Kerb guided bus: is this affordable LRT?

*With two kerb-guided bus projects operating successfully in Leeds and another having recently been launched in Bradford, **Robert Bain** interviewed **Dr. Bob Tebb** – First Yorkshire's Operations Technical Manager – to find out why Yorkshire is fast becoming the guided bus capital of the world. The interview prompted Robert to look a little closer at guided bus, and its strengths and weaknesses in the context of innovative public transport solutions.*

On Sunday 26th March 1972, trolleybus No. 844 made its way back to the Thornbury depot in Bradford; the last trolleybus to carry fare paying passengers in Britain. Over 60 years of trolleybus operation had ended and the 'motorbus' henceforth reigned triumphant.

That event and its location are significant. Only a decade later with (a) transport planners looking at an impending fuel crisis, (b) much of the local trolleybus infrastructure still in place and (c) trolleybus-trained staff still employed, the potential for the return of the trolleys to Yorkshire streets was very real and was being actively pursued by a number of people. Indirectly, this led to guided bus.

During a fact-finding mission to Europe, local planners and policy-makers visited the guided 'duo-bus' system in Essen, Germany (duo-buses have two drive systems: a conventional diesel engine and a trolleybus-like electric drive system). They returned impressed with how trolleybuses had evolved and, as a direct result, the subsequent Leeds Transport Strategy suggested a local role for the guided bus concept.

Guided bus elsewhere in the UK

The first kerb-guided bus initiative in the UK was Tracline 65 which operated along a former tram line in Birmingham from 1984 to 1987, using double-deck buses. The service stopped after three years, not because of any technical problem, but because – somewhat understandably – this pioneering technology had been deployed on a 'safe' route segment which experienced relatively little traffic congestion. In the recently deregulated environment with many institutional changes, the new operator saw little benefit in continuing with the experiment – despite a reported 26% increase in patronage overall compared to other city services.

Although the concept was being advanced in Yorkshire – indeed, a guideway and equipped vehicle were operated on test from 1989 – Ipswich beat Leeds to the post and launched its own guided bus service in January 1995. The Kesgrave guided bus scheme in Ipswich employs a 200m two-way guideway acting as a bus gate between two housing estates previously without direct road links.

Why guided bus?

An early motivator behind the drive for guided bus in Leeds was the limited land take required by this priority measure. Although the width of a bus is only 2.5m, traditional bus lanes are around 3.75m or 4m wide to allow for lateral movement/displacement. Take steering 'off the bus' – ie. employ a guidance technology – and you can reduce the cross-sectional requirement ('kinematic envelope') to 2.6m. In short, you can locate guided busways in places where bus lanes would be impractical. And, as planners know to their frustration, where urban traffic congestion is at its worst, roadspace is frequently in short supply.

Bob Tebb points out that, although this remains an attractive attribute, two other system features now dominate over space considerations:

- Self-enforcement: Even minor traffic violations (eg. parked cars, abuse by other road users) can significantly erode the potential benefits associated with bus lanes. Guideways with twin concrete running strips – precisely the width of a bus axle – and a grass or gravel area in between physically deter other traffic. (Alternative forms of deterrent – such as 'elephant traps' - are employed on other guideways around the world).
- Accessibility: At bus stops – on the guideway or on ordinary roads – with the appropriate kerb height, the vehicle's guide wheel allows the driver to 'dock' against the stop, achieving uniform close contact to allow easy, level boarding with a fixed 50mm kerb-vehicle gap. As part of the package of quality bus improvements, the East Leeds Scheme partners rebuilt 350 bus stops in its York Road corridor precisely for this purpose – thereby benefiting wheelchair users and those accompanying prams.

Preparing for guided bus in Leeds

The Leeds Transport Strategy was approved in 1991 and envisaged a range of solutions for the city's most heavily congested radial corridors. This was no one-size-fits-all approach. Guided bus was identified for two corridors: the A61 (Scott Hall Road) to the north and the A64 (York Road) to the east. These are both tight, well-defined corridors with an absence, at their inner ends, of the sort of sprawling housing development found in other parts of the city which makes mainline bus service provision less appropriate. Interestingly, from a socio-economic perspective, the former was not necessarily the most attractive in terms of being traditionally strong bus territory. That would change.

Feasibility studies demonstrated that guided bus investment along both corridors represented value-for-money (positive net present value). The more capital intensive York Road proposals (£8m) suggested greater benefits however, due to financial constraints, the Scott Hall Road corridor (£4m) was the first to be introduced. Bob Tebb comments, acknowledging hindsight, that this was a blessing as the lighter bus traffic – and the fact that there was only

Dr Bob Tebb, First Yorkshire's Operations Technical Manager and guided bus guru.

Accessibility is a major attribute of the system. At bus stops with the appropriate kerb height, the vehicle's guide wheel allows the driver to 'dock' against the stop achieving uniform close contact to allow easy, level boarding.

one operator – allowed for an easier learning curve. Critical to the success of the initiative, bus operators across the city supported the guided bus concept from the outset, even those who would not be using the guideways. Furthermore, strong support and goodwill from the other scheme partners (the City Council and the Passenger Transport Executive) created a positive environment dedicated to practical problem solving.

The implementation approach was to identify congestion hot spots along the dual carriageway corridor and to focus attention there, in terms of solutions designed to allow buses to advance to the front of traffic queues. Incremental deployment – possible with guided bus but less so with alternatives – was dictated by financial constraints, funding being made available in £1m/year awards. The selection of kerb-guided technology (see separate box) reflected the fact that other guidance technologies (also separate box) were largely unproven at the time.

The Public Private Partnership (PPP) behind the guided bus initiative has been mentioned already. Initially this involved First Leeds (the bus operator, providing services with high quality, guidewheel-equipped superbuses), Leeds City Council (guideways, bus lanes, signal priority etc.) and Metro, the Passenger Transport Executive (information, shelter provision, stops and so forth). Subsequently the partnership was extended to include another major bus operator (ARRIVA Yorkshire) in the East Leeds Scheme.

Phased introduction

The first section of guideway on Scott Hall Road opened in September 1995. An interesting characteristic of guided bus is that phased introduction leads to the realisation of immediate benefits. New vehicles were deployed but the key service parameters – such as timetabling, routes, scheduled journey times etc – were held constant. The operator reported a 9% increase in patronage in the subsequent two months; enough to cover the cost of the on-vehicle equipment within a couple of years. Other works along the corridor (more guideways, bus lanes and junction remodelling) were progressed as finance dictated.

As Bob Tebb points out, the evolutionary approach to the guideways and complementary enhancement measures along the corridor will continue into the future as new congestion 'hot spots' appear and/or other challenges for bus operations materialise. In the meantime, peak hour journey times have nearly halved and patronage has increased by over 75% since that first guideway deployment. Estimates suggest that between 10% and 20% of new passengers have shifted from car.

The East Leeds quality bus initiative

The East Leeds scheme opened on the 6th November, 2001 and runs along the A64 (York Road), a major trunk radial

Kerb guided bus: What's happening elsewhere?

The first, commercial kerb guided bus operation commenced in Essen, Germany, in 1980, followed by Birmingham in 1984 (see main feature) and then Adelaide, Australia, in 1986. The Essen and Adelaide schemes are comprehensively described in the literature (and on the web: see Internet References) and still operate today, having been extended over the years. So too does a small system in Mannheim, Germany – opened in 1992 and the first scheme to provide docking stops.

Next came Ipswich (1995) closely followed by Leeds (Scott Hall Road [1995], York Road [2001]) and, most recently, Bradford (2002). The Bradford scheme is part of a 3.5km Quality Bus Initiative along the heavily congested A641. The Bus Initiative, a partnership between the First Bradford bus company, the Passenger Transport Executive and Bradford Council, includes 2km of central guided busways in the £7m infrastructure package.

Incidentally, six 'half guided' buses were deployed in Northampton in 1996/97 along one corridor without a guideway. Docking stops were constructed for the low floor buses (with guidearms on the nearside only) to provide the accessibility benefits discussed in the main feature.

Throughout the rest of the UK, kerb guided bus has been proposed (or is being proposed) for Chester, Edinburgh, Leigh, Hull, Oxford and Cambridge. However the most recent announcement about kerb guided bus concerns the ambitious Fastway initiative in the Gatwick/Crawley/Horley area. Costing an estimated £29m, the Fastway network is to be constructed in three phases each taking one year. Approximately £17m of the costs are being funded by the private sector. The route consists of 24km, 3km of which have been designed as guided busway.

Demonstrating that this type of initiative is seldom carried forward by one organisation, the consortium behind Fastway includes West Sussex County Council, Surrey County Council, Crawley Borough Council, Reigate and Banstead Borough Council, BAA Gatwick, British Airways, Metrobus and the Go Ahead Group.

Fastway will commence operations in 2003 and aims to be fully operational by early 2005. For further information about Fastway, contact Liz Oliver at: lizoliver@inhousecommunications.co.uk, or visit the website: www.westsussex.gov.uk/fastway with heavy traffic volumes and serious congestion. As before, it is comprised of a package of measures including new buses, traffic signal prioritisation, 2.6km of new bus lanes, 2.1km of median guideway and enhanced infrastructure (eg. the 350 'accessible' bus stops mentioned earlier).

However it also has some unique characteristics, not least of which is the financial arrangement. Of the £10m total infrastructure cost, the bus operators (First Leeds and ARRIVA Yorkshire) put up £5m, split to reflect the benefits that each would receive from the initiative. Furthermore, this happened in a deregulated operating environment in which any bus operator could take advantage of the enhanced infrastructure. To the extent that there is no exclusive right to use of the guideways, this represented a relatively risky strategy by the bus operators – but one that appears to have paid off.

Due to high passenger demand, both ARRIVA Yorkshire and First Leeds operate double deckers along the York Road corridor. ARRIVA Yorkshire runs 20 and First Leeds runs 37; all Volvo units with TransBus Alexander bodywork. First Leeds also operates some Scania single deckers (identical to those used on Scott Hall Road). Early indications suggest that passengers are responding well to the initiative and both bus operators appear to be satisfied.

The past and the future

Ask Bob Tebb to reflect on the past and gaze into the future and it is clear that he is – rightfully – proud of the kerb guided bus achievements in Leeds and Bradford. He emphasises the importance of safety considerations at each stage in the design and development of the guided bus initiatives, in terms of pedestrian access and pedestrian crossings, and to the extent that the space-saving attribute of the technology has largely been forfeited to provide additional adjacent safety space for pedestrians.

Take space considerations out of the equation and he acknowledges that much of the operational achievement could have been realised with non-guided busways, although at the expense of self-enforcement, the high level of accessibility enjoyed by passengers and with less long-term security for the priority measures' continued existence.

Looking forward, passenger volumes on Scott Hall Road are now approaching levels at which double deck vehicles will be needed there too. Furthermore, equipping the vehicles with GPS-based vehicle location technology will enable the traffic signal prioritisation to be fine-tuned and lends itself to the provision of real-time passenger information. However, returning to a theme he introduced at the start of the interview, he reinforces the fact that guideway development has been conducted on an as-where-and-when basis and that the process of hot spot identification and the partnership approach to problem solving are on-going commitments.

The technology

Kerb guided bus is the form of mechanical track guidance most extensively deployed on buses. As the name suggests, the kerb (or a vertical upstand on either side of the route) is used to steer the vehicle through the use of sensing rollers – or guidewheels – positioned ahead of the bus' front wheels. The guidewheels, using 180mm diameter solid rubber tyres, are mounted on a J-beam bolted to the back of the front wheel assembly.

The bus remains a standard vehicle with standard steering. The only modification to the vehicle that is required is the installation of the guidewheels, protruding 5cm on either side of the bus. This modification adds around £2,000 to the cost of a £120,000 bus. No one manufacturer holds the patent for the guidearm/guidewheel unit (no single vendor lock-in!) and the characteristics vary slightly from supplier to supplier, however the principles and performance remain the same.

Bob Tebb points out that, in this context, the phrase 'guidable bus' is more accurate than guided bus and, indeed, reflects one of the key strengths of this technology – its inherent flexibility. For much of its time – beyond the guideway – the bus performs as a regular service vehicle on the highway and is operated (steered) manually as usual. For this reason, system proponents describe kerb guided bus as offering the best features of road and rail, satisfying both line-haul and feeder/distributor requirements.

The guideway typically comprises two reinforced concrete running tracks with a 1.2m drainage strip (eg of ballast) in the centre. Variants of this configuration exist but the principles remain the same. Tarmac may offer a marginally enhanced ride quality under normal circumstances however can not be used in a guideway because of deformation due to plasticides in the tarmac and the fact that the wheel path is exactly the same during each pass.

The running tracks have a lateral kerb set 2.6m apart. The width from the outer faces of the guidewheels on the bus is maintained at just below 2.61m – giving a slight interference fit which stops the bus 'hunting' (oscillating laterally) while in motion. Having ridden on guided buses, the author can bear testament to the smoothness of the ride.

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Observations and conclusions

Having interviewed Bob Tebb, visited the Leeds guided busway schemes, considered case studies from elsewhere, conducted a literature review (see References) and consulted with a number of professionals and academics in the field, it is possible to draw some conclusions from the kerb guided bus experience and make the following observations:

- As with many transportation initiatives, the success of these schemes relies on a partnership approach with goodwill from all sides. Fundamental to the success of the partnership is a champion with foresight and determination. The Leeds/Bradford experience demonstrates this clearly.
- Given the correct circumstances, financial contributions from the private sector can be harnessed to benefit bus infrastructure development while still making good business sense to those private contributors – even in a deregulated/competitive operating environment.
- Being able to locate guided busways within relatively confined roadspace is an important feature, however self-enforcement and accessibility are really the key system attributes.
- Although the extent of modal shift (private car to public transport) can be disputed and varies from location to location, passengers are attracted to guided bus simply because of its presence – 'the carrot'. There is every reason to believe that this modal shift could be further enhanced through the modest application of some of the 'sticks' available to planners and policy makers.
- By being able to retain the inherent flexibility of the bus, acting as its own system feeder/distributor, the need for separate feeder modes and interchange facilities is considerably reduced. Use of the phrase 'guidable bus' helps to highlight this benefit.
- The negative aspects commonly associated with bus travel (slow, unreliable services due to congestion, inaccessibility, noise, pollution, discomfort and poor, low-technology image) are all system attributes specifically addressed in modern, quality guided bus systems.
- Following on from the above, research in the US and experience elsewhere shows that passengers have no particular preference for rail over bus when service characteristics are equal.
- The benefits of guided bus have less to do with vehicle guidance and associated technologies and far more to do with segregation of road-based public transport vehicles from the general traffic mix, thus ensuring quick and reliable journey times.
- In the UK, the future looks reasonably bright for guided bus, with it having recently been extended in Yorkshire (Leeds and Bradford), with the announcement of the ambitious Fastway initiative – the first guided bus scheme in the south east of England – and with it being actively considered as part of Quality Bus proposals by a number of other towns and cities.
- Cost comparisons between Bus Rapid Transit (of which guided bus is one example) and Light Rail Transit consistently demonstrate that the capital costs associated with bus-based schemes are less than rail-based alternatives, commonly by a considerable margin. In theory, therefore, a city could provide wider coverage of Bus Rapid Transit than Light Rail Transit for an equivalent budget.

Alternative guidance technologies

As part of its preparations for the introduction of the Quayside Transit scheme, a high quality bus service linking the centres of Newcastle and Gateshead with the Quaysides area, the Quayside Transit Working Group commissioned a state-of-the-art review of automatic bus guidance technologies and alternative fuels from the Transport Operations Research Group (TORG) at Newcastle University. One of the intentions of the Quayside Scheme is to run alternatively fuelled vehicles, under automatic guidance, along a section of the North Quayside.

Earlier, in the summer of 1996, a trial was undertaken along part of this section of the proposed route of the Mercedes-Benz/AEG enhanced electronic automatic guidance system as part of the European Commission's LIFE programme. The system utilised a dual underground cable approach and has since also proved successful on the electronically guided Mercedes service vehicles operating in the Channel Tunnel. After the trial, the automatic guidance technology was passed on to a UK-based company, Transport Design International, and incorporated subsequently into the Minitram transportation system.

The Quayside Transit Working Group's investigations have identified a number of health and safety issues regarding automatic electronic guidance systems that are currently being addressed. Similar safety concerns were a contributory factor in the cancellation of the Millennium shuttle service between London and Greenwich.

An alternative approach to automatic vehicle guidance has been adopted by manufacturers Bombardier for its low-floor Guided Light Tram (GLT), whereby small metal wheels run in a central groove in the pavement to assist steering. The transport authorities in the French cities of Caen and Nancy have since adopted this system with tramways operational from 2000/01. However, both systems suffered teething problems, particularly in terms of safety (when transferring between automatic and manual guidance) and noise. These problems led to each system being shut down to allow technical inquiries to take place.

As the main features describes, a number of kerb guided busways have been operating successfully for some time – for example Adelaide, Essen, Ipswich and Leeds. In Paris, a 1.5km guideway forms part of the Trans val de Marne (TVM) busway used by a Guided Light Train and, in Mannheim, guided buses operate on 800m of track shared with trams.

In the majority of the proposals being considered for guided bus in the UK, kerb guidance is the preferred approach, although electronic automatic guidance was a strong contender for the Mersey Waterfront link in Liverpool.

Recent developments in automatic guidance technology have seen the demonstration, in July 2000, of the Translohr vehicle by manufacturers Lohr. This system uses two front rollers running on a central guideway to steer the vehicle. Under automatic guidance, power may be supplied overhead via a pantograph although other fuels are being considered when running under manual guidance. The CIVIS project involving Neoplan and Renault-Matra is investigating optical guidance technologies. Field trials of a system began in February 2001, (picture above) involving a dashboard-mounted camera, a video-monitoring system and a road-marking recognition system. Plans are to implement the system in North Las Vegas along the northern section of the Las Vegas Boulevard. Neoplan has also been involved recently in the development of a guidance system based on conductor loops embedded 20-30mm into the pavement. A similar system was tested as early as 1984 in Furth by MAN, Bosch, Mercedes-Benz and Dornier.

Additional reporting by Neil Thorpe and John Nelson, TORG, Newcastle University

BRT in the US

Bus Rapid Transit (BRT) in general is currently receiving considerable attention in the United States as transit agencies seek to improve the reliability and speed of local services. Various measures are used including dedicated busways, high occupancy vehicle lanes and traffic signal prioritisation techniques.

In September 2001, the US General Accounting Office reported to Congress the findings of a study which sought to:

1. Examine the Federal role in supporting BRT;
2. Compare the capital costs, operating costs and performance characteristics of BRT and light rail schemes;
3. Describe the other advantages and disadvantages of BRT and light rail.

The study concluded that:

- BRT systems generally had lower capital costs per mile than the light rail systems in the cities reviewed.
- Neither system had a clear advantage in terms of operating costs.
- Dedicated busway costs ranged from \$7m/mile to \$55m/mile with an average cost of \$13.5m/mile.
- Light rail systems had capital costs ranging from \$12.4m - \$118.8m/mile, with an average cost of \$34.8m/mile.
- The largest BRT system ridership was about equal to the largest light rail ridership.
- BRT routes showed generally higher operating speeds that light rail lines.
- BRT provided a more flexible approach than light rail because:
  - i. Buses could be routed to eliminate transfers
  - ii. Buses could be operated on busways, HOV lanes and city arterial streets
  - iii. BRT could be implemented in stages.
- In general, buses have a poor public image but BRT systems can be designed to offer improved service over standard bus services.
- As light rail is permanent in a corridor, it could influence economic development over time and that could help to justify the higher capital cost of light rail.

Although not focussed on guided bus, the full Congressional report (Mass Transit: Bus Rapid Transit Shows Promise) makes fascinating reading. It can be downloaded from: **www.gao.gov/new.items/d01984.pdf**

- The costs associated with guided bus and the time taken for its implementation suggest that, even where Light Rail Transit or other transport technology may be the preferred long-term solution, guided bus could have a role as an interim measure, providing early service enhancements and protecting the right of way in readiness for further development.

In closing, it would appear that, in the debate of urban bus versus urban rail, advocates of each technology have become more entrenched in their views over the years. This, despite the fact that the choice has become manifestly more difficult to make – not simpler. Each case needs to be judged on its merits in the specific local circumstance within which it is being considered. Some politicians may continue to favour the 'monument status' of light rail, but as the competing system features continue to converge – through initiatives such as guided bus – passengers' preferences will be expressed more vocally in terms of system performance, not system technologies.

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Robert Bain is a PhD research student at ITS, Leeds. He can be contacted at: rbain@its.leeds.ac.uk