Trams Return to Manchester and Sheffield

Roderick A. Smith

Introduction

Manchester and Sheffield are both situated some 220 km north-north-west of London, but are separated by 50 km across a chain of hills known as the Pennines. Both cities expanded rapidly and were key players in the Industrial Revolution. Manchester, the so-called 'Cottonopolis', was the warehousing and distribution centre of a large group of cotton manufacturing towns on the west, or Lancashire side of the Pennines. Later development of heavy engineering included such famous steam locomotive builders as Sharp, Roberts and Beyer Peacock. The opening of the Manchester Ship Canal in 1894, linked Manchester to the oceans of the world and led to the development of the Trafford Park Industrial Estate. Sheffield to the east, or Yorkshire side, already had a long history of metal working, particularly the manufacture of fine cutlery, (Chaucer made reference to 'a Sheffield thwistel' or table knife) but expanded into large-scale steel making and heavy engineering, becoming the major supplier of Europe by the latter half of the nineteenth century. Many great advances in steel making occurred there, such as the Bessemer converter, the development of tool and magnetic steels, and the invention of stainless steel.

These old smokestack industries have declined in the UK, and the economies of both cities now depend on a much more diverse range of activities. Both house major universities; Manchester, for example, building on scientific traditions such as Dalton's enunciation of atomic theory, was where Rutherford first split the atom. Fifty years ago, in 1948, Manchester was the site of the world's first execution of a stored computer programme. Modern international contributions by Manchester include the Halle orchestra and the famous soccer team, Manchester United.

In transport, Manchester was the inland terminus of the Liverpool and Manchester Railway, the world's first modern passenger railway, opened in 1830. Railways came later to Sheffield and the cities were connected by the opening of the epic 5-km Woodhead Tunnel through the Pennines in 1845. Railways in Britain were promoted and built by private companies and central government played little or no part in their planning. As a result, stations in cities were often duplicated by private companies, were inconveniently situated from the city centres and connections between them were inconvenient or non-existent. This legacy causes problems in many British cities even today and was a key reason behind the development of urban transport.

Original tram systems of both cities

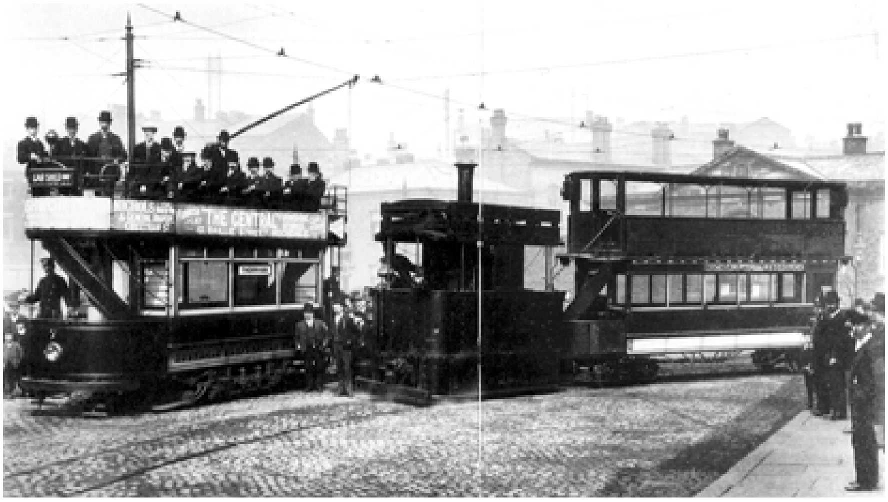
From around 1870, horse-drawn tram systems developed in both cities. Reasonable-sized trams required two horses and a team of up to ten horses per tram to cover a day's duties. Fodder for the horses was a considerable expense, and the resultant manure made the streets unwholesome. Little wonder steam traction was considered cleaner and more economical. In the case of Manchester, a system was developed connecting the city to the surrounding towns, using steam trams, which by law recycled their own smoke. But this was short lived, and both cities introduced electric trams at the turn of the century.

Extensive networks were developed which served the citizens well into the twentieth century. The heyday was perhaps the 1920s. British tramways as a whole reached their zenith in 1927 when 14,481 cars operated 4110 route km. But the internal combustion engine, first in the form of buses and later automobiles, was in the ascendancy. In the case of Sheffield, by 1945, 450 double-decker trams served some 170 kilometers of route. Replacement of routes by buses began in 1951 and the system closed in 1960—the last major tram system in England had disappeared. Closure started earlier in Manchester, beginning in the 1930s, with the last tram running in 1949.

Recent transport trends in the UK

Since the early 1950s, car ownership has increased enormously. Many resources have been put into the development of the road system; an extensive motorway

Horse-drawn tram in Sheffield circa 1886 *(Sheffield City Libraries)*



Changeover between steam and electric tram technology at Rochdale in 1905 *(Unattributed)*

system has been built, towns have been by-passed, urban highways have penetrated city centres. The share of transport carried by public modes has decreased to very low levels and the population's lifestyle has been significantly modified. Shopping is largely done at large shopping centres, local street corner shops have closed, children are driven to and from school, people commute long distances to work.

Recent Conservative governments led by Margaret Thatcher have emphasized 'self', for which the car is an icon, rather than 'community'. The government has appeared unsympathetic to public transport, and amongst a range of privatization of public utilities, has deregulated the bus industry (taken it out of local authority control and opened its operation to all) and privatized the railways. The former policy has had a significant effect, particularly in Sheffield, described later. However, in the very recent years, even before the change to a Labour government, it was realized that a free-for-all in transport was leading to unacceptable problems of congestion and pollution. A more sympathetic line towards public transport has been announced, although substantial action is still awaited. Both Manchester and Sheffield were early beneficiaries of these changes and have been allowed to develop new light rail urban transit (LRT) systems, which are described in this article. The two cases are significantly different and have met with different fortunes, so each is described separately, before drawing some general points concerning the development of urban transport systems.

Manchester

Although the population of Manchester is only 450,000, it is the centre and focus of a metropolitan area that is the home to 2.6 million people. It is located on flat land, without major geographical obstacles, and is well served from all sides by a radial railway network. However, from its earliest beginnings 150 years ago, the railway system has suffered from two major problems. The two main termini were located at the edge of the city's central area and there was no north-south link between Victoria, the largest station in England when it was built in 1844, and Piccadilly, originally opened as Bank Top in 1842.

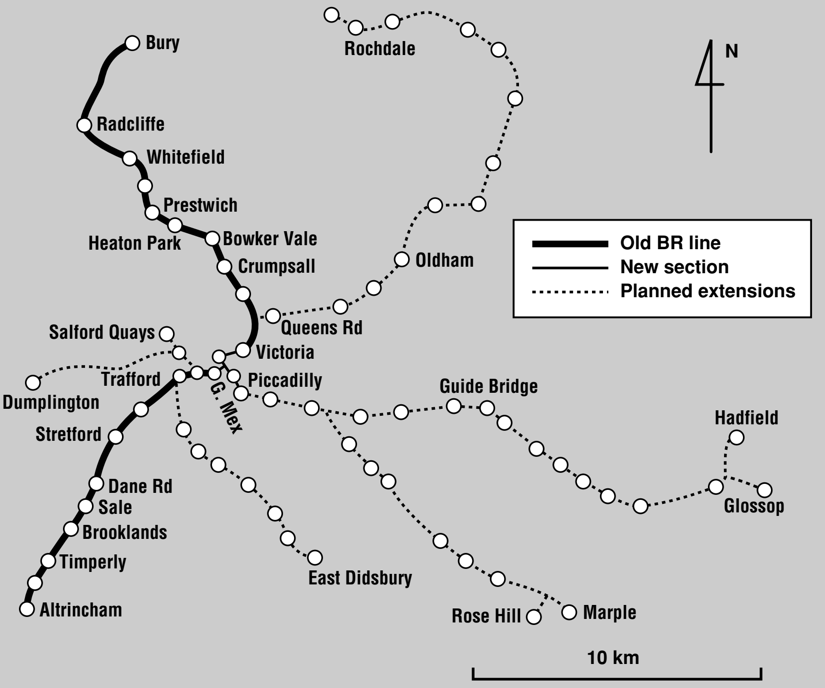
Linking Victoria and Piccadilly stations

Over the succeeding years, many schemes have been proposed to link these two stations. The first was a tunnel in 1839, then a viaduct in 1866, a circular underground railway in the early 1900s, a suspended monorail in 1966 and again a tunnel, the 'Picc-Vic Link' in 1973. All these plans floundered, mainly through lack of finance, but given the extended time-scale, one must also suggest, through lack of resolve!

In 1982, a plan was evolved to convert two existing railway lines to LRT and to construct a new section through the city centre streets linking Victoria and Piccadilly, forming a new *Metrolink* system (Fig. 1). The existing lines were the

Metrolink tram leaving Victoria for Bury *(Author)*

Figure 1 Route of Manchester *Metrolink*



(Jane's World Railways)

Piccadilly-bound Metrolink tram *(Author)*

route running roughly south from Bury through the outer residential suburbs of Radcliffe, Whitefield and Prestwich to Victoria, and the line from Altrincham in the south west, again running through residential areas, entering the city near the famous Old Trafford soccer and cricket grounds. The importance of the former route can be judged from the fact that it was the first electric railway to reach Manchester, using a third rail system, in 1916. Its development was a stimulus to the growth of residential suburbs to the north.

After several years of debate, a joint public/private consortium won a so-called design/build/operate/maintain (DBOM) contract in 1989. The main required work was to convert the existing railway lines to LRT standards and to construct new track in the city centre streets linking the lines with a spur running to Piccadilly. The total length is 31 km with 27 stations, of which the new build is 3.5 km. The strengths of this scheme are that there is an existing customer base and that future extensions can easily be incorporated by further conversion of existing railway lines.

The power supply is 750 V dc throughout. The fleet consists of 26 cars, built by GEC Alsthom-Firema, which are compared with the Sheffield cars in Table 1. Features include resilient wheels, primary rubber springs, secondary airbags, auto-

Table 1 Technical Details of the *Metrolink* and *Supertram* Vehicles

	Manchester *Metrolink*	Sheffield *Supertram*
Type/Manufacturer	Articulated, bi-directional, couplable LRV, 1,425-mm gauge, Firema (Italy) under contract to GEC Alsthom	Double-articulated, bi-directional LRV 1,435-mm gauge, Siemens-Duewag (Germany)
Doors	4 × 1,220 mm wide	4 × 1,450 mm wide
Car width	2,650 mm	2,650 mm
Car length over headstocks	29.84 m	34.75 m
Line voltage/Motor output	750 V dc / 4 × 105 kW	750 V dc / 4 × 277 kW
Max. speed	80 km/h, 48 km/h on-street	80 km/h
Tare weight	48,600 kg	46,800 kg
Capacity	86 seats, 120 standing	88 seats, 155 standing at 4 passengers/m^2
Bogies	3 bogies, 2 powered, rubber doughnut primary & air secondary suspension	4 mono-motor bogies with chevron type primary & air secondary suspension
Wheel diameter new/worn	740/690 mm	670/590 mm
Floor height above TOR	940 mm (automatic sliding step at low platforms)	450/880 mm (40% low floor)
Min. negotiable radius/ Max. gradient	25 m/6.5%	25 m/10%
Acceleration, braking	1.3, 1.3, 2.6 emergency (m/s^2)	1.3, 1.5, 3.0 emergency (m/s^2)

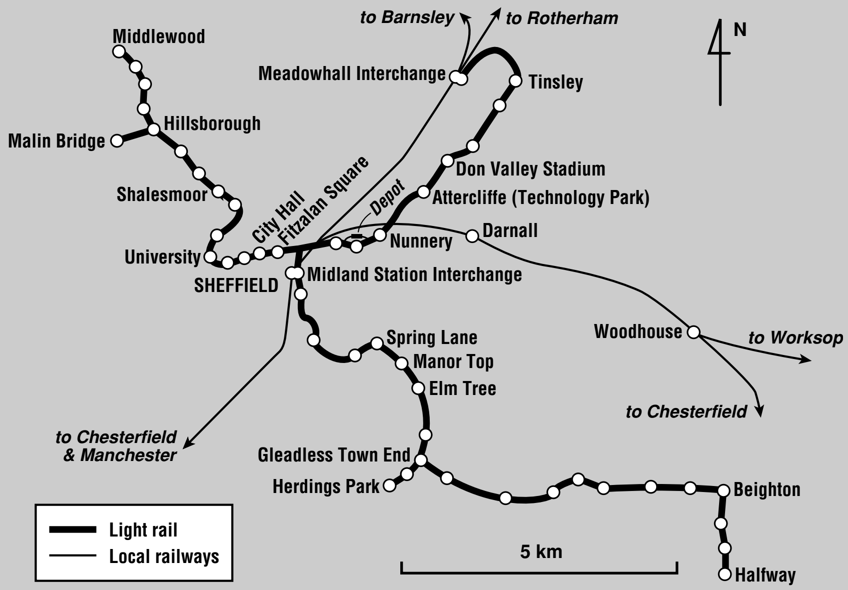
matic couplers, regenerative rheostatic braking, pneumatic disc brakes, magnetic track brakes, slip-slide detection, cab radios and a public address system. Since the platforms at existing stations are their original heights, low floor design was not possible, but automatic door steps operate at the lower city-centre street stops.

Sheffield

The geographical situation of Sheffield is very different. The hilly terrain running down from high land in the south west provided the water power for the early metal industry, but also caused the city to develop in an incoherent fashion, with a highly-focused centre supporting developments running along valley floors and spreading over intervening ridges. To many, the charm of the city is the development of separate village-like settlements in the southwestern sector, away from the Lower River Don old industrial areas on flat land to the northeast. These latter areas are undergoing rapid redevelopment, with major shopping malls, sports arenas and commercial buildings all playing a part.

The city council has been dominated by Labour for decades and tensions have occurred in the past when the national government has been Conservative. In the late 1960s and early 1970s, the local council had a policy of running very cheap buses, financed through local taxes. The buses were well patronized and the large number of commuters who travelled daily to the city centre largely chose to use the cheap buses rather than cars. Well before deregulation of the buses, the national government forced the local council to reduce its subsidy and to charge higher fares. Bus deregulation brought new operators, attracted by low entry costs, onto popular routes. The number of buses and fares rose substantially, and predictably, customers chose to use private cars. The narrow streets of the city centre became clogged with traffic and polluted by exhaust, whilst entry and exit to the city was hampered by the failure to complete an inner ring road.

Figure 2 Route of Sheffield *Supertram*



(Jane's World Railways)

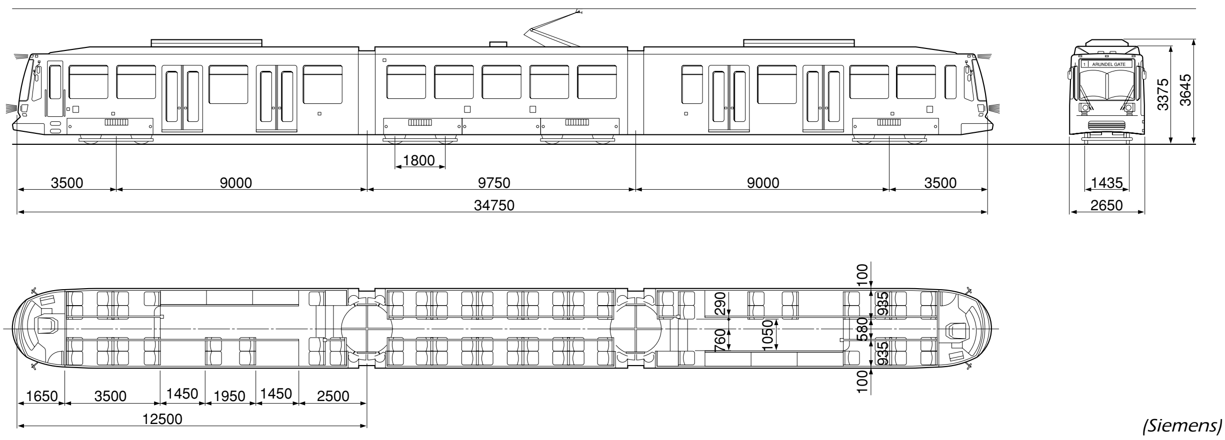
The news that the city had won funding, partly from the European Union (EU), to build a new tram system, was greeted with general enthusiasm. Building started in 1991 and the system was opened in stages during 1994/95 (Fig. 2). A total of 29 route km, linking 48 stops, was built, roughly T-shaped, with the head running north west to south east and the tail pointing north east into the Lower Don development area. About half is segregated and built on conventional ballasted track, with concrete slab track in the street sections. A glance at the route map immediately shows that half the city, or the more generally prosperous southwest sector, is not served by the tram. Although there is a stop called Midland Station Interchange, the entry is via the 'back door' and involves many stairs and considerable distance to reach the booking office. The major regional hospital, which generates many journeys by public transport, is not served, nor is the area of the city where the majority of the 20,000 students live.

Disrupted city centre

The construction period led to considerable disruption as the city-centre streets were prepared. All the utilities had to be relocated away from the slab track, both for later maintenance and to prevent damage from stray return currents from the 750-V dc supply. The water, gas, electricity, and telephone lines were found and re-routed. (I even recovered some wooden water-supply pipes, judged to be about 250-years old.) Old tram track was uncovered and removed.

However, the vehicles are impressive. Table 1 shows the details of the fleet of 25 double-articulated, partial low-floor cars. The interiors are bright with an at-

Figure 3 Main Dimensions of Sheffield *Supertram*



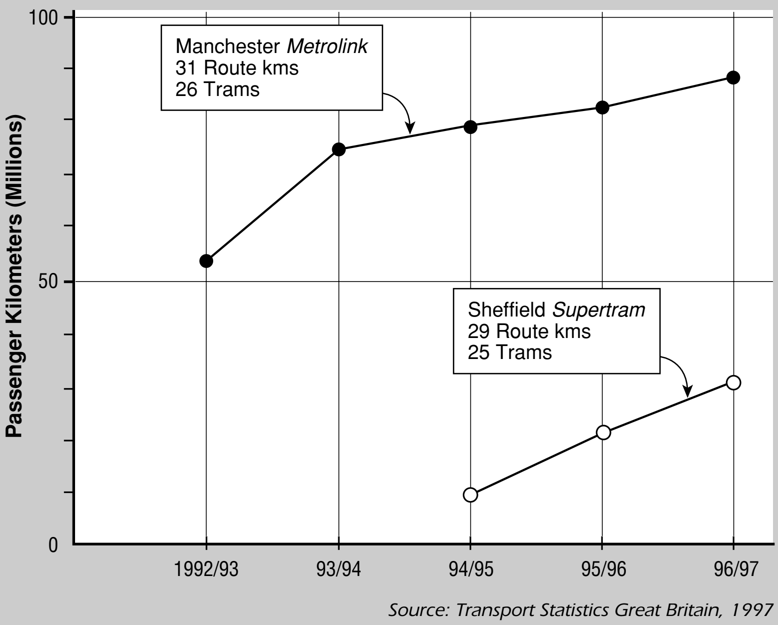
(Siemens)

tractive welcoming ambience. The name *Supertram* was coined to distinguish the new system from the long-departed old trams, and to mark the striking appearance of these fine cars, which are amongst the largest of their type in the world (Fig. 3).

The Systems In Operation

Figure 4 shows development of passenger traffic on the two systems and clearly illustrates their different fortunes. Neglecting the opening phases, by 1996-7, ridership in Manchester was running at 2.96 times the passenger km of the Sheffield system. Furthermore, the receipts/loaded tram km were 3.43 times greater in Manchester (£5.74) than Sheffield (£1.68). It has been estimated that the Manchester *Metrolink* has reduced the number of car journeys by 2.6 million/year, saving external costs in the order of £6 million. After 1 year of operation, the *Metrolink* was carrying 47% more passengers than the British Rail (BR) services they displaced, thus emphasizing the convenience of the direct city centre and cross-city connection they have provided. The Sheffield system lacks this clear strategic rationale, so it is worth discussing some of the reasons leading to its poor performance.

Figure 4 *Metrolink* and *Supertram* Passenger Kilometers



Source: Transport Statistics Great Britain, 1997

Poor *Supertram* passenger performance

Since the *Supertram* was effectively starting from a zero base, rather than having previously established customers as in Manchester, it was proportionally much more adversely affected by the bus deregulation than its Manchester counterpart. The result of maximum unrestrained competition from bus operators led to discounted fares on bus routes parallel to the tram, to lack of interchangeability of tram/

Steps between low floor and high central section of Supertram car *(Author)*

Supertram negotiating junction with other road traffic *(Author)*

bus tickets, to lack of feeding of the tram by buses and to the introduction of new low floor buses to rival the tram. Some might claim this competition is a stimulus to improved performance, but the reality is that the size of the potential customer base is not large enough to sustain unconstrained choice, and cooperation, smooth modal interchange and integration are much more likely to have produced better results.

Some self-inflicted problems must be mentioned too. The council decided not to go ahead with plans to develop two large areas of local authority housing, while at the same time demolishing three huge tower block housing centres. These two actions removed large numbers of potential passengers, most of whom were non-car users. Mention has already been made of the fact that the tram does not serve the railway and bus stations, the major hospital and the university student housing area. Basically, the tram does not run from where people live to where they wish to travel—this is a major and fundamental disadvantage.

There are also some problems associated with extensive on-street running. Although the trams have priority at traffic lights, which are numerous in the narrow and complex city-centre streets, their ability to automatically change lights in their favour is compromised when they are trapped in a queue of traffic extending well back from the approach to the lights. At certain critical junctions, such as a turn by the tram from the inner bypass onto a radial feeder road, both tram and road traffic can be seriously delayed. Because there is no real-time information at tram stops, and the interval between trams can be 10 or more minutes, potential customers are uncertain about using them. (Would smaller and more frequent trams have been a better solution?). In my own experience, my office is nearly adjacent to a tram stop, but because of the unknown waiting time and the indirect connection at the station, I often choose to take a brisk 15-minute walk to catch a train rather than a 7-minute tram ride.

Complex fare system

Finally, the tram fare structure was complicated. Zones required interpretation of a tram-stop map, tickets had to be bought from one machine and validated by another. The ticket machines suffered vandalism. These machines have been replaced by conductors, so that tickets can now be bought on-board, help and information is at hand and a reassuring degree of security is provided.

Accidents

In the latest statistics for 1996/97, there were 23 accidents reported on the Manchester *Metrolink* and 62 on the *Supertram*. The vast majority of these incidents (87%) were relatively minor, involving road vehicles running into trams, but nevertheless caused disruption to services. A few injuries have been reported involving passengers on the *Supertram*, mainly to elderly and infirm people losing balance while on the internal stairs connecting the low and high floor parts of the tram, during acceleration. It is proposed that future trams have stairs placed transverse rather than parallel to the travel direction.

Some accidents not involving trams, including a fatality, have occurred. Cars have been reported skidding on wet tram tracks. A solution to this problem is being researched but, as with the operational difficulties mentioned above, collisions would not occur if the tram ran on completely segregated track.

Current and Future Developments

Both tram systems have now changed ownership in line with government policies to increase private-sector involvement. An extension of the *Metrolink* to the Salford Quays development area and on to Eccles, is already well underway. Extensions out to Manchester's busy international airport and eastwards to the towns of Oldham and Rochdale are likely in the not too distant future.

The *Supertram* operations and maintenance up to 2024 have been purchased by Stagecoach, the national bus operator, which has made a very successful business from deregulation. New business stimuli will include more stops, and more and better 'Park and Ride' facilities, which were not featured when the tram originally opened. Possible extensions to the nearby city of Rotherham, via the huge Meadow Hall Shopping Centre and to Broomhill to serve the hospital and students community have been suggested. Finance remains a problem because the total debt for construction and later operation is now said to run to some £133 million. Although the new owners are not the main local bus operators, it is claimed that buses will have to be used to act as feeders for the tram rather than as opposition. Several new reduced-fare initiatives have already begun, together with a more flexible routing, meaning more trams are routed directly into the city centre.

Future Role of LRTs and Trams

In many countries, urban LRT systems have been successfully revived or reintroduced as methods of combating congestion and pollution. There are many excellent examples in Europe, the USA and, latterly, in Japan.

In the UK, Newcastle developed its Tyne & Wear Metro from 1980, largely taking over British Rail (BR) tracks; the London Docklands' fully automatic unmanned LRT serves a large new development area. There are schemes in different planning stages for Birmingham, Nottingham, Croydon and Bristol.

As a proponent of railways, I would like to be able to claim that LRT is the obvious way forward. However, for it to be successful, several criteria need to be met. Among the most obvious are determining the market and ensuring it is of sufficient size. Will it be existing users of public transport, or will it be converts from car users? In the case of Sheffield, there was some ambiguity. As far as passengers are concerned, rapid travel, coupled with high frequencies and reliability are key issues. If the frequency is high, then timetables are unnecessary and the need for real-time information diminishes. The tracked system used by trams disrupts city life in the construction phase. It was so bad in Sheffield that people became unsympathetic towards their new asset. Likewise, the track imposes limits on where the tram can operate. If pollution concerns are the key policy issues, then electric trolley buses may yet make a comeback.

It is clear that if mixed-traffic running is unavoidable, and in old cities, the structure of the roads often makes it inevitable, then the LRT must have priority. If we move to favouring one particular mode of transport, then we have acknowledged that the 'Pull' of the tram needs to be augmented by a 'Push' to force people to change modes, principally from the car. If we are to break out of the spiralling use of the automobile, which is becoming so detrimental to our cities, I think it is inevitable that the unpalatable polices already being perused by some cities, like road pricing, expensive parking and high fuel charges, will have to be sugared with ideas like tax rebates for commuting on public transport.

The technical and engineering challenges facing the designers of LRT systems are not particularly arduous. Lighter, cheaper systems are already on the drawing board; shared-running on conventional track has already been demonstrated as feasible. The real problems lie in the integration of new systems with existing transport infrastructure, and the design of the systems to match the expectations and desires of the potential users. The best technical system in the world will not be successful if it does not hold a place in the hearts and minds of the population it is designed to serve. ■

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