Development continues on existing routes, however, and new lines are still built. Perhaps the most notable of these in the last forty years is the Japanese Tokaido line, opened in 1964 for the high-speed *Shinkansen*. This led the way for other countries to develop fast main lines solely or mainly for the use of express passenger traffic; the French *Lignes à Grande Vitesse* are excellent examples of this. Not all new construction is of this kind, however: in some parts of the world (China is a good example) it is still considered worthwhile to build conventional railways of a very considerable length in the pursuit of economic development and social change. Virtually all these new systems run on standard gauge (4ft8½in/1435mm) track, and although the materials, traction, and principles of management employed almost invariably differ from those of the pioneering railways, the same basic technical principles look set to take the mechanically worked railway into its third century.

Railways as World Heritage sites – some theoretical and practical considerations

What makes a railway potentially a World Heritage site? Since all heritage is intimately bound up with the creation of collective identities, be these at the local, the regional, the national, or the global level, it is clearly impossible to expect a single, straightforward answer (Lowenthal 1997). In many countries the railways' past enjoys a high public profile, reflecting the part that they have come to play in the formation of communal identities over the last 200 years. Indeed, in some parts of the world – Britain is arguably the most extreme example, although the USA is probably not far behind – the level of lay interest in railways is such that the volume of research emanating from this quarter far outweighs that from academic sources. This brings both advantages and disadvantages. Some lay work achieves academic standards of scholarship, and more generally there is an enthusiastic commitment to search out the kind of detail which can prove useful in developing a more rounded appreciation of particular railways or sites. Less positively, lay enthusiasms are sometimes so passionate that it can be very difficult to reconcile conflicting points of view over the merits of locations that might be thought worthy of designation as World Heritage sites.

Nevertheless, the fundamental criteria set out in the World Heritage Convention must provide the basic tools for any study that hopes to achieve consensus. The intention here is to demonstrate that these basic criteria can be developed in ways that will enable the World Heritage Committee to come to a reasoned judgement on those railways and related sites nominated for designation by the national parties to the Convention. We also offer some illustrative examples of the relevance and applicability of our proposed criteria.

Our fundamental assumption – and it is one that is shared by virtually all those who have commented on our proposals – is also one common to all modern historiography of large-scale technologies: that railways are above all *socio-technical systems* in which it is ultimately impossible to separate out the 'social' and 'technical' aspects. While it may prove desirable, or indeed necessary, to do so for analytical purposes, a proper appreciation of the historical significance of any particular railway will only be gained by seeing it in the round; as both the product of, and an influence on, wider social circumstances.

This perspective stands in sharp contrast to that of many railway enthusiasts or 'railfans,' who too often sees locomotion as being all important – much being made of steam operation in particular – while the specialist infrastructure, the social organization, and the wider historical context of railways' development are given less weight than they deserve. There is also the practical difficulty that in several countries locomotives and rolling stock have been designated as national monuments. The designation of such items as World Heritage sites is probably inappropriate, not least because of the likelihood of an exceedingly large number of nominations. Permitting such classes of objects for designation would also raise many further issues, not least those of ownership and access, which it is impossible to address in this study. The criteria developed here are intended partly to correct such 'lococentrism,' facilitating the undertaking of more detailed studies that will comprehend individual railways as fully contextualized sites.

The history of railways has long been the subject of comparatively disinterested academic enquiry, resulting in a body of knowledge which comprehends the rich diversity of railway development around the world. It is by reference to this stock of work – incomplete or inadequate though it might be with regard to certain periods, subjects, or geographical areas –

that there is the best opportunity of building consensus around a set of criteria for World Heritage listing. Such criteria must enable the universal elements of the world-wide evolution of railways to be identified. Once agreed, these criteria may be used by the World Heritage Committee to establish the ground rules for the preparation of the detailed studies of individual sites that the nominating parties must submit. We hope, too, that the criteria will assist the Committee in coming to its own views on the merits of particular locations.

This study is concerned with the development of criteria for World Heritage status that can be applied to surviving routes (whether or not they are still operating as railways) and other features on the ground that can either be followed or visited, at least in part. Some overlap with other industrial sites and transport systems will be inevitable. The routes of railways, canals and roads were often physically linked. Railway companies frequently came to own canals, while the transfer of technologies between the different modes occurred regularly, especially during the construction phase: railway lines were built by teams of men known in Britain and elsewhere as 'navvies' – derived from the name 'navigator' that groups of labourers acquired while building inland waterways. Railway workshops benefited from advances in other industries, and in turn were able to influence other transport technologies through the development of the machines and rolling stock they produced. Similarly, railway technologies were transferred across the world. The first steam locomotive in the USA was built in Stourbridge in Britain in 1829. The Americans then adapted the technology to their own circumstances. This process was repeated between various countries over the next century or so, and has now come full circle, with Japan leading the development of high-speed trains (the *Shinkansen*) and Europeans following suit in the last thirty years.

The remains of early railways – that is to say, those which date from before about 1830 – will require particular consideration by the Committee. They deserve recognition as precursors of the later, more influential systems, but there is a real danger that important sites will be missed as our understanding of the international significance of these lines and their remnants is not, with one or two exceptions, as deep as it might be.[1] They should also be taken as special cases because their remains are often quite different from those of railways of more recent construction, tending to have more in common with sites of considerable antiquity. This is true of some of the very early mine railways and associated equipment, some of which is now preserved in museums; unfortunately, having been taken out of place and context this cannot now qualify for World Heritage status. But even if they do not score particularly highly according to the general criteria proposed here, some early railway sites are surely worthy of consideration on other grounds. For example, civil engineering from the classical period helped the builders of the Causey Arch on the Tanfield Waggonway in County Durham (England). No span as large as this had ever been constructed in 1727, so the builders drew on examples from the ancient world to see how it might be done. One could argue that the resulting structure, demonstrating as it did the practicality of large-scale masonry arches, was as significant for the subsequent course of the history of inland transport in general (canals and roads as well as railways) as was, say, Coalbrookdale and the Ironbridge Gorge for industrial history.

There are other issues, particularly those of authenticity and conservation, which clearly must be addressed by the World Heritage Committee but which we do not attempt to deal with in any depth here, chiefly because they do not raise questions that are fundamentally different

[1] These comments are based on the findings of the International Early Railways Conference held at the University of Durham, UK, September 1998.

from those involved in any number of other areas of heritage (Burman 1997). No operating railway can be wholly authentic from a strictly historical point of view; items wear out and are replaced, methods of organization and operating are adapted to changing circumstances. However, arguably continuity through change is part of what makes a railway landscape or location: railways are by their very nature evolving socio-technical systems. Indeed, the drive to modernize and become more efficient appears to be an imperative of modern railway management world-wide. The key challenge is to identify just what it is about a railway location that makes it worthy of World Heritage status. A focus on the purely physical aspects of structures or technologies arguably makes it more likely that a site will be deemed 'inauthentic' as modernization proceeds than if equal (or greater) weight is given to the historical continuity of a railway's socio-economic functions. This is not an argument for any weakening of the imperative of good management of those historic features which do remain. Co-operation between railway operators and conservation bodies can make sensitive development possible and ensure that the integrity of sites is maintained, as the example of the British network over the last two decades shows (Burman & Stratton 1997). It is, we suggest, preferable to have a viable and useful railway rather than one which faces an uncertain future.

The proposed criteria for internationally significant railways

The following criteria essay a means of identifying the universal aspects of the very diverse development of railways around the globe. They are derived from four principal sources:

1. the consensus emerging among parties interested in the wider issues of the designation of industrial sites and locations, particularly as recorded in the earlier studies on canals and bridges undertaken for the World Heritage Committee;
2. the views of those attending an international conference held in March 1998 at the National Railway Museum, York (UK);
3. the opinions of those correspondents who were unable to attend in person (lists of those within the second and third categories are given in the Appendix);
4. our own, imperfect understanding of the current state of knowledge of railway history internationally.

The proposals are not listed in any particular order of merit: indeed, it will be apparent from our earlier comments that no such ranking would be appropriate

CRITERION 1: A creative work indicative of genius

Something like this criterion has long been applied in the informal ranking of railways around the world. It fits well with the long-standing approach to history that seeks to identify 'Great Men'; railways are technical systems designed and built by engineers, therefore it should be possible to identify the world's great railways with the great engineers.

Understood in this way the criterion is most easily applied to railways whose chief engineers were highly innovative in their approach and treatment of difficulties; the Great Western Railway under the Englishman Isambard Kingdom Brunel, for example, or the spectacular Semmering Railway through the high Alps, built by the Austrian Karl Ritter von Ghega.

Modern scholarship suggests that the criterion should be interpreted more widely, however. Biographers' and historians' perceptions of the great engineers have shifted quite markedly in recent years: the kind of heroic perspective favoured, for example, by the 19th century English writer Samuel Smiles is no longer regarded as adequate. While not wishing to deny the great skills and abilities of individual engineers such as Brunel or the Stephensons, scholars tend to stress the co-operative nature of railway building (Jarvis 1994). Perhaps, then, sites should be taken as memorials not only to the engineers ultimately responsible for their design and construction but also all those others – many of whom will never be known – with a hand in bringing them to completion. Moreover, with a highly complex socio-technical system like a railway, many skills and abilities in addition to those of the engineer were required. Should we not, for instance, look for genius in the financing and managerial organization of railways? In this way sites could come to symbolize the wider societies and cultures that gave them birth.

CRITERION 2: The influence of, and on, innovative technology

The primary purpose of a railway is to provide a transport service for goods or passengers. But technology serves a critical role in all of this, and thus it is proper that the role of innovative technologies should be acknowledged in any set of criteria for World Heritage status.

The technology of the railway includes its course – the trackbed, embankments and cuttings, engineering and architectural structures, and the constructional methods employed. The transfer of technologies from and to other industries and transport modes should also be borne in mind, particularly the imaginative application of new materials and constructional techniques, such as those associated with the move from iron to steel from the 1860s, and experimentation with structural concrete towards the end of the 19th century. Likewise, while early railways were built largely by hand, mechanization was rapidly introduced, particularly in those countries such as the USA where labour was in short supply. The mechanical technologies of locomotives and rolling stock (passenger coaches and goods vehicles) are just as relevant, although less easily acknowledged in any study that focuses on fixed sites and locations. Nevertheless, places relating to the construction and maintenance of vehicles may be considered. Fixed motive power in the form of winding engines or water balances may also be relevant: for example, that important English railway, the Stockton & Darlington, originally used stationary haulage engines where the gradient was thought too steep for locomotives.

The criterion of innovative technology may apply to different types and periods of railway development. International transfers of ideas took place very early in the history of the mechanically worked railway. Early Blenkinsop and Murray locomotives from Britain were exported and used in Germany in the 1810s. Similarly, the Festiniog Railway in Wales pioneered the use of steam power on narrow (less than 4ft8½in or 1435mm) gauge in the 1860s. The use of a gauge of 2ft (600mm) meant that it was possible to construct a railway more cheaply and in more inhospitable terrain than might otherwise have been the case. Many engineers from overseas were inspired by what they saw and took ideas and principles away with them to use in their own countries: the Darjeeling Himalayan Railway in India tackled mountainous country in much the same way as the Festiniog did. International transfers were a feature of much later periods as well. In this century, for instance, the fundamental principles of the Japanese *Shinkansen* have been applied to European high-speed operations.

Technical matters always need to be taken in context. Modern historiography of technology typically requires an interdisciplinary approach: social, economic, environmental, and political factors among others influenced technical change and development on the railways (eg Rosenberg & Vincenti 1978). To exclude history from technology (or for that matter technology from history) is to miss a vital part of the story: technical change has both informed, and been informed by, social and economic change around the globe.

CRITERION 3: Outstanding or typical example

There is a place for the designation of sites either because they have always been outstanding in some regard or because, although once commonplace or typical, they have become special simply by virtue of their survival. Particular historical events and associations will help with the identification of outstanding locations: originality and authenticity might be factors justifying the designation of railways on the grounds of typicality.

There is a case, for instance, for designating an example of a secondary main line which, although not outstanding according to any of the other criteria, would be of international importance because of its historical integrity – still fulfilling its transport purpose while having an excellent heritage content. The Newcastle & Carlisle Railway in England might fall into this category. Opened in 1836 and still in use, its role as secondary route has helped to ensure the survival of many structures illustrating the line's development from its earliest days. Similarly, one mountain railway might be selected as typical from among the many in, say, Switzerland and Austria.

Particular structures or locales may also be seen as typical. Something such as a steam-locomotive servicing depot which remains complete with all its infrastructure (water tower, shed, turntable, and fuelling facilities) may be worth designating as a symbol both of the technology of the railway and as a place of work. As such places become much rarer, the precise location of survivors becomes of less importance than the power of what remains on the ground to stand as symbols for what was once commonplace around the world.

Passenger stations are a particularly attractive kind of structure from both perspectives. Yet they are also difficult to assess. There are internationally many fine stations in terms of architecture and historical significance, and it would be very easy to designate a great number (Richards & MacKenzie 1986). Perhaps the best option would be to include large termini and through stations in a separate category of World Heritage sites embracing urban structures in the context of townscapes. Smaller stations, on the other hand, could be considered, where appropriate, as part of the case for a complete railway.

CRITERION 4: Illustrative of economic or social developments

Despite our strictures to the contrary, a case could be made for saying that this is the principal criterion by which sites should be judged. After all, railways were built to perform a transport function, and this basic function has served many political, social, economic, and cultural purposes in addition to fulfilling people's desires to travel and trade. However, this very diversity brings its own challenges. As we indicated in the introduction to this study, the railways' influence on social and economic life has not been the same around the world, presenting us with the challenge of identifying just what it is about a particular site that represents a universal experience. The problem is made even more complex by the fact that opinions over the normative value of what the railways enabled could – and still do – differ considerably.

Even if one leaves the problem of these conflicting evaluations to one side, there is the added difficulty that most historians agree that it is extremely difficult to isolate the wider effects of railway development on the complex societies of Europe and North America. Claims that the railways were single-handedly responsible for the take-off of industrialization, for example, simply do not stand up to the rigour of modern scholarship. This does not mean, of course, that railways were irrelevant or unimportant, but it does imply that any claims for the designation of particular sites on the basis of this criterion need to be justified by means of careful studies rather than mere assertion.

The difficulty of assessing the direct social and economic contribution made by railways can be alleviated in the case of one, admittedly somewhat unusual class of settlement, the railway town or locale. These were places that the coming of the railway called directly into being, either for its own purposes such as the development of workshops or by allowing the exploitation of resources that previously had been hampered by poor communications. Places such as Crewe or Swindon in the United Kingdom, or the Eveleigh district of Sydney, New South Wales (Australia), are good examples of the former kind and could be found almost anywhere there were railways. Detailed studies often reveal that railway companies adopted all kinds of policies designed to secure social cohesion among their workers, perhaps by the paternalistic building of housing and other amenities for their workers (eg Drummond 1995). Settlements of the latter type, by contrast, were far more common in North America or those parts of the world that fell under the influence of the imperial powers than they were in Europe.

This criterion has the advantage of admitting for consideration several important types of railway that would rarely qualify on other grounds. Suburban, street (tramways), and underground railways affected the growth and social development of many urban places. The role of railways as lines of communication along which suburban settlement spread is illustrated very well, in Britain at least, by London's 'Metroland' – the developments of the 1920s and 1930s spurred by the Metropolitan Railway. This pattern had earlier been found in many large towns and cities across the world, from the Paris Métro to the overhead urban railways ('El's') of New York, Chicago and elsewhere. Street railways or tramways played a critical role in the development of many major cities, some of which, like Los Angeles, are now almost completely dominated by road transport; perhaps consideration should be given to designating one of the surviving great urban tramways. Even where railways were not critical for the movement of people and goods inside the town or city, the siting of passenger and goods terminals usually had significant and long term consequences for the urban morphology (Bond & Divall 1999).

None of these criteria can be allowed to stand apart from the others. Since railways are socio-technical systems, all the criteria must be applied to each site that is nominated for World Heritage status. Of course, particular railways will be deemed more significant on certain grounds rather than others. One location might be of great technical significance, another of considerable social or economic value. How then can one weigh the two in the balance? Unfortunately there can be no neat formula: there is – perhaps fortunately – no heritage equivalent of the quantitative approach of, say, cost-benefit analysis. By choosing one railway site as a World Heritage site over another we also choose, in some small way, to make ourselves.

The criteria in practice – some railways of note

The railway sites analysed here serve to demonstrate the applicability of the proposed criteria and to show, in outline, the kinds of factor that the World Heritage Committee might consider asking States Parties to the Convention to bear in mind when making their nominations.

Although we have tried to demonstrate the relevance of the proposed criteria to a range of sites, both in terms of geographical spread and type of railway, these brief studies are only illustrative. In particular, the inclusion of any location does not imply that in our opinion it should – or should not – be considered as a World Heritage site. The same applies, of course, to the many potential sites that are not mentioned here. It follows that these studies are listed in no particular rank.

Case 1: The Moscow Underground

Urban railways, including tramways or street railways, rank among the least regarded but most significant of locations from a social and economic perspective. This system, described as the 'Showpiece of the Revolution,' is the most heavily used underground railway in the world. Planned as a unified whole, unlike those in most other cities, it carries about nine million passengers a day over nearly 200km (125 miles) of track. The first line opened in 1935, and others have followed, all part of a plan to provide an efficient means of moving the people of the vast city of Moscow. Reflecting the political ideology of the time, the Underground was built on a grand scale, so as to be a prestige feature as well as a practical solution to a transport problem. The earlier stations show that no expense was spared on fine design and ornamentation. One writer has described the system as 'the most beautiful underground railway in the world' (Nock 1973: 182).

As an outstanding mass transit railway, the Moscow Underground exemplifies the social and economic criterion for World Heritage status. It is also a masterpiece indicative of genius. Here, however, one encounters a problem commonly found with outstanding achievements of modern industrial society: there is no single name which can be picked out as responsible engineer. This need not matter, however, if one accepts that a site or location may reflect the wider cultural context within which it was built. The Moscow Underground is significant partly because it was an elegant solution to a pressing transport problem, relieving the surface transport systems of bus and tram of much of the commuter pressure which had built up as the city expanded. It is also remarkable as a symbol of the modernization of Russia under the Soviet regime (under Tsarist control, plans for an underground had been abandoned in 1900).

The many kilometres of railway follow the historic development of the city, with ten lines radiating out in all directions from the centre and connected on the periphery of the city by a circular route. Although the plan for the system was drawn up as one, the building of the routes took place in stages, each line reflecting the political and ideological development of the Soviet Union. Some have even suggested that the Moscow Underground is the former USSR in microcosm.

Construction involved the use of several unusual and pioneering techniques to overcome a number of geological difficulties. These included such practices as chemically solidifying the earth around the tunnel profile and freezing the ground in order to permit excavation, then lining the tunnel walls with concrete (itself a difficult process as concrete requires a certain amount of warmth to set). Even the removal of the spoil from construction caused problems, and it is no wonder that the first line's building alone occupied 30,000 men.

The stations are quite unparalleled anywhere in the world. The main objective was to provide friendly and convenient spaces for the public which avoided any suggestion of being 'underground' (considering the tyrannical nature of the Stalinist regime there is, to say the least, a considerable historical irony here). No attempt was made to standardize designs, and some highly individual and striking buildings resulted from the ideas of leading Soviet architects. The stations were designed to impress, and they do impress. An air of opulence characterizes the majority of stations, which are far removed from anything which one might find as an underground station elsewhere in the world. With many stations having walls of marble in various hues, glass ceilings, wide platforms, and soft diffused lighting, the Moscow Underground is truly an outstanding example of its type. Compared with other underground systems, it is *sui generis*, yet for all its grandeur, it is extremely practical and functions well. In addition, partly owing to the Russian practice of shift working, overcrowding is minimal and the vast stations always give the impression of effortlessly absorbing traffic even at the busiest of times. Cleanliness and efficiency continues to be of paramount importance, achieved partly by lavish staffing.

A more beautiful and inspired array of media (architecture, sculpture, painting, and decorative arts) as a vision of functional public space would be hard to find. The Moscow Underground as a whole exemplifies many of the criteria for World Heritage status. The first line, built from 1932 to 1935, is perhaps the single best example. As a high point of the Soviet avant-garde, its combination of modernism and practicality continues to serve the Russian city of Moscow today.

Case 2: The Semmering Pass, Austria[2]

It was in Europe that railways first began to penetrate really mountainous country. The pioneer mountain railway was, in many respects, the Austrian line over the Semmering Pass built between 1848 and 1854. It also reasonably can be described as the first 'imperial' railway, linking as it did the capital of Vienna with Austria's Italian possessions to the south. Admittedly, though, its function was not to extend the economic and political reach of new and dynamic empires, as the colonial railways built later in the century were, but to prop up a moribund and decaying one.[3]

The Semmering line, engineered by Karl Ritter von Ghega, runs from Gloggnitz to Murzzuschlag, crosses the high Alps in a 42km (26 mile) long section known as the Semmering Pass. It still forms part of the railway from Vienna in Austria to Italy and Slovenia. The Adriatic port of Trieste had special importance as part of the Austro-Hungarian Empire: since it was the only access the state had to the sea, an efficient railway connection was of the utmost importance. An Imperial Edict for a line over the Semmering was passed in 1844, but the original plans were shelved after doubts over tunnelling. The revolution of 1848 in Vienna changed the political climate and increased pressure for the line's construction. Designed for locomotive operation throughout, the railway became a prototype for mountainous railways and led the way for others to cross the Alps by rail.

---

[2] This study draws heavily on G Dinhobl and C. Schühbock (1998).

[3] This paragraph is taken from (Lee 1998).

Its civil engineering neatly demonstrates the relevance of the technical criterion for World Heritage status. For example, new techniques had to be developed to cope with the difficult mountainous circumstances when little or no mechanical assistance was available; viaducts had to be constructed on both curves and gradients together, for instance. Surveying was all done from the ground, through crags, ravines, and heavily wooded slopes. How von Ghega managed to engineer a line through this on a steady gradient is little short of marvellous. Yet in other ways the railway was conservatively engineered. As far as materials were concerned, von Ghega rejected the use of iron and steel as a matter of principle; the result was sixteen brick and stone viaducts. Nevertheless, construction was an organizational as well as a technical achievement. At the peak of building, some 20,000 men were employed. The building of the Semmering Railway was very much a ground-breaking exercise, after which nothing seemed impossible: it was claimed that there was nowhere that a railway could not be built after this. The line was quickly recognized as an outstanding example of engineering; once it had been fully opened, sightseers came in large numbers to view the railway and the landscape through which it passed.

The line also exemplifies the way in railways must be treated as technical *systems*. The line was planned by von Ghega to operate with steam locomotives. A competition was held in 1851 to find the most suitable type of engine, an approach similar to that adopted by the directors of the Liverpool & Manchester Railway at Rainhill in 1829. The result was that mechanical engineers were spurred to design engines that met the arduous requirements of the Semmering Pass and the railway was run by locomotives in its entirety. Steam worked for a century, but electrification took place between 1956 and 1959. This was by no means an early use of the power, but was significant for the amount of extra traffic which was accommodated.

Apart from this and the construction of a new, second Semmering tunnel from 1949 to 1952, today's railway is still substantially that designed by von Ghega. The continued operation of the line is a sound testimony to his engineering genius.

Case 3: Baltimore & Ohio Railroad, United States of America

This was the first railroad of any length in the USA, being chartered in 1827. Inspired by the British example of the Stockton & Darlington Railway, its opening was virtually contemporaneous with that of the Liverpool & Manchester. Described as 'America's pioneering railroad' (although it was neither the first railroad in the continent nor the earliest steam-powered line), it was the USA's most ambitious early transport project and its most successful. The B&O is an excellent example of the inspirational transfer of technology from one country to another (Harwood 1994: 48).

Given the huge differences in social, political, economic, and geographical circumstances between Britain and the USA, the English examples finally proved to be of limited practical relevance to the story of the B&O and indeed that of the wider railway system of North America (Robbins 1998: 115-121). Nevertheless, the international dimension was crucial in the early days. The B&O was the railway on which, in 1830, steam locomotion was first applied in the USA with any measure of success; the engineers involved in the project had visited Britain to gain ideas, several having attended the Rainhill Trials. Similarly, the extensive use of brick and stone in the line's structures shows how ideas were taken from the British model. The B&O's bridges were strongly built from the outset to carry heavy traffic and steam locomotives, and many are still in use today, including the Thomas viaduct of 1834 which, at the time of its construction, was highly unusual in being built on a curve. This structure closely resembled the Liverpool & Manchester Railway's Sankey Brook viaduct and is a good example of the 'design and build' policy adopted by the railway's promoters. The structure was designed and constructed by Benjamin Latrobe, one of several engineers responsible for the B&O. Many of the railway's civil engineers went on to form the core of the railway engineering profession in the USA, the line itself being described as a 'lecture room to thousands' (Dilts 1993: 2).

The railroad also confirms the significance of social and economic criteria for judging a site's standing as a World Heritage site. By the time it reached the Ohio river in 1857 the B&O ran for 380 miles (600km) and it was a key factor in the development of the USA. Planning and engineering overcame natural obstacles in the form of mountain wildernesses, and the successful opening of the line in stages provided the impetus for further progress, not least the development and extension of the Western frontier. The entrepreneurs promoting the railway were simultaneously guarding their own interests while expanding the young nation's physical and economic horizons. The building of the railway revitalized Baltimore as a port, spurred its industrial development and contributed to the reshaping of its urban geography, as well as its financial, educational, and cultural institutions. By allowing faster and cheaper distribution of goods, the line contributed to Maryland's economic expansion, particularly aiding the growth of the state's iron and coal industries. However, the line was not just of regional importance. Even at the time of its construction, the railway was considered a national endeavour. It became the first leg of the US railroad system, with Baltimore its base - 'the birthplace of American railroading.'[4]

Case 4: The Great Zig Zag, Australia[5]

As the 19th century progressed the focus of railway construction shifted beyond Europe and the United States as the age of new imperialism established itself in some of the more far flung parts of the world. Australia's first railway opened in 1854, the Zig Zag following in 1868.

The Great Zig Zag brought the main western line of the New South Wales Railways over the Great Dividing Range of the Blue Mountains into the Lithgow Valley, some 94 miles (150km) west of Sydney. It was the means chosen by the railway's engineer, John Whitton (1819-1898), to overcome the greatest natural obstacle on this, the first railway to penetrate into the interior of Australia. Whitton would have preferred to use a long tunnel, but, as his immediate superior, John Rae, the Under-Secretary for Public Works, reported, 'the low state of the country's finances compelled him to adopt zigzags, instead of tunnels, or abandon the works entirely (Rae 1873: 2-3).

Whitton is the only 19th century Australian engineer whose work F A Talbot discussed in his 1911 account of the 'railway conquest of the world' (Talbot 1911:177-80). Moreover, Whitton's greatest work was completed earlier than Talbot describes. When Whitton 'conquered,' to use Talbot's terminology, the Great Dividing Range and thereby opened up the interior of the Australian continent for intensive exploitation, the technology which allowed the railway to spread across the world did not yet exist. Whitton's transmontane lines were built in the 1860s, by hand, from iron rails, and with bridges of stone or wrought iron.

[4] Communication from William Withuhn, Curator of Transportation, National Museum of American History, Smithsonian Institution, 22 April 1998.

[5] This study is by Dr Robert Lee.

Dynamite and steel were not as yet being used in railway applications. Whitton had to use the expensive and relatively cumbersome technology of the pioneer English railway builders, but in a colony which was remote and impecunious and across terrain far more inhospitable than anything in England, if not quite as forbidding as that confronting later railway builders in Africa and Asia. At the time, only in India and Canada were railway builders attempting anything quite as ambitious, and in those places greater population and imperial political imperatives meant that resources were available on a far more lavish scale than Whitton could ever command.

Whitton's English training meant that he felt obliged to build his railways solidly: every one of his three cast-iron plate bridges and his numerous sandstone arched viaducts of the 1860s still stands, some still carrying heavy rail traffic. Whitton's two great compromises were to use grades far steeper than were the norm on English main lines of the 1860s, 1 in 30 in the down direction, 1 in 42 on the up, which carried the bulk of the heavy export traffic, and to resort to zigzags where the topography was particularly poor. There were two on the western line, one of which (at Lithgow) is particularly spectacular and survives intact.

The Great Zig Zag involved the construction of three elegant sandstone viaducts, one of five and two of nine arches; cuttings up to nearly 80ft (24m) deep; and two tunnels, one of which was opened out into a cutting before completion. The work was difficult and expensive. The 15 mile (24km) contract which included the Great Zig Zag cost £328,284 or £21,886 per mile, very expensive indeed for a single-track railway whose land costs were zero. The precipitous nature of the slope down which the zigzag was built combined with the unpredictable, often savagely cold and windy climate of the valley, made the task a hazardous one. The line descended from its summit of 3658ft (1114m) at the portal of the Clarence tunnel into the valley.

Railway operations began over the Great Zig Zag on 18 October 1868, effectively opening the interior of New South Wales to intensified European settlement, transforming it from a gigantic sheep walk into a rich agricultural country. The subsequent history of the line is as interesting as its construction. In short, it rapidly became a casualty of its own success. New industries were spawned by the railway, notably the cultivation of wheat and coal mining. These were far heavier commodities than the wool and gold which had dominated the economy of the interior of Australia before the coming of the railway. Traffic soon grew to the extent that the zigzag was a bottleneck. Its bottom road was duplicated in 1880 and a series of crossing loops installed. The Great Zig Zag also did much to stimulate tourist traffic to the region, an early and unusual instance of a railway creating its own traffic. As John Rae succinctly observed, 'zigzags, though not so convenient for traffic as tunnels, are more picturesque in appearance'(Rae 1898:11). A tourist platform was built at Bottom Points and as early as 1881 a public reserve of 550 acres (223ha) was proclaimed around the Great Zig Zag, ensuring the preservation of the wild grandeur of the site.

In 1893 the decision was taken to eliminate the zigzag, but work did not begin until 1908. Construction of the zigzag deviation took a little over two years and involved the boring of ten tunnels with a total length of nearly 3km. The deviation, opened on 16 October 1910, continued to use the zigzag's bottom road, with its 1 in 42 grade and 8 chain (160m) radius curve, the sharpest on any main line in New South Wales. Electrified in 1957, the bottom road continues to carry a huge traffic, including coal trains loaded up to 4100 tonnes and frequent passenger trains. Until 1975 the viaducts and tunnel of the middle and upper road were cared for by the Zig Zag Trust, but in that year a 3ft6in (1067mm) gauge line, on which former Queensland and South Australian Railways equipment operates, was laid on the middle road. In 1988 the line was relaid on the top road and through the Clarence tunnel, and passenger services on the revived railway began operating on 364 days per year, even if on a different gauge from the original line.

Thus the Great Zig Zag has remained partially in use (along its bottom road) and fully intact throughout its history. The revived operations on the middle and top roads are not authentic, inasmuch as they are on a different gauge and use rolling stock built after 1910 (passenger cars from the 1920s, steam locomotives from the 1950s, and diesel railcars from the 1960s). Nonetheless, the operators have taken great care to build authentic line-side structures, including a magnificent timber signal box at Bottom Points, and this important site is not just very well maintained, but extensively visited and enjoyed by about 250,000 people each year. Most are ignorant of just how significant in world terms the site is, given the early date of its construction and its unique combination of solid British civil engineering, typical of the world's earliest railways, with a structure as unconventional and more usually associated with much lighter railways as a zigzag. Apart from the reversing station on the Bhore Ghat section of the Bombay-Poona line of the Great Indian Peninsula Railway, the two zigzags on this line were the first such structures in the world. It is undoubtedly the outstanding railway site in Australia and one of the finest in the world.

Case 5: The Darjeeling Himalayan Railway, India[6]

The Darjeeling Himalayan Railway is an outstanding line on several counts, but it is particularly significant with regard to social, economic, and political effects and the route's relationship with the landscape.

Darjeeling, sited at an elevation of over 2000m in the eastern Himalaya, was the first hill station of British India and also the first to be served by rail. The origins of Darjeeling and its railway are part of the expansion of British India during the last decades of East India Company rule. By the early 19th century the Company was the dominant power in northern India and frequently intervened in disputes between Indian princes. Such intervention on behalf of the Raja of Sikkim in 1829 resulted in East India Company officers exploring the then almost uninhabited Darjeeling area. They were impressed, both with its military significance, commanding a pass into Nepal, and with its potential as a cool-climate sanatorium which was not too far from Calcutta, then capital of both the Bengal Presidency and British India as a whole. The Governor-General, Lord William Bentinck, was an enthusiastic westernizer, and so he opened negotiations with the Raja of Sikkim with a view to its acquisition. The Raja ceded the district to the Company in 1833, and in return was granted an annual allowance. Subsequent annexations in the early 1850s made Darjeeling, previously an East India Company enclave in Sikkim, contiguous with the Company's Bengal Presidency.

Darjeeling grew rapidly under British rule. The population was only about 100 in 1839 but reached 10,000 a decade later. The Hill Cart Road, so named because it was graded so that a bullock cart could climb it, was built from Siliguri on the plains. The cultivation of tea, for which Darjeeling has become famous, began in the early 1840s. At that time, China had close to a monopoly on Europe's tea supplies, so seeds were brought to Darjeeling to begin the industry. Despite the Hill Cart Road, however, transport remained the district's great problem. Railway construction on the plains between 1858 and 1878, partly by the broad-gauge Eastern Bengal Railway (EBR) and partly by the metre-gauge state-owned Northern Bengal Railway (NBR), connected Calcutta with Siliguri, at the foot of the Himalaya. This

[6] This study is by Dr Robert Lee.

made travel easier for Europeans, who could afford the fares, but did little to encourage further growth in Darjeeling. In the late 1870s, rice, the population's staple, was sold in Siliguri for 98 rupees per ton, but for 240 rupees in Darjeeling.

Neither the EBR nor the NBR could see how they could extend their lines to Darjeeling, although it was the putative destination of both. Franklin Prestage, the local agent of the EBR, worked out the scheme for the building a narrow-gauge (2ft or 600mm) light railway to Darjeeling. In 1878, the year of the opening of the NBR line to Siliguri, he wrote a persuasive proposal to build the line. There would be a Bengal Government guarantee, which would ensure security for investors, but in return the railway company would be obliged to pay the Government for maintenance of the Hill Cart Road out of its profits. The contract was signed on 8 April 1879 and less than a year later the first train ran from Siliguri to Tindharia. The line was opened in stages, reaching the summit at Ghoom (7402ft/2256m) on 4 April 1881 and the terminus exactly three months later.

The technological inspiration for the line was not any Indian precedent – the 2ft gauge Baroda Railways were worked by bullocks and laid across flat terrain – but the Festiniog Railway in Wales. It had been converted successfully from horse to steam operation in 1868. The big difference was that the Festiniog's freight traffic was nearly all downhill. The commodity, slate, was also very heavy in relation to its volume, so considerable tonnages could be conveyed in small wagons. The DHR would be carting rice and other supplies up the hill and teas down it. Moreover, there would be a sizeable passenger and mail traffic. The railway did have one big advantage over the Festiniog. This was a far more generous loading gauge, permitting larger locomotives and other rolling stock, but it also had much steeper grades - up to 1 in 20 compared with the Festiniog's 1 in 50. The *average* grade over the 64km between Sukna, where the DHR leaves the plains, and the summit at Ghoom is 1 in 30.5.

The DHR does not feature any grand structures. In fact, the whole point of the line's engineering was precisely to avoid the expense of such features. The remarkable features of the DHR are its steep grades and cheap but effective expedients its engineers adopted to enable it to climb so much in so short a distance. These included, at the time of its opening, four loops, where the line climbed in a circle above itself, and four zigzags. A new loop, the famous Batasia double loop, was built in 1919 to eliminate the 1 in 20 section between Ghoom and Darjeeling, and in 1943 one of the lower loops was replaced by a zigzag, of which there are now five. Curvature is very severe, with the sharpest having a radius of just 59ft (18m). Some of the more alarmingly located sites have been graced with names like Agony Point and Sensation Corner, although the smallest of the Indian hill railways, the Matheran line near Bombay, probably has the most entertainingly named engineering feature – One Kiss Tunnel. For most of its route the DHR follows the Hill Cart Road, which it crosses 132 times.

The DHR was estimated to cost 1,400,000 rupees: Prestage completed it for 1,700,000 rupees which, considering the untried nature of the enterprise, was a good result. It was a profitable line from the start and, until nationalization in 1948, never needed to call on the government guarantee. Revenue and traffic both grew rapidly, along with the Darjeeling district's economy as a whole. Darjeeling's cool climate assured a steady stream of mostly European first-class passengers, while the necessity to ship rice into the district and the growth of tea planting meant that there was plenty of freight flowing in both directions. Motor traffic began to eat into the passenger traffic during the 1920s, but freight traffic and then wartime demands kept the railway's finances buoyant. However, the railway has never really recovered from the effects of Partition in 1947, which led to its railway connections with the rest of India being severed for a period. Even as traffic to Darjeeling revived, most of it began to go by road, as trucks and buses improved. For the DHR, for all its charms, was and remains a slow railway. Today freight traffic has been lost and passenger figures are down to around 100,000 per annum (Sarkar 1980: 8-10, 14-7; Bandhari 1984: 1-36).

Despite its small size, this is a very significant railway in any terms. It has helped make Darjeeling synonymous with quality tea, by breaking the transport bottleneck which inhibited the district's growth in the late 19th century. It was the first hill railway of its type, and so was the precedent for the later Nilgiri, Simla, and Matheran lines in India, as well as for railways such as the Dalat line in Vietnam and the Maymyo line in Burma. It demonstrated, even more startlingly than the conversion of the Festiniog to steam operation had done, what could be done with a very narrow-gauge railway in terms of the traffic that could be conveyed, the economy of construction, and the terrain that could be overcome.

From its inception, the DHR was widely recognized as a remarkable railway. In heritage terms, the railway is well preserved, and the changes have not damaged its value. The station at Darjeeling is a mid 20th century *Art Déco* folly, but most of the larger intermediate stations remain much as they were at the line's opening. The locomotives working the line to this day are all to a design thought out by Prestage. Thirty-two of these class B 0-4-0 saddle tank locomotives were delivered between 1887 and 1927, and about twenty are still working on the line. This continuity in motive power adds to the railway's heritage value.

Despite its small scale, the engineering, social, political, and economic impact of the DHR are significant enough to justify its place on any list of important railways. However, what really makes the DHR outstanding is its relationship to the landscape through which it passes. The railway begins on the plains of West Bengal and soon begins climbing through a remnant of lowland jungle, including stands of teak. As the railway climbs, so the flora changes, and its upper sections are dominated by enormous Himalayan pines, which in misty weather give a surreal quality to the landscape. It frequently hugs the edge of hillsides with drops, often of thousands of feet, to the plains and valleys below. Towering over the entire scene is the perennially snow-covered bulk of Kanchenjunga, at 28,146ft (8579m) the third highest mountain in the world. From Kurseong (31 miles or 49km from Siliguri at an elevation of 4846ft or 1524m) the railway offers frequent views of this stupendous mountain, which by Ghoom dominates the entire landscape. Thus, from the tiny train, the passenger can look down on the stifling tropical plains of Bengal or up into the eternal snows of the highest peaks of the Himalaya. No railway anywhere else offers such a sight.

Case 6: The Liverpool & Manchester Railway, United Kingdom

The world's first main line constructed for both passenger and freight business, dating from 1830, is an excellent example of a railway where much of the route is still in use. The two original termini, at Liverpool Road, Manchester, and Edge Hill, Liverpool, were soon superseded (although both still survive in part), but the rest of the railway is still heavily used, demonstrating its sound economic and technical basis.

The Liverpool & Manchester's role as the international prototype for the Stephensonian mechanically worked railway – engineered to a high but, for European nations, not impossibly expensive standard – makes it an excellent illustration of the criterion of technology transfer. Earlier mechanically worked railways had tended to be of the 'hybrid' variety, utilizing both fixed and locomotive haulage; the Liverpool & Manchester was, with the exception of one short, steep stretch at the Liverpool end, the first to be built and completed solely for locomotive operation (Donaghy 1972). It therefore constituted a new kind of railway – the main line, built to link large centres of population and carry goods and passengers in both directions, a precedent which then spread world-wide. The famous Rainhill locomotive trials of October 1829 took place on a section of the Liverpool & Manchester to determine the type of engine which would be adopted. The winner, Robert Stephenson's *Rocket,* set a course for nearly 150 years of steam locomotive development. The massive contribution to the Liverpool & Manchester of Robert Stephenson and his father George, the railway's chief engineer, suggests that particular sites may indeed be seen as works illustrative of creative genius even though in this, as in so many other cases, modern scholarship reveals that success was dependent upon the contributions of a great number of individuals (Smith 1994; Rolt 1960) .

The Liverpool & Manchester is also illustrative of the intimate relationship between railway development and social and economic factors. The promotion of the line was a direct consequence of attempts to break the virtual monopoly held by the proprietors of the Bridgewater Canal on transport between two of England's most rapidly industrializing cities. Once built, the railway itself contributed to the rapid quickening of the pace of industrialization in north-west England. These effects were partly the result of the railway's high technical standards: it provided quick, reliable and comparatively cheap transport along its direct, gently curved, and easily graded route. Such engineering required large and extensive earthworks and other, often innovative, technical features. The deep cutting through rock at Olive Mount, Liverpool, and the method used by George Stephenson to cross Chat Moss, a notorious area of bog, are particular features of note. So too, for rather different reasons, is the memorial to the Member of Parliament, William Huskisson, run down on the railway's opening day by *Rocket*. The improved lines of communications across the country heralded by the Liverpool & Manchester played an important, if imperfectly understood, part in the political and social evolution of Britain throughout the 19th century (Simmons 1986).

The Liverpool & Manchester also demonstrates the kind of conflicts that inevitably occur on a working railway between historical authenticity and originality on the one hand and renewals on the other. Yet this very continuity of operation demonstrates that the railway has remained true to something like its original purpose for nearly 170 years. Many original features survive apart from the route itself. Liverpool Road station is now part of the Museum of Science and Industry in Manchester, and as an early goods handling complex is very complete. As well as the original passenger station, the site incorporates a brick curved viaduct past the 1830 warehouse, quite an engineering feat at the time although it is hidden by the buildings on both sides (Fitzgerald 1980). At the other end of the line, Edge Hill passenger station is listed nationally as being of historic importance, and Chatsworth Street cutting, where the stationary haulage engines gave way to locomotives, has been excavated and is partially in use as a head-shunt for a marshalling yard. The fact that many of the original features on the rest of the railway remain in use says much about the quality of the engineering that went into their construction. Several original skew bridges (a technology transferred from canals) survive, features that the original company took great pride in. At Sankey Brook is the first railway viaduct in the world of any length; this now carries much longer and heavier trains than it was ever designed to carry. The viaduct is also of note in that it carries the railway over the first commercial canal in Britain. At St Helens is the site of the first bridging of one railway over another, where the St Helens & Runcorn Gap Railway passed over the Liverpool & Manchester.

As the railway which set the precedent for what was to come, the Liverpool & Manchester Railway is a remarkable survival of a transport corridor that demonstrates the relevance of many of the proposed criteria for World Heritage status.

Case 7: The Great Western Railway, United Kingdom

It has been remarked that the Great Western Railway was built by gentlemen for gentlemen. The original main line, constructed from 1838 to 1841, runs from Paddington in west London (though the present splendid station dates only from 1854) to Bristol Temple Meads (where much of the original survives, adapted for reuse). In conception and execution the railway was a grand affair, although as with most lines in Britain considerations of commerce and profit were always as much, if not more, in the minds of the original promoters than those of civic and class identity (Gren 1998). It is still the principal route to the west of England, carrying fast expresses now as it was always intended to do.

Above all the GWR is as an excellent demonstration of how the criterion of works illustrative of genius may be applied in many ways. The railway was dominated, more than any other in Britain, by the vision of just one man, Isambard Kingdom Brunel. This very dominance serves to illustrate the need to be sensitive to the many different kinds of skills and resources needed to build a railway. Brunel came to pre-eminence partly because of the particular pattern of financing the line, which meant that shareholders were divided amongst themselves and unable to exercise the usual measure of control over their employee (Gren 1998). However, whatever the reason, the Great Western was shaped by Brunel’s arguably flawed genius for strategic thinking (Vaughan 1991). Along the route are constant reminders that this railway was once built to the broad gauge of 7ft (2135mm), while many surviving structures bear the mark of his innovative civil engineering. Significant Brunellian features include the Wharncliffe Viaduct, the Sonning Cutting, and the bridge over the Thames at Maidenhead with its two long, flat arches, a triumph of civil engineering which cynics said would collapse when the scaffolding was removed. The 2 mile long Box Tunnel in Wiltshire, with its ornate portals, and a handful of surviving stations show the engineer’s wide-ranging influence in their architectural styling (Pugsley 1976). Brunel’s hold over the GWR was almost total, gaining the railway a reputation at the time of being ‘The Finest Work in England’ (Rolt 1960: 141).

Economic considerations were very much part of the planning of the GWR. These, too, were developed in the grand style. Brunel intended that the railway would not only join London and Bristol but would also form part of a link between London and New York, employing iron steamships from Bristol. Transatlantic trade would be encouraged by the new link. This was socio-technical system building of the highest order, and Brunel’s vision goes part way to explain the willingness of the GWR’s backers to put forward the very large financial sums needed for the line’s construction: their livelihoods would benefit from the new railway. The social relevance of railways is also borne out by the GWR. The route passes through the early railway town of Swindon, a settlement that owed its very existence to Brunel’s decision to site the railway’s principal workshops there. The town still bears many signs of its origins, although the workshops are no longer in use and have been partially cleared (Cattell & Falconer 1995).

As with the Liverpool & Manchester and other operating railways, the Great Western is likely in the future to produce many dilemmas as modern requirements come to be reconciled with the desire to ensure the survival of original features. These challenges are made less pressing than usual by the very fact that Brunel constructed an extremely well (perhaps over-) engineered railway with such a thorough attention to detail that much of it remains suitable for high-speed use today. As a complete and still operating entity, ‘Brunel's Billiard Table’ with gentle curves and lack of sharp gradients is a fine tribute to the man who designed and the men who built it.

Case 8: The Shinkansen, Japan

The Japanese Shinkansen has been to modern high-speed railways what the Liverpool & Manchester line was to rail travel in the 1830s in terms of technical innovation.

After World War II, the population and industrial expansion which took place on the coastal belt of Japan between Tokyo and Osaka forced the Japanese National Railways (JNR) to find ways to expand its carrying capacity. It appeared futile to try to find extra capacity on the already overstretched 3ft6in (1067mm) gauge Tokaido main line. In any case, operations were severely hampered by frequent level crossings – as many as a thousand – and the route was lined by buildings, preventing the construction of additional lines of track. Since it was passenger traffic which was expanding at the greatest rate, it was decided to build an entirely new standard-gauge railway from Tokyo to Osaka which would serve only the most important intermediate settlements. The choice of the standard gauge also meant that a higher speed would be possible. The narrow-gauge line could then concentrate on handling goods and local passenger traffic.

The new railway was to be something quite unprecedented world-wide. Having only one purpose, it could be engineered solely for one type of train, a train where speed and comfort were of the essence. The power was electricity, and from the start a very frequent service was run throughout the day. Trains were of a standard type, running at very high speeds on a double-track line, all supervised from a central control centre in Tokyo. Through the use of modern technology to communicate with the trains, this New Tokaido line was able to dispense with track-side signalling, the first ever main line to do so. The route was entirely new, although roughly parallel to the original narrow-gauge line for much of the distance. Connecting only the principal towns, the total number of stations on the line is twelve, including the two termini.

One could argue that the *Shinkansen* illustrates the continued relevance in the 20th century of the criterion of genius, a genius which changed the concept of travel by train into a new efficient system which continues to spread its influence throughout the world in the quest for speed and efficiency, drawing boundaries ever closer. The head of the *Shinkansen* design team was Hideo Shima, who worked on the track and trains to create something completely different. The line was built on a raised concrete base with the express intention of avoiding steep gradients and curves: this was a breakthrough in passenger train technology similar to the conversion of the airline industry to jet propulsion. From Osaka to Tokyo, the route has 3000 bridges and 67 tunnels to make it as level as possible, the result being that on average trains arrive within 40 seconds of their scheduled time. The individual cars of the train have their own electric motors, and each train set is air-conditioned and employs air suspension. Safety standards are exemplary. Seismometers installed along the track automatically trigger equipment to halt the trains if any tremors occur in this area of tectonic activity; since opening, no passenger has ever been killed in an accident. Hideo Shima also designed the aerodynamic front of the train, which gave rise to the name 'Bullet Train.' Eventually he was given the Japanese Order of Cultural Merit for his work, and he was also the first non-Westerner to receive the prestigious James Watt award for mechanical engineering.

The *Shinkansen* also illustrates the applicability of the criterion of significant social and economic effects to railways of the 20th century. The line was opened for limited traffic in 1964, and began full operations in 1966. It was an immediate success, both financially and operationally. Despite high construction and operating costs, the new line was able to deliver a healthy surplus of revenue over and above the capital charges and running costs, even though social and economic considerations on the part of the Japanese government kept fares at a comparatively low level. Further lines and extensions on essentially the same model were planned and built as a result: speed was what passengers customers wanted, and they were willing to pay a premium over the usual fare to get it. Politicians pushed to have lines built to their areas as a symbol of economic prowess, while the trains were also agents of social change in that young people in the countryside were able to have quick access to urban areas.

The *Shinkansen* exemplifies the criterion of international technology transfer in the modern period. Engineers in Europe watched the success of the Japanese high-speed line with envy, but it was to be a decade before anything like it would be emulated outside Japan. Now, thirty years on, it is possible to see the fundamental concept of the *Shinkansen* in the new high-speed trains such as the French TGV, the German ICE, and Franco-British-Belgian Eurostar which run on purpose-built railways across Europe. On a national scale the original *Shinkansen* had symbolized Japan's final movement out of the shadows of war-time defeat and industrial dependency. Now in the late 20th century the line stands additionally as a symbol of international leadership in the technology of high-speed land transport (Whitelegg *et al* 1993).

Conclusion

Railways are among the most important of industrial locations worthy of designation as World Heritage Sites. The designation of a carefully selected number of outstanding sites would bring to greater prominence the many ways in which railways have contributed – and in many cases continue to contribute – to the social, economic, political, cultural, and technical evolution of almost every country around the globe.

This survey does not pretend to identify those railway locations that are worthy of designation. It seeks only to provide a little of the general background that is needed to appreciate the true historical significance of railways, and to demonstrate the applicability of the usual criteria for World Heritage Sites to the particular case of railways.

Not all railways worthy of World Heritage status need be designated in their own right. Railways have always been built as a means to some other end, and it would be fitting if this fact were reflected by the inclusion of railways as integral parts of locations designated as World Heritage sites partly or chiefly for other reasons. This has, of course, already happened in one or two instances: for example, the routes of several early railways fall within the Ironbridge Gorge World Heritage Site. Again, complexes of important warehouses and other goods facilities at points along a route might be included within other kinds of designated sites, where appropriate, in order to demonstrate the railways' interaction with industry and other modes of transport.

Nevertheless, railways enjoy a distinctive enough identity as a kind of socio-technical system for them to be worthy of designation in their own right. Their long history has produced a rich heritage fully the equal of any other aspect of modern society. Continued usage is surely the most fitting recognition that the present generation can accord the achievements of the railways' past. Yet the continued relevance of railways to contemporary society in many parts of the world means that certain aspects of their heritage is at risk from unsympathetic modernization and renewal. The designation of outstanding railway locations as World Heritage Sites can help to ensure a future whereby the achievements of the past are recognised and appreciated as an integral part of the continuing evolution of railways into the next century.

Acknowledgements

This survey would not have been possible without the generous financial assistance of ICOMOS from funds provided by the Austrian Government, and of the UK's National Museum of Science and Industry (National Railway Museum). It was compiled with the assistance of Professor Colin Divall of the Institute of Railway Studies, York. The considerable input of some 70 experts, both in person and through correspondence, is also gratefully acknowledged. Special thanks are due to Dr Robert Lee of the University of Western Sydney, MacArthur, New South Wales, Australia (who contributed the studies on the Darjeeling Himalayan Railway and the Great Zig-Zag); Mme Marie-Nöelle Polino of AHICF, Paris; Herr Günter Dinhobl of the Austrian Alliance for Nature; and the guiding hand of Professor Henry Cleere, World Heritage Coordinator, ICOMOS, Paris. The help and encouragement of colleagues in the Institute of Railway Studies and the National Railway Museum is also warmly appreciated.

Much of the study is based on the proceedings of the World Railway Heritage Conference, held at the National Railway Museum, York, on 16 March 1998, and on subsequent discussions. The photographs used are from the collections of the National Railway Museum and individual correspondents.

Select Bibliography

Ambler, ed (1999), *The History and Practice of Britain's Railways: A New Research Agenda*. Aldershot: Scolar Press

Bandhari, R R (1984), *Exotic Indian Hill Railways*. New Delhi: Ministry of Railways

Biddle, G, & O S Nock (1983), *The Railway Heritage of Britain*. London: Michael Joseph

Bond, W, & C Divall, eds (forthcoming, 1999), *Suburbanising the Masses: Public Transport and Urban Development in Historical Perspective.* Aldershot: Scolar Press

Burman, Peter (1997), 'Philosophies for conserving the railway heritage', in Burman & Stratton, eds, 18-33

Burman, Peter, & Stratton, Michael, eds (1997), *Conserving the Railway Heritage.* London: E & F N Spon

Burton, Anthony (1994), *The Railway Empire.* London: John Murray

Cattell, J, & Falconer, K (1995), *Swindon: The Legacy of a Railway Town*. London: HMSO

Chandler, Alfred D, jr (1990), *Scale and Scope.* Cambridge (MA) and London, Harvard University Press

Channon, G, ed. (1996), *Railways Volume 2 - Studies in Transport History*. Aldershot: Scolar Press

Cossons, Neil (1997), 'An agenda for the railway heritage', in Burman and Stratton, eds (1997), 3-17

Danley, S, and L Marx, eds (1990), *The Railroad in American Art: Representations of Technology and Change*, Cambridge (MA): MIT Press

Davis, Clarence B, and Kenneth E Wilburn jr (with R Robinson), eds (1991), *Railway Imperialism*. New York: Greenwood Press

Dilts, James D (1993), *The Great Road - The Building of the Baltimore & Ohio, the Nation's First Railroad, 1823-1853*. Stanford (CA): Stanford University Press

Dinhobl, G. & C Schuhböck (1998), *Semmering Railway*. Vienna: Alliance for Nature

Divall, Colin (forthcoming, 1999), 'Technical change and railway systems', in Ambler, ed. (1999)

Dobbin, Frank (1994), *Forging Industrial Policy: The United States, Britain and France in the Railway Age*. Cambridge (UK): Cambridge University Press

Donaghy, Thomas P (1972), *Liverpool & Manchester Railway Operations 1831-1845*. Newton Abbot: David & Charles

Drummond, D (1995), *Crewe: Railway Town, Company and People, 1840-1914*. Aldershot: Scolar Press

Fitzgerald, R S (1980), *Liverpool Road Station, Manchester: An Historical and Architectural Survey*. Manchester: Manchester University Press

Gourvish, Terry, ed (1996), *Railways Volume 1 - Studies in Transport History*. Aldershot: Scolar Press

Greene, J Patrick (1994), 'The archaeology of the world's oldest railway station building', in Shorland-Ball, ed. (1994), 126-34

Gren, André (1998), *The Financing of Railway Promotion in the 1830s*, IRS Working Paper No. 4. York: Institute of Railway Studies

Harwood, Herbert H, jr (1994), 'The early Baltimore & Ohio Railroad and its physical remains, in Shorland-Ball, ed, 48-62

Hawes, H C P (1966), *Underground Railways of the World.* London: Temple Press

Hughes, M. (1988), *Rail 300 - The World High Speed Train Race.* Newton Abbot: David & Charles

Hughes, Stephen (1996), *The International Canal Monuments List.* Paris: ICOMOS

Jerczynski, M, R Kola, K Soida, & J Wesołowski, (1998), *Railway World Heritage Sites - Proposals from Poland*. Warsaw: Polish Association of Railway Enthusiasts

Kellett, J R (1969), *Railways and Victorian Cities*. London: Routledge & Kegan Paul

Kerr, Ian (1997), *Building the Railways of the Raj 1850-1900*. Calcutta, Chennai and Mumbai: Oxford University Press

Kusumsiri, Kodituwakku (1998), *Railway Heritage in Sri Lanka*. Sigiriya: Central Cultural Fund

Lee, Robert (1998), *Railways in Asia and the Pacific*, IRS Working Paper No. 5. York: Institute of Railway Studies

Legget, Robert F (1993), *Railroads of Canada*. Vancouver: Douglas, David & Charles,

Lewis, M J T (1974), *Early Wooden Railways.* London: Routledge & Kegan Paul

Lowenthal, David (1997), *The Heritage Crusade and the Spoils of History*. London: Viking

Meeks, C V S (1957), *The Railway Station: An Architectural History*. London: Architectural Press

Nock, O S (1973), *Underground Railways of the World.* London: A & C Black

Nock, O. S. (1978), *World Atlas of Railways.* London: Artists House

Nye, David (1994), *The American Technological Sublime*. London and Cambridge (MA): MIT Press

Pugsley, A (1976), *The Works of Isambard Kingdom Brunel: An Engineering Appreciation*. London: Institution of Civil Engineers

Rae, John (1873), *Report of the Commissioner of Railways*, Sydney: New South Wales Legislative Assembly

Rae, John (1898), *Thirty-five years on the New South Wales Railways, the Work of the Late Mr John Whitton, C.E., Engineer-in-Chief of the New South Wales Railways*. Sydney: privately published

Raistrick, Arthur (1973), *Industrial Archaeology.* St Albans: Granada

Ransom, P J G (1981), *The Archaeology of Railways.* Tadworth: World's Work

Richards, J, and J M MacKenzie. (1986), *The Railway Station: A Social History*, Oxford: Oxford University Press

Robbins, Michael (3rd ed, 1998), *The Railway Age*. Manchester: Mandolin

Rolt, L T C (1957), *Isambard Kingdom Brunel*. London: Longmans, Green & Co.

Rolt, L T C (1960), *George and Robert Stephenson: The Railway Revolution.* London: Longman

Rosenberg, Nathan, and Walter Vincenti (1978), *The Britannia Bridge: The Generation and Diffusion of Technical Knowledge*. London and Cambridge (MA): MIT Press

Sarkar, R L (1980), *Eastern Himalayas, a Panoramic Overview*. Darjeeling: Indian Institute of Hill Economy

Schivelbusch, W (1986), *The Railway Journey: The Industrialization of Space and Time in the 19th Century*. Leamington Spa: Berg

Shorland-Ball, ed. (1994), *Common Roots - Separate Branches: Railway History and Preservation*. York: National Railway Museum

Simmons, Jack (1986), *The Railway in Town and Country: 1830-1914*. Newton Abbot: David & Charles

Smith, Denis, ed (1994), *Perceptions of Great Engineers - Fact and Fantasy*. London: Science Museum

Stover, John F (rev ed, 1997) *American Railroads*. Chicago (IL): University of Chicago Press

Szostak, R (1991), *The Role of Transportation in the Industrial Revolution: A Comparison of England and France*. Montreal: McGill University Press

Talbot, Frederick A (1911), *The Railway Conquest of the World*. London: William Heinemann

Talbot, Frederick A. (1913), *Railway Wonders of the World*. London: Cassell & Co.

Thomson, Ian (1998), *La Casa Máquinas de Ferrocarriles.* Santiago de Chile: CCMFA

Trinder, Barrie S (1982), *The Making of the Industrial Landscape.* London: J M Dent

Trinder, Barrie S, ed (1992), *The Blackwell Encyclopaedia of Industrial Archaeology.* Oxford: Blackwell

Vance, James E, jr (1995), *The North American Railroad: Its Origin, Evolution and Geography*. Baltimore and London: Johns Hopkins University Press

Vaughan, A (1991), *Isambard Kingdom Brunel - Engineering Knight-Errant.* London: John Murray

Ville, Simon P (1990), *Transport and the Development of the European Economy, 1750-1918*. London: Macmillan

Watts, J (1998), Obituary of Hideo Shima, *Guardian*, London, 21 March

Wheatley, G (1997), *World Heritage Sites.* London: English Heritage

White, John H, jr (1994), 'Old debts and new visions: the interchange of ideas in railway engineering,' in Shorland-Ball, ed (1994), 65-87

Whitelegg, J, S Hultén, and T Flink (1993), *High Speed Trains: Fast Tracks to the Future*. Hawes: Leading Edge

Wosk, Julie (1992), *Breaking the Frame: Technology and the Visual Arts in the Nineteenth Century*. New Brunswick (NJ): Rutgers University Press

Appendix - Members of the Advisory Committee and Correspondents

Advisory Committee

Professor Henry Cleere, World Heritage Co-ordinator, ICOMOS, Paris, France, and Institute of Archaeology, University College London, UK.
Sir Neil Cossons, Director, National Museum of Science and Industry, London, UK
Professor Colin Divall, Head, Institute of Railway Studies, York, UK
Stephen Hughes, Royal Commission of Ancient and Historical Monuments in Wales, UK
Dr Robert Lee, University of Western Sydney, MacArthur, New South Wales, Australia
Ashwani Lohani, Director, National Rail Museum, India
Marie-Noëlle Polino, AHICF, Paris, France
Andrew Scott, Head, National Railway Museum, York, UK
Dr Michael Stratton, University of York, UK
Dr Barrie Trinder, Nene College, Northampton, UK

Participants in the International Conference, York, 16 March 1998

In addition to members of the Advisory Committee:

Michael Bailey, Institute of Railway Studies, York, UK
Gordon Biddle, independent scholar, UK
Winstan Bond, National Tramway Museum, Crich, UK
Tadej Brate, Ministry of Culture, Slovenia
Phillip Butterworth, University of New South Wales, Australia
Mike Clarke, Milepost Research, Accrington, UK
Jim Cornell, Railway Heritage Trust, UK
Anthony Coulls, Institute of Railway Studies, York, UK (*Conference co-ordinator)*
Günter Dinhobl, Alliance for Nature, Austria
Clive Ellam, Vice-President, Newcomen Society, UK
Helen Gomersall, West Yorkshire Archaeological Service, Wakefield, UK
Victoria Haworth, Robert Stephenson Trust, Newcastle, UK
Dr Tony Heywood, Bradford University, UK
Dieter Hopkin, National Railway Museum, York, UK
Sinikka Joutsalmi, Department of Antiquities, Finland
J Mitchell & J Fleming, Heritage Engineering, Glasgow, UK
Jill Murdoch, Institute of Railway Studies, York, UK
Peter Northover, University of Oxford
David Percival, Royal Commission on Ancient and Historic Monuments in Wales, Aberystwyth, UK
Martin Robertson, English Heritage consultant, Bath, UK
Bob Scarlett, independent scholar, Sunderland, UK
Christian Schuhböck, Alliance for Nature, Austria
Peter Semmens, independent scholar, York, UK
Denis Smith, President, Newcomen Society, UK
D P Tripathi, Indian State Railways, India
Audrey Trotti, University of York, UK
Jacek Wesołowski, Politechnika Łodz, Poland
John Wilcock, Staffordshire University, UK

John Wonnacott, Institute of Railway Studies, York, UK

Correspondents

Lars Olov Karlsson, Curator, Banmuseet, Sweden
Jurgen Franzke, Director, DB Museum, Nuremberg, Germany
Tatsuhiko Suga, Executive Director, East Japan Railway Culture Foundation, Japan
Dr Anthony Streeten, English Heritage, London, UK
David Mitchell, Hertfordshire, UK
Dr Paul Waters, British Overseas Railway Historical Trust, Surrey, UK
Rabbi Walter Rothschild, Berlin, Germany
Ian Thomson, Chile
Professor Senake Bandaranayake, Sri Lanka
Professor V V Alexeyev, Ekaterinburg, Russia
Dr Eugene Rukosuyev, Institute of History and Archaeology, Ekaterinburg, Russia
C Weevers, Rijksdienst voor de Monumentenzorg, The Netherlands
Professor Georges Calteux, Luxembourg
Andris Biedrins, Latvia
Christopher Andreae, Historica Research Ltd, Canada
Guido Vanderhulst, La Fonderie, Belgium
Professor Jorge O Gazaneo, Argentina
Dr M J T Lewis, University of Hull, UK
Thomas Kappel, Denmark
Hossam Mahdy, Architectural Conservation Consultant, Egypt
Charles Alban, USA
Greg Hallam, Historical Researcher, Australia
Bela Banerjee, Ministry of Railways, India
B Z Manyangadze, Mutare Museum, Zimbabwe
Nick Sbarounis, Association of the Friends of the Railway, Greece
Omar Gil Soja, FADARTE, Uruguay
Billiard Lishiko, Curator, South West Region Railway Museum, Zimbabwe
Angel Ferrer, Rosario, Argentina
Jorge Waddell, Fundación Museo Ferroviario, Argentina
Kodituwakku A Kusumsiri, Research Officer, Sigiriya Project, Sri Lanka
Lou Rae, Tasmania
Robert C Post, President, Society for the History of Technology, USA
Andreas Dreier, Director, Norwegian Railway Museum, Norway
William L Withuhn, Curator of Transportation, Smithsonian Institution, USA

Our apologies to anyone who has been accidentally omitted.