A bus-based transitway or light rail? Continuing the saga on choice versus blind commitment

Abstract

Over the last fifteen years, we have seen the (re)introduction of trams (or light rail) as a suggested 'solution' to delivering public transport at a lower cost than heavy rail in the low to medium density trafficked corridors. As an alternative, bus-based transitways are also coming into vogue, but are often compared with light rail and frequently criticised in favour of light rail on the grounds of their lack of permanence because of the opportunity to convert the right-of-way into a facility for cars and trucks. In this paper, we consider the evidence on the costs and benefits of light rail and bus-based transitway systems, with particular attention given to the biases in the positions taken by advocates of either form of public transport. The lessons to date reinforce the importance of delivering seamless transport services with good geographical coverage and sufficient flexibility to respond to changing market needs if we are to make a difference to the dominance of the automobile.

Refereed Paper

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INTRODUCTION

In most cities, buses move more public transport passengers than any other public mode. Buses, however, operate mainly on mixed-mode infrastructure, competing with cars and trucks, a regime that has not, in general, favoured bus services. This has provided a strong argument in support of rail systems on dedicated right-of-way, free from the movement constraints of competing modes. The rail emphasis, however, has often come at a great expense (with non-commensurate benefits), especially in corridors where the traffic levels are quite low (Richmond 1998; Mackett and Edwards 1998), and door-to-door connection is a major influence on mode choice.

Over the last fifteen years, we have seen the (re)introduction of trams (or light rail) as a suggested 'solution' to delivering public transport at a lower cost than heavy rail in the low to medium density trafficked corridors. Very few light rail systems have proven 'successful' on the criteria used to justify their construction and operation, such as reducing car use (see below), raising fundamental questions about the viability of public transport in general and light rail in particular. The lessons to date reinforce the importance of delivering seamless transport services with good geographical coverage and sufficient flexibility to respond to changing market needs if we are to make a difference to the dominance of the automobile. The potential for dedicated bus-based infrastructure along major corridors with efficient interchanges and bus distribution deep into suburbia is recognised as having such potential, yet has been neglected internationally (with few exceptions such as Ottawa and Curitiba) relative to light rail. London Transport Buses, in its Annual Review 1998, has recently renewed the call for the 'establishment of segregated busways' stating that '... it is now time to be more positive in taking road space from the private car'.

Bus-based transitways are often compared with light rail and frequently criticised in favour of light rail on the grounds of their lack of permanence because of the opportunity to convert the right-of-way into a facility for cars and trucks (Smith and Hensher 1998). Hensher and Waters (1994) and Richmond (1998) have put the case for bus-based transitways as a preferred option in most urban contexts where light rail has been evaluated. For many years, the arguments for and against light rail and bus-based transitway systems have persisted, with light rail often the victor on ideological grounds. Unfortunately, light rail is increasingly the purveyor of substantial debt and operating subsidy (Mackett and Edwards 1998; Richmond 1998).

One very positive outcome of the ongoing light rail 'debate' is a recognition of the need to consider a larger set of public transport options than has traditionally been the case (including non-investment outcomes such as pricing and regulation) under a reasonable set of patronage assumptions. Notable comparative studies include Stone *et al* (1992), Kain (1988, 1990), Biehler (1989), Nisar *et al* (1989), Richmond (1991, 1998), Pushkarev and Zupan (1980), Pickerell (1984, 1991, 1992), Smith and Hensher (1998), Mackett and Edwards (1998) and Taylor and Wright (1984).

The majority of bus-based schemes in most countries have generally been tried on a smaller scale than is necessary to give real advantages to buses (Stokes *et al* 1991; Batz 1986; Pettigrew and Angus 1992; Richmond 1998) and to compare them meaningfully with light rail. Typical transit lanes are usually not long enough to have a competitive effect with alternative public transport options or the automobile. It is not valid to compare the impact of short bus lanes with longer dedicated-way transit systems. However, there are some important examples of longer distance bus-based transitway operations in the USA, Canada, Brazil and Australia. The longer bus-based transitways such as the Shirley Highway into Washington DC from Virginia is 19.2 kilometres with two reversible priority lanes in the median. The San Bernardino bus-based transitway in California is 18 kilometres (Gordon and Muretta 1983) and the Route 55 HOV lane in Orange County is 20 kilometres (Giuliano et.al. 1990). The 12-kilometre Adelaide (South Australia) O-Bahn (or Northeast Busway) and the system in Rochefort (Belgium) are fully grade-separated from all other roads, and passenger interchanges are widely spaced, allowing running speeds of up to 100 km/h (Chapman 1992). The M2 tollroad in Sydney, New South Wales has 16 kilometres of dedicated busway with buses running at capacity patronage during the peaks. A series of express bus-based transitways covering 55 kilometres are in place in Curitiba (Brazil) which occupy the median of each road, separated from slow-moving traffic lanes by pedestrian islands (Herbst 1992). Ottawa (Canada) has installed extensive dedicated bus-based transitways. The relevant comparisons between bus and Light Rail Transit (LRT) should focus on examples of these lengthy bus-based transitways.

We consider the evidence on the costs and benefits of light rail and bus-based transitway systems, with particular attention given to the biases in the positions taken by advocates of either form of public transport.

TAKING A CLOSER LOOK AT LIGHT RAIL AND BUS-BASED TRANSITWAYS

A Return to the Past or a Genuine advance in Technological-led improved Accessibility?

> *'Yet another male politician, Alliance's list MP Grant Dillon, comes out in favour of light rail as the panacea to Auckland's transport problems, overlooking the fact that a lot of relatively cheaper bus lanes are failing to eventuate, due to cost. Buses are, therefore, neither as full nor frequent as they should be in a city of over 1 million people. I wonder if these men have ever given up playing with their Meccano sets?' Jan O'Connor, Takapuna, Letters to the Editor, New Zealand Herald, March 7, 1997.*

An increasing number of 'new' urban public transport systems are being developed in cities around the world, particularly light rail. The main objective of building such systems is to reduce car use, and so reduce road congestion and environmental damage. In many cases, the systems are expected to stimulate development.

As a way of achieving these objectives, what is the evidence that light rail rather than a bus-based transitway system or a less technologically driven 'solution' to improved public transport services is the way to go? The evidence consists primarily of two types: the costs of alternative systems and their effectiveness in attracting patronage (especially from car use). A third criterion, often implicit, is the impact on land-use and future travel patterns. This is alleged to be an important advantage of LRT systems.

Strong views exist on the merits of light rail as a preferred alternative to dedicated bus-based transitway systems. Why did many of these cities supporting and building light rail not consider having a very flexible bus system on the dedicated alignment, which has the capability of offering much better door-to-door service than a very inflexible fixed rail system? The answers are relatively simple — the adage that 'trains are sexy and buses are boring' (quoted from the Mayor of Los Angeles) says it all. We have previously described this as 'choice versus blind commitment' (Hensher and Waters 1994).

When the evidence suggests that one can move three times as many people by dedicated bus-based transitway systems for the same cost, or the same number of people for one-third of the cost as light rail, one wonders about the rationality of urban planning. For example, Wentworth (1997) concludes, from a review of the proposal to extend the light rail system in Sydney between Central Railway and Circular Quay, that a re-designed bus system would provide a better immediate result at a greatly reduced cost. He asks:

> *'... perhaps the investors themselves may have been taken for a ride by professional promoters... Or is it just an innocent mistake? The only thing clear is that there is something fishy about the whole affair.'*

The New South Wales Government has recently announced a bus-based transitway in preference to LRT for a 20 km transitway between Parramatta and Liverpool, two of the major regional centres in Sydney. The proposed Liverpool–Parramatta Transitway (LPT) is an innovative development in the provision of infrastructure tailored to the specific needs of bus transport. Existing transit ways (T2, T3 lanes) make a contribution, but they are limited in their ability to deliver sizeable benefits through time savings and seamless transport service to passengers and operating cost savings to bus operators. The LPT provides a real opportunity to deliver substantial benefits to operators and passengers. With appropriate planning and design, the opportunity exists to provide almost seamless door-to-door public transport services, with buses on the existing networks connecting into the LPT.

The LPT feasibility study compared light rail with a bus-based transitway and concluded that the bus system was significantly better in delivering higher levels of frequency (typically every three minutes compared to every nine minutes for LRT) with lower incidence of transfers compared to using a feeder bus to connect to light rail. Since transfers are a major source of dissatisfaction, this is a crucial issue in attracting patronage. Although LRT costs per passenger kilometre are often argued to be lower than for bus systems, these comparisons are usually spurious because they are based on theoretical

capacity and not on actual patronage. For LRT to provide an effective level of service it most likely has to operate at a frequency which does not maximise patronage on each trip. If this is the case, the advantage of light rail on operating costs per passenger kilometre is eroded. On construction costs, an integrated bus rapid transit system in Sydney can be expected to cost, at grade (in $M / km), based on the Brisbane Busways experience, from $0.1M / km with shared use of existing road, $1M / km with widening of an existing road and $1.5M / km in an exclusive corridor. In contrast LRT under the same three corridor contexts is respectively (on advice from GHD Transmark, March 1998) $3.4M / km, $2.10M / km and $2.02M / km.

The Brazilian experience of Curitiba, Porto Allegre and Sao Paulo supports the contention that, under appropriate regulation, organisation and capital investment, bus based transit systems are capable of transporting large volumes of passengers at reasonable speeds for minimal capital and operational costs. Table 1 illustrates this capacity by a comparison of the volumes achieved by bus-based transitways in these cities with a number of heavy rail corridors in the Sydney metropolitan region.

On the evidence, bus-based transitways function as efficient high volume transport corridors where the operations are adapted from traditional bus practice and where substantial infrastructure investments are made in bus stops, terminals and vehicle types. Advantages of bus-based transitways over rail-based systems, such as the avoidance of transfers at terminals and the use of standard equipment, may correlate negatively with the capacity the bus-based transitway can achieve. Certainly the most successful high-volume bus-based transitways in Brazil require both passenger transfer and specialised equipment. On the other hand, where bus-based transitway systems are based merely on providing road space for operators to utilise (as in Porto Allegre), this results in low operating speeds and low productivity.

Although previous research has suggested that bus-based transitways on the Porto Allegre model could efficiently transport 39,000 passengers / hour (Cornwell and Cracknell 1990), operating experience in Brazil does not confirm this figure. The current maximum volume carried on an efficient bus-based transitway (i.e. with an average speed greater than 20km / h) is 11,000 passengers / hour in Curitiba, and where volumes exceed this, the average bus speed drops towards that of the surrounding traffic flow. It remains to be seen whether the Curitiba 'surface subway' and the proposed systems in Sao Paulo will be capable of both moving 22,000 passengers / hour volume and maintaining average speeds in excess of 25 km / h, as predicted.

Nevertheless, the existing bus-based transitways can provide an equivalent capacity to an LRT system, at a fraction of the capital costs. As Cornwell and Cracknell concluded:

> *'The capacity of a well designed and efficiently managed busway can be equivalent to that of an LRT, on a comparable basis (for example, degree of segregation; stop spacing).' (Cornwell and Cracknell 1990, 195)*

and that

Table 1

Volume Of Passengers Using Transport Corridors In The Peak Direction Of Travel During The Peak Hour

City	Mode	Line	Pax / Hour
Curitiba	Busway	Pinheirinho	11000
Porto Allegre	Busway	Assis Brasil	20000
Sao Paulo	Busway	Santo Amaro	25000
Sydney	Heavy Rail	Carlingford	400
Sydney	Heavy Rail	Bankstown	5700
Sydney	Heavy Rail	Bondi Junction	6200
Sydney	Heavy Rail	Chatswood	11900
Sydney	Heavy Rail	Parramatta	14800
Sydney	Heavy Rail	Strathfield	28000
Sydney	Bus Lane	Military Road	6700

Source: Smith and Hensher 1998

> *'... it should be noted that despite the current wave of LRT proposals, and the considerable resources which have been invested in various LRTs (Manila, Hong Kong, Rio de Janeiro etc.), the consultants know of no LRT in a less-developed country which outperforms the busways surveyed in terms of productivity (passenger volumes x speeds).' (Cornwell and Cracknell 1990, 200)*

In interpreting comparisons between LRT and bus-based transitway systems, it is important to note the contrast between 'theoretical' capacity and capacity achieved.

In summary, the evidence from a survey by Mackett and Edwards (1998) suggests that, in general, the impacts of light rail compared to bus-based systems are very limited in scale. The difference occurs because the evaluation framework that is often used as part of the development process usually ignores the latent (i.e. unsatisfied) demand for car use and so is liable to predict higher levels of patronage on the new system, and greater reductions in car use and consequential effects, than will be the case. Furthermore, the forecast patronage on the new systems often do not justify the construction of light rail (except where estimates have been inflated), but the planning and legislative framework under which schemes are developed (notably in Britain and the USA) militates against innovation and more cost-effective systems (Edwards and Mackett 1996). This suggests that there is a need to adopt funding formulae that relate levels of local and non-local expenditure to the overall benefits more carefully. There is substantial evidence from the literature that expenditure on new rail-based schemes diverts resources away from bus routes used by the lower-income segment with no alternative mechanised mode of travel (e.g. Richmond 1998).

MORE ON THE COST OF ALTERNATIVE SYSTEMS

Pickerell (1984) updated by Richmond (1998) compared actual bus system costs with best practice light rail costs, where buses are local services operating on congested roads. Pickerell uses Pushkarev and Zupan's concept of a rail/bus threshold, defined in terms of passenger miles per lane mile and peak hour passengers in the peak direction assuming an average trip length of 8 kilometres, and bus operating speed of 12 mph. Pickerell shows that the bus/light rail breakeven point for little or no grade separation is 21,000 peak hour passengers in the peak direction, 37,000 with considerable light rail grade separation, and 61,000 where grade separation is accompanied by a one-fifth tunnel. When buses are assumed to operate on exclusive or congestion-controlled right-of-ways, they are able to attain speeds equal to or higher than light rail (Kain 1988) and hence the breakeven peak hour passengers will be much higher. Pushkarev and Zupan (1980, xiii), a much cited report by advocates of light rail, suggests in a comparison with high-performance bus systems, a breakeven for LRT of two to three times as high as the thresholds reported above, i.e. 42,000 to 180,000, depending on grade separation of light rail and level of service. The choice of base line bus alternative is extremely important in any comparison.

Comparing light rail with the average for buses is not very useful because it fails to compare the performance of equivalent types of service and fails to demonstrate the impact of implementing new rail service on total system financial performance. It is essential to compare rail performance to that of equivalent density bus services and to include the productivity of new feeder bus routes whose costs are 'caused' by light rail, but which light rail management never includes with light rail costs in assessing the rail system's financial performance. The evidence suggest that bus services which are typical of those replaced by rail services have much higher productivity than bus systems in general (benefiting from economies of density); in contrast, the new feeder bus services to support the rail network run at much higher costs and hence lower productivity than the bus system as a whole (derived from the Institute of Transport's International Benchmarking subscription program for the bus and coach industry).

A comparison of the life cycle costs of providing bus services compared to light rail in Los Angeles (using the construction and budgeted operating costs of the LRT Blue Line) leads to a conclusion that for the same level of funding, Los Angeles can either afford to build and operate the Blue Line for 30 years or operate 430 buses for 33 years, including the cost of building the operating divisions to support these new buses. For the same cost, however, the buses would produce over four-and-one-half times as many passenger kilometres and carry over nine times as many passengers (Rubin 1991). The decision to go with rail transit appears to have little economic or

social basis. One can only surmise that there may be a physical planner's implicit assumption in the decision — that rail systems, unlike bus systems, can shape land use and that this alone is sufficient reason for justifying high levels of rail subsidy. As discussed in a later section, we find the 'evidence' that rail *per se* is more powerful than bus-based transitways in shaping land use is somewhat questionable. There are ways of combining any form of transport with incentives / disincentives through land use legislation and / or pricing to achieve an outcome supportive of public transport.

Stone *et al* (1992) compare a guideway bus priority system and light rail in an active rail corridor, under modal splits ranging from 0.5% to 50%. The LRT system operates on the existing rails with new bridges and track as needed for the dual guideway system. Thus we have a situation of a relatively expensive bus priority system and a relatively inexpensive light rail system. The LRT system utilises the existing dual track structure and bridges in the first 12 kilometres of the rail corridor, with new single track and bridges being built to complement the remaining 13 kilometres of single track. The dual guideway (similar to the O-Bahn in Adelaide) requires separate structures at all existing and new grade separations. Some additional cut and fill is necessary to build the parallel guideway. While both options have approximately the same travel time, the bus priority system costs 30% less than the LRT system. Stone *et al* state that the high capacity of light rail cannot be exploited without future increases in transit demand (something which plagues all public transport), a feeder bus system, and land use changes favouring higher ridership (an issue which is controversial, although see the Ottawa experience through regulation, discussed below). The inherent lower cost of the bus-based transitway reduces financial risk while its off-guideway flexibility automatically broadens service opportunities.

A study of public transport options in Canberra (Denis Johnston and Associates 1992) suggests that a bus-based transitway is more cost efficient than light rail. All operating and maintenance costs excluding depreciation and interest are $3.00–$3.50 per vehicle kilometre for a bus-based transitway and $3–$5 per vehicle kilometre for light rail, and capital costs are approximately 50% lower for a bus-based transitway. They argue, however, in support of light rail because it has the advantage of permanence due to its fixed track characteristic, the latter providing greater confidence for developers and other investors in ways which aid public transport use. The legislated procedures implemented in Ottawa and Curitiba, however, provide strong examples of how bus systems can also achieve such benefits, without relying on the argument of fixed track in order to secure the characteristic of permanence (Smith and Hensher 1998).

The Canberra study indicates that there is no strong evidence that patronage would be significantly different for a bus-based transitway or light rail, throwing doubt on the reported operating costs per passenger kilometre (4.5 cents and 3 cents respectively for conventional on-road bus and light rail), which assume higher loadings for light rail. The opportunities to achieve patronage levels in the ranges supportive of light rail are remote indeed. Any visitor to Canberra will notice the general absence of traffic congestion and existing bus services with unacceptably low passenger loads, throwing doubt on the wisdom of any major investment in light rail or a bus-based transitway, given Canberra's urban strategy. Seven years on, no decision has been taken on light rail although the popular view in planning circles in 1999 is that a bus-based system on *existing* roads makes eminently better sense, given the low patronage estimates.

Curitiba, in Brazil, introduced a bus priority system at a cost of $US54million, 300 times less than a subway and also less expensive than light rail (Herbst 1992). Curitiba's buses transport 1.3 million passengers per day, four times the number of subway passengers in Rio de Janeiro (a city of 10 million residents, more than six times the size of Curitiba).

Pittsburg opted for exclusive bus-based transitways in preference for LRT. In a comprehensive review of the Pittsburgh experience contrasted with a number of LRT projects in Buffalo, Pittsburgh, Portland, Sacramento and San Diego, Biehler (1989) concludes that

> *'…busways offer an advantage over light rail for many applications due to their attractiveness to riders, cost-effectiveness, and flexibility.' (Biehler 1989, 90)*

The South Busway, opened in 1977, is 6.4 kilometres, primarily at grade with one section in a tunnel. The East Busway, opened in 1983, is 11.2 kilometres entirely at grade except for a one-third kilometre elevated section. The LRT systems, against which the bus-based transitways have been evaluated, are

still making adjustments to maximise patronage, in particular utilising the bus-feeder concept as part of an overall public transport system.

Although any comparison of systems located in different urban areas is problematic, nevertheless some amount of comparison is permissible in order to form a judgment on the relative merits of each system. As of 1987, the unit operating costs for each system are $0.43 for Pittsburgh East and $0.56 for Pittsburgh South. These estimates compare with the LRT range of $0.85 (San Diego) to $1.50 (Pittsburgh). We recognise the inadequacy of such a measure of effectiveness, despite the striking differences in costs.

The most telling evidence is provided by Kain and Liu (1995) who compare the operating and capital costs of San Diego light rail with an equivalent bus system. Most comparisons between systems (especially in the USA) use operating costs per boarding as their performance indicator, in contrast to a total cost per boarding, the latter including capital costs. Kain and Liu (1995) conclude that San Diego's LRT operating cost per trip is substantially lower than any of the bus operators. In contrast the San Diego bus transit system has the lowest fully allocated capital and operating cost per boarding by a significant margin.

Figure 1 shows that LRT systems are not moving any more people per hour during the peak than could be handled by one lane of a freeway. In contrast, bus and high occupancy vehicle (HOV) lanes do move more people than would a freeway or an LRT with modest ridership. The HOV lanes look particularly good since they achieve higher utilisation of the facility than one restricted to transit vehicles only. But note that even bus-only lanes (e.g. Houston, Pittsburgh) outperform the LRT lines listed. The important implications of this comparison in Table 2 are: (i) the bus-based transitways are shorter in length than the LRT lines, (ii) they carry about the same number of passengers per day (at higher rates of ridership because of shorter length), and (iii) they cost about the same per kilometre to construct as the *lower* end of LRT cost estimates.

MORE ON PATRONAGE?

An obvious consideration in any debate on modal futures is the capability of a mode to attract patronage. The previous sections noted several examples showing that bus systems can service more passengers per dollar than LRT systems. Much of the literature on LRT ignores the demand side of the picture, concentrating on issues of costs and technology. Presumably the basic purpose of urban passenger transport is to provide the technological basis for mobility in order to give people the accessibility they require. It is not to transport subsidised fresh air. It is somehow assumed in most commentaries on LRT that there is a sufficiently strong demand to justify a (subsidised) public transport service, and that the consequences on the environment are net positive. Indeed, official projections of light rail system ridership have erred substantially on the high side. For example, the actual ridership on the Portland LRT (cited by Newman and Kenworthy (1999) as an example of best practice) was only 45% of the official forecast (Gordon and Wilson 1985).

In the United States there have been many instances of massive over-forecasting of the impacts of new rail systems. It has been suggested that local politicians and planners are so keen to obtain a new light rail or metro system that their enthusiasm has outweighed their judgement (Richmond 1998).

The Portland (Oregon) light rail line diverted 6,500 daily trips from the automobile out of a total of nearly 4 million daily trips (Hensher 1992). This is equivalent to less than 50 days of natural travel growth in total person trips over the last 10 years in the metropolitan area. In Los Angeles, the number of new rail transit trips since the entire Blue Line opened is 21,000 out of 38 million daily trips (with 63% diverted from bus). The days gained from the Blue Line in Los Angeles are estimated as equivalent to fewer than 5 days of natural travel growth over the last 10 years. The implication is that the entire proposed light rail investment of nearly $US2 billion in Portland and $US6 billion in Los Angeles might 'buy' a year's growth (Cox 1991).

The overriding evidence suggests that up to 70 per cent of new rail patronage is diverted from bus (an experience reproduced in Sydney and Perth), with buses re-routed to serve rail interchanges. The Blue Line in Los Angeles is indicative of one such outcome. The Blue Line has a taxpayer cost of $US21 per rider per day. Since few of its riders are former drivers (as opposed to bus users), the system costs taxpayers $US37,489 per year for every car it currently removes from the freeways. A comparison of the life cycle costs of providing bus services compared to light rail in Los Angeles (using the construction and budgeted operating costs of the LRT Blue Line) leads to a conclusion that for the same level of

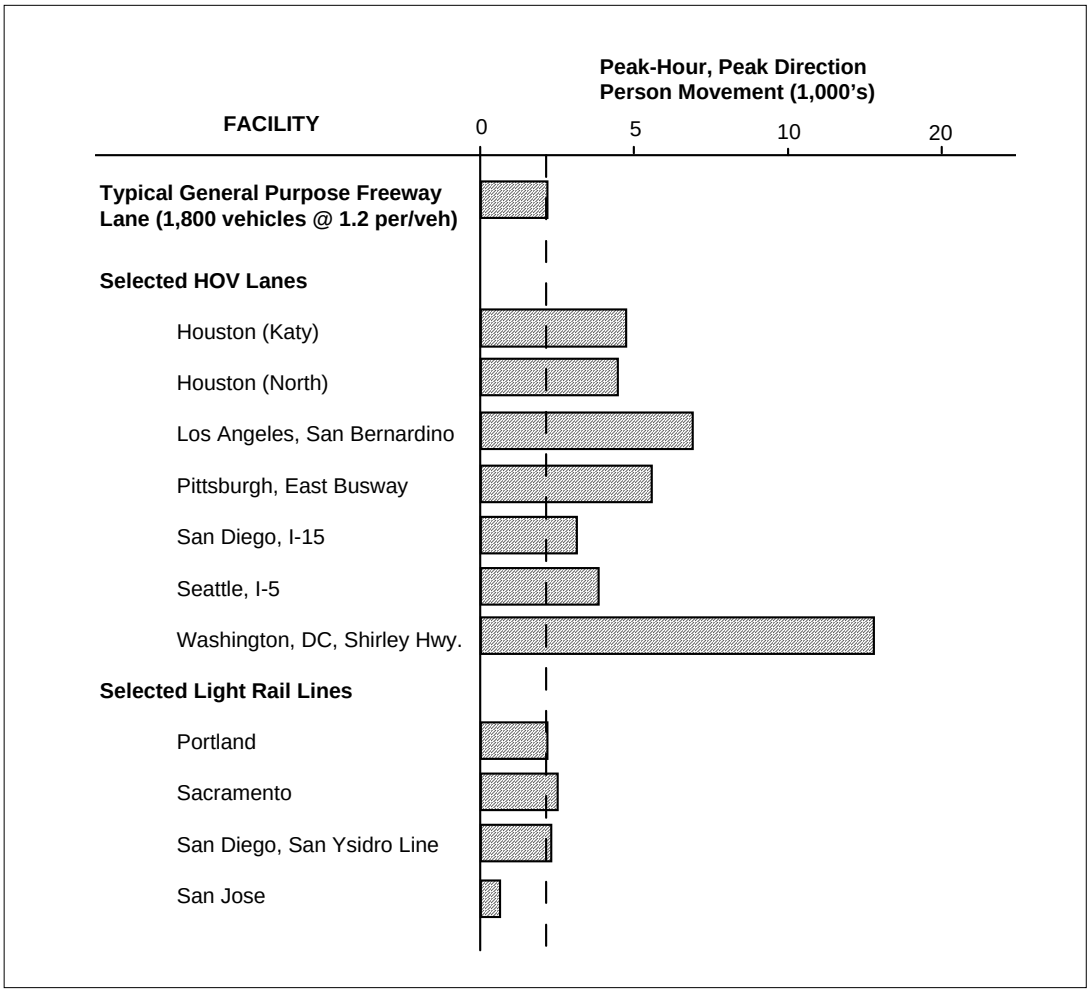

Figure 1
A Comparison of Ridership Rates of a Number of USA Bus-based transitway Systems and LRT Systems (the LRT systems selected are regarded as the most 'successful', especially San Diego)

funding, Los Angeles could have either afforded to build and operate the Blue Line for 30 years or operate 430 buses for 33 years, including the cost of building the operating divisions to support these new buses. For the same cost, however, the buses would produce over four-and-one-half times as many passenger kilometres and carry over nine times as many passengers (Rubin 1991). This result is reached even though the assumptions made tended to favour the Blue Line on several important issues.

The Northern Suburbs Transit System (NSTS) in Perth, West Australia, which opened in 1992, attracted both previous car and bus users, with 64% of its patronage coming from bus. When the impact of road traffic is calculated, we find that the vehicle volumes per week day have dropped by less than 2,800 vehicles out of a total of 100,000, or 2.8% (Luk et al 1998). This is very small and raises questions about the value of an expensive heavy rail system which impacts significantly on a bus system and little on car demand. A dedicated bus-based transitway on the existing expressway may have been a better proposition. The Gold Coast railway in Queensland is another example of a failed effort to attract drivers out of their car — its primary source of patronage is ex-bus travellers. Is this really the way to redress the imbalance?

Sydney has also embraced the *old idea* of inflexible public transport with the return to its streets of a steel-on-steel light rail system between Ultimo and Pyrmont in southern central Sydney. We are now seeing the mingling of trams with cars and buses as the street system struggles to cope with another form of old public transport which competes with walking and buses far more than it has attracted individuals out of their cars. Even with high parking prices in and near the Central City of $8 per day on average (see Hensher and King 1999), this increased accessibility

offered by more public transport technology has done little more than provide an interesting tourist attraction and satisfy the needs of those who believe in trains as the only form of public transport.

The new Sydney Star City casino is expected to be a major traffic generator. Indeed, so important was the Casino in early discussions with Government that a risk provision in the privatisation contract stated that 'If the permanent Casino opens for trading more than 12 months after the light-rail is completed, or after 31 March 1998 if this is a later date, the Department of Transport will be liable to pay the Pyrmont Light Rail Company $8,219 per day until the Casino opens'. This says a lot about patronage risk from other sources. As of late February 1999, the patronage levels are well below forecasts with a peak in the very early hours of the morning as casino staff return home. Mees (1998) undertook a survey of Sydney light rail passengers in mid-1998 to investigate the sources of patronage and found that the main passenger groups are tourists and Star City employees. She also found that '…light rail in Sydney has limited impact on reducing car use, and the majority of passengers are attracted from pedestrian or other public transport services, hence is directly competing with other sustainable modes' (page 13).

A cost benefit comparison of LRT and an exclusive bus-based transitway applicable to Sydney (Ip 1992) under peak loads varying from 1,500 passenger car units (pcu) per hour to 4,500 pcu per hour and total daily one-way flow from 15,000 pcu to 70,000 pcu, produced benefit-cost ratios varying from 0.94 to 5.43 for LRT and 1.09 to 7.32 for a bus-based transitway. In all cases, the bus-based transitway had a benefit-cost ratio significantly higher than LRT, even allowing for a 25% higher level of patronage using the LRT than the bus-based transitway system. The usefulness of these figures, however, is critically dependent on patronage assumptions.

Limited consideration is given in the literature to incentives required to get people out of their cars and to increase rail use to a level which does not require massive subsidy. There is a strong presumption that the argued merits of rail systems such as environmentally friendly high capacity with typically low fares will provide the necessary incentives. Despite the best of intentions, the failure in the last 20 years to attract significant levels of new patronage to rail is in large measure due to the lack of disincentive to using the car (Hensher 1998).

A common conclusion from many investigations of new light or heavy rail in the major Western capitals with densities typical of USA and Australian cities *and* inefficient prices is that rail systems cannot attract sufficient patronage to justify them:

> *'Unfortunately, the more we learned about the cost and ridership of this proposal, the more convinced we became that it does not deserve legislative or public support. Our opposition is dominated by one simple, general conclusion – Metropolitan Council and Regional Transit Board projections establish clearly that LRT would attract so few people from driver-only cars that it could not* significantly *increase transit ridership.' (Citizen's League, 1991)*

Richmond's 1998 update for the USA and Canada reinforces and extends the conclusions of Pickerell (1984). In the words of Richmond:

> *'Optimistic claims that new urban rail systems would increase transit patronage, reduce congestion, and improve the environment while at the same time improving the financial performance of transit systems have proved incorrect in most instances. …The evidence shows that the capital funds spent have generated few benefits.' (Richmond 1998, page 39)*

One of the most disturbing features of the rail bias is the damage it has done to bus operations.

> *'While rail's contribution to increasing transit ridership … has been mostly minimal, changes in bus operating practices designed to accommodate rail have generally had a negative effect on the financial productivity of the transit systems concerned.' (Richmond 1998, page 39)*

A growing concern in any comparisons between bus-based transitways and light rail is the quality of the data on patronage. In the USA most data are for unlinked trips (or boardings) and not complete journeys (i.e. linked trips). This means that a previous bus traveller who may have had a single bus trip but now is forced through loss of service to use the new bus to rail station and rail alternative is actually recorded as two unlinked trips. Such reporting has tended to inflate the true amount of travel by public

transport. It is ironical that a degradation of service levels creates an increase in the number of unlinked trips which are used by proponents of light (and heavy rail) to promote the virtues of rail as a attractor of increased patronage.

Indeed, when linked trip data is used, there usually is a noticeable loss in patronage to public transport due to the diminution of service levels through patrons being forced to change modes consequent on a loss of the cross-regional bus services. Rail ridership in the USA and UK has been encouraged by the simple expedient of taking alternatives away. The general pattern has been to discontinue through bus services and instead terminate them at suburban light rail stations. The number of passengers attracted to rail who are 'new' to transit are in most cases insubstantial. The Denver experience is an excellent example of this outcome:

> *'In no case has new rail been shown to have a noticeable impact upon highway congestion or air quality; although the Denver light rail system has satisfied the objective of removing from center-city streets buses diverted to terminate at light rail stations.' (Richmond 1998, page 40)*

Gross ridership figures for light rail in places such as San Diego and Portland may seem impressive. However, a total systems perspective shows that the total impact on public transport patronage is not only slight but also that equal or better results can be obtained from relatively minor adjustments of fare levels and low cost improvements to existing bus services. The West Australian heavy rail, and the Gold Coast and Sydney light rail investments are very good examples of this outcome. Hardly something to be proud of and giving great civic pride. A common comment in Sydney is that few people seem to be using the light rail system.

The argument that light rail (in contrast to bus-based transitways) is needed to catalyse changes in travel patterns is questionable. While it is the case that the Blue (South) Line in San Diego is a very successful project in providing the rallying point for transit development (and its financial performance is impressive), it is the exception rather than the rule. It is well behind the Ottawa bus-based transitway on financial performance. However, Pittsburgh's busway system, like Ottawa and Curitiba in particular, provide impressive counterarguments to the claim that light rail is needed to catalyse changes in travel patterns. Originally built with the idea of using a bus-based transitway as a transition plan towards light rail (like so many of the proposals), its success has resulted in management losing interest in light rail and pursuing further development of the bus system. Ottawa, Pittsburgh and Miami all contradict the notion that buses cannot provide the capacity of light rail. As Richmond says '…The moral is that high-performance but less glamorous projects can gain local acceptability once success has been demonstrated' (Richmond 1998, page 44).

One wonders why we are investing such large sums into rail systems when the returns are so poor and expensive per additional passenger trip, and the success in attracting people out of their cars is so miniscule. The same arguments, but for lower cost, may well apply to bus-based transitway systems but the financial risk is considerably less.

IMPACTS OF PUBLIC TRANSPORT FACILITIES ON LAND USE

All forms of transport infrastructure have some impact on land use, be it freeways or public transport. The real issue is to what extent there is a linkage between the provision of particular types of public transport and land use. In particular, does LRT have land use impacts that are different from bus-based transitways, and is the difference substantial and desirable?

Using property values as a surrogate for land development impacts, not an unreasonable assumption, a survey of 2,500 properties in San Diego concluded that property values are determined by factors other than LRT (Urban Transportation Monitor, August 21, 1992). The study compared similarly developed properties adjacent to the transit facilities, properties that were outside the influence of LRT, and properties that were operating prior to the advent of LRT. There was no impact on residential properties, with most commercial uses having no impact, except for one motel and one small retail centre near a station that showed a 25% increase in lease rates attributed to LRT. Access overall was a far more important consideration.

Our conclusion from the limited evidence is that any transport infrastructure investment will have a significant impact on land use where it contributes in a non-marginal way to accessibility, regardless of its nature.

The M4, a tolled motorway in Sydney, for example, is already having an impact on land use in the western areas of Sydney resulting in increased median land values. Washington DC Metrorail, which has a 26% modal share for downtown travel, has impacted on land use around stations and contributed to property values in some locations, although other factors have in general dominated the shape of land use — in particular the quality of the location overall. An inquiry by Brindle (1992) into the Toronto experience (a city extensively cited by Newman and Kenworthy (1989, 1999), as an example of how rail systems encouraged re-urbanisation), concluded that:

> *'the experts interviewed in Toronto were hesitant to claim "proof" of a close relationship between transit and land development, or that the transit-supported centres ... had so far produced significant improvements in travel efficiency and lifestyle.' (Brindle 1992, 23)*

When one reviews the evidence on the role of public transport in stimulating particular land uses, the overriding feature for development-stimulus is the permanence and volume of public transport system increases. This is the claimed basis for preferring LRT over bus systems. Although buses take people to where activities are and follow the movement of activities over a wide geographic pattern (Paaswell and Berechman 1982), in contrast, some argue that rail systems have a more active land use / transport relationship because of their perceived permanency.

The begging question is: what makes for permanence? One of the arguments frequently propounded by supporters of LRT is that it cannot be taken away, whereas a busway system can, although we cannot find any cities where this has actually occurred. The cost of producing flexible service capable of potentially responding to changing geographic activity patterns is the price of reduced commitment to the facility. There is greater truth in this statement where dedicated bus-based transitway infrastructure is not in place, especially infrastructure built specifically for exclusive bus use. Ottawa's busway system combined with strong land use regulatory powers illustrates what can be done for bus-based transitways to have a significant impact on land use. The system operates just like any other rail system with vehicles stopping at each 'station'. Ramp access is provided for express and limited stop routes so that a direct no-transfer service is provided between the residential and major trip generator locations. High rise in Ottawa–Carleton is already occurring at some stations and an integrated shopping centre / transitway station has recently been opened. Over $US700m in new construction is under way around transitway stations (Henry 1989).

Ottawa's legislatively mandated land use and transportation plan gives precedence to public transit over all forms of road construction or road widenings, with planning regulations requiring developers to concentrate developments near transit, to orient buildings and private access to transit stops, to provide walkways and transit-only roadways through developments, and to enter into agreements with the municipality on matters such as staging construction to accommodate transit.

The Ottawa transitway (or bus-based transitway) is unlike a bus lane in that it provides (i) rapid service between 'stations' (similar to a rail rapid service); (ii) direct express services via transitway providing the local feeder as well as the linehaul service without transfer; (iii) general urban areawide transit service that uses the transitway for a part of the overall route and thus enhances not only its average overall speed but also the frequency of service between some stations on the transitway; and (iv) local service to stations provided by feeders.

The message from Ottawa and Curitiba is that a metropolitan strategy can embed an effective bus-based system within its overall land use / transport plan that can produce the same types of impacts as rail. Based on the Ottawa and Curitiba experience, what is required is enabling legislation with a mandated land use / transport plan that explicitly prioritises the role of bus-based systems. If we look at the recent experience in Perth (Western Australia), the only noticeable development impacts after nearly a decade of electrification and six years of the new Northern Suburbs Rail System occurred where a government development agency has taken the running in East Perth, Subiaco and Joondalup.

The arguments in favour of rail-systems are mainly premised on the absence of such legislation. It may be that bus-based systems require much more directed assistance via legislation than does a rail system in order to have an impact on land use. Of course, contradictory legislation and zoning could thwart rail impacts on land use. The implication is that appropriate zoning and possible legislation should be an integral part of transport and land-use

strategies. If this coordination is done, bus systems are all the more attractive because they are considerably less expensive for a given amount of returned benefit and more flexible in responding to change. It may be that the bus-based system must be seen as having the essential characteristic claimed by rail — permanence and dedication. The value of HOV lanes with multiple-occupant automobiles must be weighed against this perception of 'rail characteristicity' if busway systems are to act as catalysts for land use planning as well as providing a high level of service.

In designing a bus-based priority system which has an effective collection and distribution capability deep into suburbia, the density of passenger movement through bus-based transitway stations as well as fewer stations (compared to rail) might act to reduce the attraction of land use development at and/or near the bus stations in contrast to the LRT stations. Nevertheless, the appreciation of land values and the agglomeration of activity close to stations should not be seen as of higher priority in an overall metropolitan strategy, in contrast to improving mobility and accessibility. A mix of objectives is necessary.

Ottawa may well have got it right (Henry 1989; Nisar *et al* 1989). Transportation service provision should foremost cater for the dispersed travel needs of the population, as well as recognising the desirability of agglomeration economies spread throughout the metropolitan area, aided significantly by legislative reform. There is scope in the longer term to encourage the decentralisation of activities (which is happening anyway) and hence reduce the reliance on the central core of urban areas, and hence reduce average trip lengths (Hensher 1993, 1998).

Curitiba, a city of 1.6 million located 400 kilometres south west of Sao Paulo, implemented a master plan in the late 1960s which restricted high-density growth to several slender corridors radiating from the city centre. The traditional core has given way to a cluster of high rises and scattered outlying development with all tall buildings arrayed along five transportation axes. Express bus-based transitways occupy the median of each road. To achieve this, the city brought or condemned a substantial amount of land along or close to the transportation axes and enacted zoning regulations that restricted high-density development to a two-to-four-block corridor on both sides of the road. Flower street, an auto-free downtown pedestrian zone was created, banishing cars in a 17-block area.

The Brazilian experience supports the key interrelationships that exist between successful bus-based transitway operation and long term planning, land use, appropriate regulation and political stability. Where bus-based transitways have been implemented in isolation from coherent planning and land use strategies, the results have been either partial, inefficient systems (as in Sao Paulo) or overcrowded systems, that cannot adequately meet demand (Porto Allegre and Sao Paulo). The outstanding feature of Curitiba is that an integrated system of bus service types has developed in response to a clear and structured urban plan. This combination of a planning-driven 'bus-friendly' urban form and a market-driven, innovative bus operation has provided Curitiba with an excellent transport system. The bus-based transitways are no more than an important element in this process.

Furthermore, the contrast between Curitiba and Sao Paulo is not so much in the preparation of plans, but in their consistent implementation over a thirty year time-frame. Political stability has enabled the planning and innovation in Curitiba to deliver results. Similarly, the effective use of bus-based transitways is also dependent on an integrated regulatory regime. The decline in the effectiveness of the Porto Allegre busways results from the removal of the 'umbrella' regulation of EBTU. Although the multiple operators have effectively developed a system-wide fare system, they have not been able to maintain the efficiencies of the bus-based transitways. Similarly, a major restraint on the Santo Amaro bus-based transitway in Sao Paulo is the presence of 'pirate' bus operators, who overload the capacity. An efficient bus-based transitway requires a firm and coherent system of regulation.

The bus-based transitway systems in Curitiba, Porto Allegre and Sao Paulo provide an illustration of the strengths and weaknesses of this transport mode. Although these systems have operating weaknesses, and although many aspects of their operation are not transferable to other national contexts, they nevertheless provide working examples of the capacity of the bus to provide cheap and efficient solutions to major urban transport problems.

The Ottawa and Curitiba experiences are worthy of special investigation. They appear currently to offer the best examples of how a bus-based system can be a major alternative to light rail in terms of the wider range of criteria used to justify a rail-based public transport system. It is easy to be critical about the

strong arm approaches to legislated zoning (some supporters of LRT suggest that zoning legislation is not required to achieve these types of land use reforms), but it did achieve the objective of using a more cost-efficient form of public transport. The success of legislative regulation depends very much on a commitment. The USA experience in legislative reform in order to achieve efficient and effective reform of public transport favouring bus and LRT systems has not met with success as well summarised by Henry (1989):

> *'While such formidable land use controls [as in Ottawa] may be envied by many U.S. planners, it is most unlikely that the massive legal, political, and other obstacles to their implementation in U.S. cities could be overcome.' (Henry, 1989, 177)*

It is encouraging, however, to note the success of Pittsburgh who succeeded in introducing a bus-based transitway system in contrast to light rail without the imposition of legislative zoning. Markets can be and often are stronger instruments in achieving outcomes if properly managed.

AN ASSESSMENT OF CURRENT EXPERIENCE

This section brings together various points gleaned from the reviews of current experience and the arguments in the bus transitway–LRT debate. The main point is that the enthusiasm (almost blind commitment) for LRT has caused many to overlook the potential for more cost-effective bus-based systems and even simpler improvements to bus services that do not require dedicated right of way:

1. Bus-based transitway systems can be shorter in length than LRT because the routes that use them can fan out into residential and commercial areas for closer collection and distribution. Transfers and transfer time are reduced. LRT can have feeder buses but with added time delay (and often higher unit operating and capital costs than an integrated bus system), although the disutility of a bus-rail transfer penalty is lower than for a bus–bus transfer. This provides some basis for promoting the design of bus–based transitways in the context of the entire collection and distribution task, ensuring that the exclusive bus-based transitway combines with the entire matrix task of buses to minimise transfers, as successfully executed in Curitiba (Herbst 1992), Ottawa and Pittsburgh.

Table 2

CMTC Busways In Sao Paulo - 1994

	Paes de Barros	Santo Amaro Avenue 9 de Julho	Vila Nova Cachoeinha
Year of Opening	1980	1987	1991
Type of Bus	Trolley	Trolley & Diesel	Diesel
Length	3.4 km	14.6 km *	11.0 km †
Terminals	1	1	2
Overtaking Lanes	No	Yes	No
Busway Rates †	6	27	14
Number of Buses	61	372	159
Buses / Peak Hour	30	250 §	75
Pax Capacity / Hour	3000	25000	8250
Peak Hour Operation Speed	N / A	AM: 21.0 km / h PM: 11.2 km / h	AM: 23.0 km / h PM: 16.0 km / h

Sources : SMT 1993a and SMT 1993b.

Notes: * Of the 14.6km, only 11.0km is exclusive bus roadway.

† Of the 11.0km, only 5.5km is exclusive bus roadway.

† Includes both Trunk Routes (using the corridor) and associated Feeder Routes.

§ In addition, up to 50 illegal buses use this corridor per hour.

2. We know that transfers are a major constraint on the use of public transport (Horowitz and Zlosel 1981; Charles River Associates 1989; Richmond 1998). The act of changing buses or between bus and LRT produces a large penalty that is independent of the amount of time involved in transferring. This suggests that long-term strategies should include the provision of a better mix of more direct but less frequent bus routes and more frequent services, adding branches and opening loops. Public transport networks that are planned to minimise travellers' disutility, *including transfer penalties* (i.e. not just time, but the act of transfer), will look substantially different from those planned to minimise overall travel time. LRT appears to work against this objective.

   A three-tiered bus system, arguably one of the most efficient in the world, was introduced in Curitiba which allows passengers to transfer without charge from the red express services along the axes to the yellow feeder services that circulate through outlying districts and bring passengers to transfer stations, and to the green inter-district buses that travel in concentric circles to connect outlying areas. A computerised traffic control system gives priority to buses. There are 100 tubular bus shelters, with passengers paying fares at a turnstile at the end of a clear tube and then waiting inside, entering the bus from sliding doors in the tube. Boarding and alighting is considerably speeded up.

3. The total operating costs per passenger of LRT are typically higher than the typical bus-based transitway, where comparisons are possible. The most cost-effective LRT is 60–80% higher on unit operating costs than a bus-based transitway. The comparison must be qualified by the fact that LRT trip lengths are longer, although the bus-based transitway component of the bus trip only is typically used in the comparison. When the fully integrated bus–LRT or bus–bus systems are compared on unit operating and capital costs, the latter is even more attractive financially. The level of patronage will be critical to the outcome.

4. Bus-based transitway systems are simpler to operate and maintain than LRT systems, the latter typically attracting a sizeable support system such as an operations control centre and maintenance facilities. The interrelations between communication, signal power and propulsion systems for LRT is more likely to contribute to complexity and bureaucracy which is significantly less (but not absent) for bus-based transitways.

5. We seem to have accepted the division between the ownership of the infrastructure for bus provision and the operation of the buses. We are struggling with this dichotomy for rail-based systems. The issue of subsidy cannot be ignored in both systems. If we draw on the property rights argument, there is a very clear case for allowing any bus operator to access the bus priority infrastructure; and hence a case for having the infrastructure owned by a non-local bus operator. Although this division can also apply for rail, it is more likely to gain acceptance for bus systems because of the perception of a more 'natural' division than for rail. Indeed, access by non-bus vehicles to share the infrastructure to maximise the use of the excess capacity in the off-peak in particular is a more attractive proposition than LRT. The New South Wales Government is struggling with this dichotomy at present with the Liverpool–Parramatta Bus-based Transitway.

6. Bus-based transitway systems permit far more flexible operation (Moffat 1991). Buses travelling in the one direction can pass more easily than LRT, especially when off-line bus-based transitway stations are used. Fouracre and Gardner (1992) note that the provision of overtaking facilities at bus stops is found to be a particularly effective way to increase throughput (up to a theoretical estimate of 30,000 passengers per hour in one direction) and to decrease journey times, particularly when limited-stop or express services are operated. As bus use builds up, the opportunity for bus-chaining (especially as a guideway technology) becomes feasible.

7. Although it is argued that LRT operates at a greater theoretical capacity than a bus-based transitway, this has been questioned under closer assessment (Goodwin *et al* 1991). Biehler (1989) claims that the capacity of light rail is about 200 passengers per vehicle times 40 vehicles per hour (90 second headway) or 8,000 passengers per hour. Articulated buses operating at 60 second headway yield 6,000 passengers per hour, assuming 100 passengers per bus. One must be conscious of the possibility of requiring a transfer

where the patronage demand on a 'feeder' service is not sufficiently high to justify articulated buses. It can be argued, however, that the elimination of transfers will increase patronage and hence is a strong case for articulated buses in the collection, linehaul (bus-based transitway), and distribution stages.

The critical consideration here must be the success that each mode can have in attracting patronage. Time and time again we come back to the nature and success of marketing strategies in promoting the various forms of public transport *and* the importance of redressing the pricing and other distortions which encourage the car. Critical issues will always centre on the factors that influence the choice between car and public transport.

8. Although LRT can be entrained creating multiples of base capacity per hour, bus-based transitway capacity can be greatly enhanced by multiple buses using a single off-line station as well as through-buses which can pass very easily (as can LRT, but at quite an expense for additional track). The bus-based transitway can also serve as the guideway for local bus services that have collected patronage locally and then become express non-stop to the central business district or a regional centre.

On a number of reasonable assumptions, the patronage potential for a bus-based transitway can be as high as twice that of LRT. The relativities will be determined by the sophistication of the design of the bus-based transitway system. Establishing actual patronage is another issue, although we have yet to find any unambiguous evidence to suggest that you can attract more people to LRT than a bus-based scheme. This arises because of *the difficulty of finding very similar circumstances in which both LRT and a geographically comparable bus-based system are in place*. Certainly the performance of the dedicated bus-based transitway systems in Curitiba, Pittsburgh and Ottawa deserve closer scrutiny.

CONCLUSIONS

There is a lot of support for an attractive alternative to the car in cities. However, it is very important, if public transport is to be the way ahead, that the investment in such systems is made in a rational way. There is a need for less expensive technology and consideration of more appropriate ways of addressing the problems caused by the automobile. Although there are signs of a shift from light rail to bus-based systems, following on from the earlier shift from metro to light rail (Edwards and Mackett 1996), there are still many examples of more sophisticated technology being used than is necessary.

This all suggests that there are three major issues to be addressed:

- first, how to counter arguments about the very expensive 'image benefits' bestowed by a brand new light rail system that a bus cannot provide,
- second, how to amend the funding mechanism so that the maximum benefit is obtained from the investment of public money in urban transport, and
- third, how to amend the analytical process so that it does not overestimate the benefits of a new public transport system.

The first two issues are related. The usual procedure is for local planners and politicians to promote and design a scheme, and then to apply to the appropriate government for the funding. It is easier to make the case for a 'high-tech' discrete rail-based system rather than upgrading an existing bus system.

The USA transit experience is clouded by the availability of cheap money and the absence of any effort to provide incentives to attract patronage. Much of the debate in the 1990s on new rail systems in the USA has emanated from overzealous forecasts of patronage at the time of seeking financial support from Capital Hill. These projects failed to recognise how difficult it is to get people out of their cars:

> *'The impetus for building rail systems in the US has little if anything to do with passenger demand. It is largely related to the availability of federal money to build such rail systems.' (Cox 1991)*

> *Those responsible for transportation planning seemed more concerned about raising and spending vast sums of money than with improving mobility or improving transit service and increasing ridership.' (Kain, 1988, page 198)*

The quote from John Kain sensitises us to the growing emphasis on opportunities for raising and spending large sums of money on nicely visible infrastructure such as light rail systems which are 'permanent' in ways which appeal to civic pride, to owners of

strategically located property investments, and to politicians who see an opportunity for historical associations with physical monuments. Newman and Kenworthy (1989, 28) put forth the view that good rail transit systems provide the opportunity for highlighting public values in ways which give a city new pride and hope for the future. While this may have some truth, it should not deny the capability of achieving the same impact with a high quality dedicated bus-based transitway. The images created in promotion of the proposed Liverpool-Parramatta transitway in Sydney actually are more appealing to civic pride than the existing heavy and light rail systems.

What is needed is a funding regime that permits the development of maximum accessibility for a given sum. In many cities, $200 million spent on a bus system would produce more improvement in accessibility than the same amount spent on a single light rail line, because the former system would cover a much larger area and so serve more people. However, it would not be so glamorous, and so the politicians and planners might not be so willing to plan and promote it. Nor would it be so easy to finance under present funding regimes that are geared to individual projects rather than achieving maximum benefits. In fact, in Britain outside London, because of bus deregulation it would be almost impossible to develop a large comprehensive bus-based system. Thus, there has been the irony of a national government, which was committed to reducing public expenditure, funding expensive light-rail schemes because its desire to introduce market forces to bus operations meant that local bus services could not be planned and coordinated (Mackett and Edwards 1996a,b, 1998). All large cities in Britain either have or are developing new light rail systems. It is likely that light rail is not appropriate for smaller cities, but bus-based systems cannot be used in the UK for the reasons cited above. Some smaller cities are considering bus-based transitways and kerb-guided buses, but none are near to implementation. The existing kerb-guided bus system in Leeds and a similar system in Ipswich are very modest.

What about the future for bus systems? Buses, especially bus-based transitway systems, are arguably better value for money and if designed properly can have the essential 'characteristicity' of permanence and visibility claimed to be important to attract property development along the route, which is compatible with medium to high density corridor mobility. To achieve this, the bus industry needs a 'wake-up' call. The opportunities are extensive, but the industry is far too traditional (often complacent), often lacking lateral thinking and not pro-active enough. Furthermore, despite the appeal of bus-based transitways, there is still a lot that can be achieved by simple solutions such as adding more buses, adjusting fare schedules, improving information systems, integrating ticketing which is lost in the debate on over whether special rights-of-way for buses as against light rail are better.

The message is simple and powerful: distance our thinking from an obsession with technology and move to study needs as a starting point of inquiry. Do not ask if light rail is feasible, but ask who the stakeholders are and proceed to investigate how they may best be served. Institutionally, the presence of economies of network integrity may force a review of the existing spatially bounded franchised arrangements for bus service provision in cities such as Sydney, London and Auckland. This is the challenge.

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David Hensher

is Professor of Management and Director of the Institute of Transport Studies: The Australian Key Centre of Teaching and Research in Transport Management at The University of Sydney as well as in the Department of Civil Engineering at Monash University. David is a Fellow of the Academy of Social Science in Australia, Immediate Past President of the International Association of Travel Behaviour Research and a Vice-Chair of the International Scientific Committee of the World Conference of Transport Research. David is on the editorial boards of nine of the leading transport journals and Area Editor of *Transport Reviews*. He has published extensively (over 200 papers) in international transport and economics journals, as well as five books. He is a member of the executive committee reviewing bus transport bids for the Olympic Games, and a member of the NSW Government's Peer Review Committee for the 1998 Strategic Transport Plan.

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Contact

David A. Hensher
Professor of Management and Director of the Instituteof Transport Studies
Faculty of Economics
The University of Sydney NSW 2006 Australia
Email Davidh@its.usyd.edu.au

Editor's note

Discussion in response to this paper is encouraged. Contributions may be in the form of papers offered for refereeing, technical notes presenting supporting or contrary data, 'Opinion' articles or letters.