EFFECTIVE BUS-BASED TRANSIT ORIENTED DEVELOPMENT

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Transit oriented development (TOD) has been hailed as an essential part of planning tomorrow's communities because of the efficient use it makes of resources such as fossil fuel, arable land and public investment funds. The desirability of communities based on TOD principles will increase as fuel becomes scarcer and societies search for neighbourhood structures that encourage personal activity and social inter-action. This paper takes the values of this form of urban development as given, but then asks "How can TOD be achieved with greater efficiency and across wider economic models of urban growth?"

We argue that defining and applying best practice in bus service planning will not only deliver successful TOD-places, but in many instances, will be more effective than other, more expensive transit options. In the latter case, the savings in start-up funding can enable the best outcomes of TOD to be applied across the wider range of new and affordable communities. By knowing and understanding how to make bus-based TODs effective, the design and planning of these future centres would incorporate these principles and improve the community outcomes.

This paper will focus on new communities, built to reflect how people expect to live in the future. We are looking at new areas in urban metropolises rather than whole new towns, although not all the principles differ between the two cases. While we focus on the new, some of the proofs and examples offered come from established areas. Some of the most compelling models of how we could live in more sustainable communities in the future are taken from communities that were created as tram-based (or street-car) suburbs in the previous century but had evolved to bus-based communities with the withdrawal of tram service. The relevance of these examples arises from parallels in the development objectives of the periods – housing for rapid urbanisation, limited capacity to expand utilities, need for a variety of price points in housing, and demand for a collective rather than individual form of travel.

What are some of the community features that enable us to replicate the success of the older areas? The strongest, overarching principle is to consider how to reduce the overall travel time door-to-door for all trip purposes. This

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requires planners to minimise distances to transit access at origins and destinations, to manage the entire transfer process, to offer the highest reasonable service frequency, to give priority to travel speeds for buses, to facilitate linked trips for varied purposes and to remove fare and information collection delays. These are the performance aspects of bus-oriented centres, but modes compete on personal appeal, too. The way marketing reaches out to individual preferences to obtain a larger share of the market buying the same type of car, planners must seek to focus on the preferences of passengers so that bus service meets the mass market's expectations of comfort, ease of use, safety and prestige.

The final fundamental of our approach is to build a good business base for bus services. Where a transit business can be maintained, there will be patronage growth, service frequency and customer satisfaction. In contrast, where the funding principles of the transit service are based upon a social safety net approach, transit will provide the minimum service to meet contractual obligations and there is no stake for the operator in service growth or customer satisfaction. Perhaps, more importantly for the future of the community, there is no pride in ownershipof, or relationship between, the service and the new centre. This was the significant finding of Professor Hass-Klau (2005, and presentations in Sydney, 2001) on which mode was "best" for an area. The successful system was a source of pride for the community. People used it and felt they were sharing in the best their community could offer, whereas, too often bus services offered the minimum cost per passenger or were deemed suitable for those members of the community most in need. This under-selling of bus transit's potential can impair the success of the centre's development and must be addressed from the earliest stages of the project.

WHAT TOD OBJECTIVES DOES BUS TRANSIT SERVE WELL?

Creating a centre of activity

Bus planning for new areas has to look at a hierarchy of services. For linking major urban centres to central business districts there must be a bus rapid transit (BRT) system or other high performance/high capacity mode. Then in major urban centres, local bus services either join the BRT network or act as feeder services to the BRT and major urban centre. The meeting point of these services is a natural hub and centre of the community.

For the more local bus stops, there is still the neighbourhood-defining aspect of their placement. A pair of stops becomes the obvious place to have a safe, pedestrian crossing of a collector road. Local mixed businesses, or services like DVD rentals, dry cleaning/bag washing, ATMs and take-away food outlets make good frontage land uses at bus stops because they minimise what passengers have to carry on-board and have business hours and lighting that usually increase waiting passengers' feelings of security and convenience. Planners just have to come up with means to keep the bus stops clear of cars!

Encouraging high land values which intensify and mix land uses

In describing the advantages of TOD centres, commentators and planners use adjectival phrases like "diversity, vibrancy, activated frontages and rich environments." These are the benefits from recognising the principle of minimising door-to-door travel time. Many trips are linked, and the more closely aligned the destinations are for say dropping a child at school, buying a newspaper and a cup of coffee and then boarding a commuter service, the more benefits flow. For the traveller, unproductive time is reduced; for the bus transit operator, there is a larger market for its services without additional route kilometres; for the community, externalities like pollution and congestion are minimised; and for landowners, orienting their developments to transit, their property values are increased. Accessibility increases the activities that would wish to rent/purchase the central space and encourages more uses to occur through vertical space expansion or best use for at-grade space. Locating parking or servicing in basements or backdoors of developments because the high value, TOD space is at the bus stop in front, is perhaps the most compelling measure of successful TOD.

Permeability of the Mobility Network

Another key aspect of TOD is the design of the mobility networks for pedestrians, cars, buses, cyclists and commercial traffic that minimises individual travel times, but not necessarily door-to-door times, when parking is included. Road safety research has led to many modern residential and employment areas having a smaller proportion of their road and footpath network kilometres in through-alignments vs dead-end alignments. This trend reduced traffic levels and injury risks on certain streets but added kilometres of travel and congestion to other parts of the mobility network. Re-establishing the direct walking trip to central business and transport places is important to the success of TOD, but seeing it is accomplished without increased accident risks is a design challenge. Measuring pedestrian walking distance instead of the time of car trips has proven to be a basic but critical part of rethinking how we plan new communities. Most passengers walk to bus stops, and those walk trips may be the critical determinant of a passenger's modal choice.

Maximising the Capacity of the Transport Infrastructure

Another one of the fundamental breakthroughs of TOD approach has been to consider the passenger carrying capacity of the mobility networks, not the vehicle capacity. The vehicle measure is still entrenched in our planning and modelling of road networks and has to be upgraded for a true paradigm shift to occur, and we are gradually getting there. One of the attacks on TOD-based planning is that increased density in the use of land will inevitably lead to increased congestion. This is by definition true, if you only measure vehicle capacity, and not the passenger capacity of the mobility network. It is an important insight that under traditional town planning practice road capacity has been too often increased in isolation from its passenger capacity so

insufficient passenger mobility increases have occurred. This matching of increases in mobility and land use is the "integration" that has to happen for effective TOD. Bus transit gives the most flexible means of increasing passenger capacity over road networks. The service's passenger capacity can be increased by vehicle size, service headways and hours of operation, management of dwell times and faster travel time between stops.

Recognising that the fundamental transport unit is the pedestrian

TOD recognises that the basic scale of design must be attuned to the pedestrian. By building the car park into our homes and the offices, transport planners have allowed this fundamental fact to be disguised as the pedestrian component has become hidden for many trips. Use of shopping centre car parks clearly reveals how even daily trips are subject to this rule, and how travellers will go to great lengths to minimise their walk. We minimise our walking for many reasons, to avoid exposure to bad weather, to reduce our efforts when carrying heavy objects, to arrive faster, but mostly because it has become a travel habit. Just as we do not consciously go through all the decisions in a four-step travel model before making a trip, we have accepted the rule of thumb that the best walk is a short walk. Activists promoting exercise to combat increased obesity in the population are going to try and motivate us a number of ways to change that view, but the most successful in the long term will be good urban design that returns mobility network priority to pedestrians.

Bus operations always had to recognise that the pedestrian was the customer, but too often stop placement became secondary to other traffic considerations on the street. Again, performance speed measurements were misplaced on the vehicle instead of the door-to-door trip of the pedestrian. This misapprehension can lead to promotion of longer intervals between bus stops as a principle without regard to the local activity levels or no lack of consideration to how passengers cross barriers to get to bus stops in both directions for their trip. In major centres, the interchange area around rapid transit stops has to welcome all feeding modes while making them subservient to the walking scale of the centre and its design and function. Not every bus passenger will go to the transit station, some will go to other bus stops or the town centre, so all these walking paths have to be considered and minimised.

VIBRANT, NEW CENTRES BUILT ON BUS TRANSIT

Functional urban design is the cornerstone of the transit-oriented centres that work and meet their objectives. This is not a tautology in that we are referring to the effort expended on linking activities and transit services at the pedestrian scale. Successful new centres built on bus transit contain their most accessible point at a single transit hub. The hub has to be perceived as a coherent location from which potential passengers can reach a range of destinations, at least one of which is a rapid connection to the regional CBD. This hub is the centre for all modes; pedestrian, car passenger, bicycle, bus,

etc, but it is not the centre for vehicle storage. There must coherence in the design and logic of the centre so the users, new and continuing, can understand, appreciate and endorse the effective patterns of travel.

In his classic system review, ***The Transit Metropolis***, Robert Cervero (1998) looks at two of the long-standing examples of successful bus based transit cities, Ottawa and Curitiba. Both of these are worth reviewing in terms of what they said about the outer areas developing around the bus-based service.

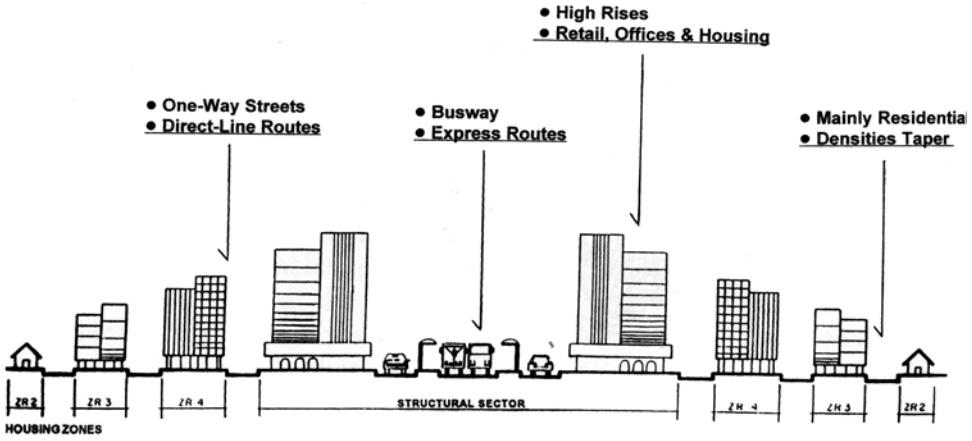
In Ottawa, three critical factors for the developing centres along the Transitway routes were the grade-separated corridor, the urban greenbelt and the regional planning power over employment location. By maintaining policy continuity of the transit orientation through land use and service planning, implementing, and monitoring progress, the intended results were achieved with lower government investment and more quickly than other Canadian cities that followed the more popular light rail scenario, such as Edmonton, Calgary and Vancouver. The three factors worked in tandem because the grade-separated Transitway corridor could deliver premium service, the greenbelt constrained the suburbanising tendency that leads to ineffective dispersal of trip ends, and the planning power to restrain retail and other suburban employment sites to within 400 m of Transitway stations was invoked and reasserted as required.

Two major sub-centres were already emerging in the region when the Transitway planning began, Orléans and Kanata. The crucial aspect of the plan was to recognise their importance in the regional distribution of centres and to restrict development in other sectors as they were "secondary employment centres". More than 10,000 new jobs were to be provided in these primary employment centres in "a rich mix of offices, shops, hotels, community facilities and civic buildings that are architecturally integrated." Once employment targets are set, then residential development can occur in the transit stop catchment. Even as the system was developing, suburban employment centres were attracting 30% of their work trips by Transitway and suburban shopping centres were attracting about 25% of their shoppers from the Transitway.

A specific example quoted by Cervero (1998) was the St Laurent Shopping Centre. As its development was concurrent with the Transitway, a cooperative approach was taken in cost sharing as the developer dedicated land for the station and provided the accessways for the passengers. In exchange, as well as a direct connection into the Centre from the Station, the City allowed the developer to reduce its required parking provision by 25 car parking spaces for each bus bay in the station. The Head of OC Transpo's Long Range Planning Section said that Transitway illustrated the value of fixed infrastructure, not fixed guideway. He also cited the development of Place d'Orléans as "how a busway station will be able to influence growth decades before a separate

right-of-way is built to it." Park and ride is discouraged in favour of the local feeder and express services.

The famous linear-city urbanisation of Curitiba, Brazil, is based on bus transit, which again has out-performed the mode shares achieved in bigger and denser cities in the country such as Sao Paolo and Rio. At first this is surprising since Curitiba is more affluent with higher car ownership than the other two, but people who know the value of their time invest it more wisely. The city has been cited for its integrated service system, but it based much of its success on achieving its development goals which were based on people not vehicles. The city centre would not expand in floorspace but it would attract more trips as it was rearranged to be a cultural centre preserving its character with the growth in residential and employment floorspace channel to the other communities developing along the Express Bus, (that frequently stop), and rapid Direct Bus corridors. The containment of the CBD has a tremendous impetus to spur development where mobility was being improved.



source: Robert Cervero *The Transit Metropolis*, Island Press, pp 274

One of the unique opportunities offered Curitiba was an effective land bank generated by a failed 60m wide radial boulevard-based plan. Land had been acquired but not built upon because sufficient project funds and land could not be obtained. However, when the bus-transit system was devised, this land allowed for quicker take up of the integrated scheme and the ability to offer bonuses for optimal transit generating uses in, for instance, office space was allowed more floorspace than residential as it generates more trips in transit corridors. Also "activating" commercial uses were largely unregulated on the base two floors of all development as such uses naturally provide access corridors and a comfortable environment in which to walk and wait for transit.

The urban design of the surroundings of the transit hubs is a major factor in success whether the form is linear as in the case of Curitiba, clustered in shares between cars and buses as in Ottawa or in the crescents and circles of Calthorpe's schematics. The design logic in all of these potential bus-oriented centres varies, but it is all comprehensible from the planners to the users,

builders and co-inhabiters. Even the residents and workers who may not use the transit system need to perceive the benefits and purpose of the transit-oriented design so they can respond to the optimal performance of the centre.

Some features we have observed that have undermined vibrant centres and need to be avoided are:

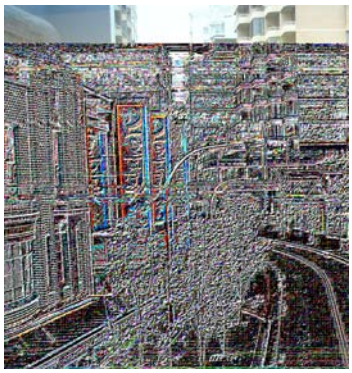
- Service patterns that replace frequency with co-ordinated transfers at set intervals such as hourly or even half-hourly. This reduces the activity levels outside the meet times, and inevitably leads to maximum waits for delayed services. It also loads interchanging facilities with peak demand spurts so facilities are over-provided and apparently under-utilised right in the core of the centre.
- Accommodating bus parking or layover in the centre of accessibility. Centres have to be the hub of pedestrian and passenger movement, where you can find the maximum capacities on the transit services. The supporting infrastructure has to be efficiently nearby and easily reached, but not increasing the passenger-time vectors of the station/interchange.
- Designing only for the workday commuter. Weekends and holidays are around a third of the year, even for that portion of the populace that work. Bus transit centres have to work everyday of the year with the same logic and patterns. Not only is it good business sense, it demonstrates the advantages of the integrated services and design when many try them out for the first time. Often passageways get locked for security reasons when the abutting offices or businesses are not operating. Bus stops /stations /interchanges then become less accessible and mobility is reduced. The integration of the centre and its vibrancy are also undermined.

BUSES SHARE WELL WITH OTHER ROAD USERS

Good examples of bus-oriented centres are usually at-grade, especially in the new, developing areas we are focussing upon. Roads are an important part of the at-grade public domain, but they cannot be allowed to dominate the urban form. Therefore, we need to design systems which use the road most efficiently, not just for transit capacity, but for overall mobility within the centre. Rubber tyre systems share well because they use no special infrastructure in the street that reduces capacity for other users. Buses are not tethered power supplies, so they can respond to blockages and immediate demands for route alterations immediately. Buses can be fuel efficient, quiet and minimally polluting, but sadly these are not always traits fleet operators are willing to purchase without incentives.

Pedestrians and buses can usually mix quite safely and need little formal separation where good visibility of approaching traffic is available. Formal

handling of large volumes of pedestrians crossing the bus routes remains the main feature to be addressed. Buses can also mix well with taxis as long as the passenger pick up/drop-off areas are not in conflict. This is the main reason the Harbour Bridge Bus Lane boosts performance for both modes despite the dominance of taxi vehicles; neither can serve passengers in the lane.



Sydney's Bondi Junction has recently refashioned its Transit Mall which has an enviable safety and accessibility even with the high levels of use. ITS can also help manage road space, so peak hour bus stops become off-peak loading zones for local businesses, and guidance systems can be added for delivery vehicles using technology like those that control our tidal flow traffic systems. Kerb space is often the scarcest resource in transit centres, and it needs to be well-managed along with the lane controls.

Buses can mix safely with bicycles and motorcycles as long as lanes are sufficiently wide. If lanes are narrowed to reduce pedestrian crossing times or slow bus speeds, then separation would be required for the safety of the vulnerable road users and for the performance of the high capacity vehicles. Bus rapid transit is particularly well-suited to new centres where much of the feeder support could come from cyclists as this extends the areas of reasonable density from the centres and requires less land in roads to support the centre's growth. Buses are such high capacity users of road lanes, they leave lots of capacity for cyclists.

In sharing roads efficiently in centres between buses and other uses, there are some situations that should be avoided:

- Removing clues from the designs that vehicles use the area. Safety requires pedestrians to perceive they are in an area where vehicles operate and they need to exercise care. This is best served by upright kerbs remaining along the bus route, made prominent by being in contrasting materials to the footpath and carriageway.
- Ignoring transit vehicle priority just before a stop. There is no delay more frustrating as that right before a bus stop. Passengers want to exit immediately when the stop is close, even where the situation may not be safe enough. Set downs should be separated from pick ups if transit delay is inevitable if buses have to progress through congestion to a shared stop.
- Overlooking the delays from turning traffic, especially when pedestrian flows are high. If turning traffic does not clear because of

lane congestion or the constant flow of pedestrians through the intersection, then turning traffic has to be managed to return the priority of movement to the transit vehicle.

- Squeezing passenger capacity to maintain road capacity. The most egregious example of this is the creation of bus bays by cutting into footpaths just where you would want capacity for waiting passengers. Other examples are crossing footpaths at transit stops with many driveways for centre car parking, and providing slip turn lanes that yield traffic islands with insufficient space to accommodate those waiting to cross the street during a pedestrian phase.
- Yielding priority at the destination's front door. Transit has to keep its priority to the "front door" of a development to minimise its door-to-door travel time. Just pushing the bus stops away somewhat, so car passengers can be dropped or taxis loaded, adds travel time and indicates that bus passengers are not valued as highly as other travellers.

PERMEABLE BUS NETWORKS FOR TRANSIT SUPPORT

Perhaps the strongest operational advantage of bus service in transit-oriented centres is the hierarchy of services that can be offered. Not only can bus operate a number of service types on generic road infrastructure, it can change capacity responsively and switch single vehicles and operators between services. New urbanists commend grid road networks which can be adapted effectively for bus transit, but they are not the only format that can work. Radial and web structures also have their desirable characteristics, but the road network and the service pattern need to work in tandem and converge more strongly as the density of demand increases in their passenger catchments. The only real danger is to assign a bus stop rule to match idealised road networks. Stops must be activity based, not spaced by rules of thumb. Stations have to consider the present and future destination patterns not regular spacing. Optimal stop location is always a trade off between delays to people on the bus and delays to passengers accessing the stop from their trip origin or destination. Again, minimising door-to-door travel time is the basis for service design.

Successful bus based transit systems such as Ottawa's, Curitiba's, Brisbane's and Adelaide's all offer train-like trunk services on reserved corridors, along with buses that operate as feeder services in local communities, then join the transit corridor for express travel to a limited number of major stops. The systems support each other and receive the best value from the investment in the high priority corridor. They are popular because they make the transit service faster door-to-door and because they make the system easier to use, more understandable, both benefits from reducing transfers.

Bus services can also seek bus-only links between suburban cul-de-sacs and traffic calmed areas that may prevent unintended use by general traffic. Even in areas where some retro-fitting of the road networks is required to provide acceptably direct bus services, the needs of the bus service under common principles of routing can help set program priorities. As areas become higher order activity centres, more direct bus routes are needed to increase the capacity of the road network.

Consideration of the above points should avoid these common inefficiencies:

- Routing bus services to reach a passenger. Too often operators can lose sight of the fact that we are trying to provide a "mass" transit system so we need to consider the timing of the entire bus load and not a particular passenger, no matter how long standing. Routes have to be updated as more efficient paths are possible. Services have to be monitored so their effectiveness is maintained and pursued.
- Sacrificing service quality for service equity. This can be related to the point above, but if centres are to be transit oriented, then the services have to be efficient. If a particular corridor is generating higher growth levels, it should not be held to the same level of provision as nearby corridors. The operator has to respond to growth immediately so service quality is not reduced. That is an important feature of being transit-oriented.

EFFICIENT USE OF TRANSPORT INFRASTRUCTURE

New centres building on bus-based transit have the potential to be the most efficient users of space allocated to transport. While we seek increased density and mixed activity around hubs in the transit network, the mode used for the transit does not impact directly on the density that results, but the mode provided can have an impact on the amount of land required to provide the planned capacity. Guided busway systems such as Adelaide's and Leeds provide high quality ride, but the really impressive aspect is the minimum space required for the guideways. In Adelaide, the high capacity infrastructure has a cross-section of just 6.20m (between outer edges of guideways) while in Rouen the optical guidance bus system requires a metre and a half less roadspace than conventional bus service. Recent light rail services have dynamic envelops of 8.5m in the straight, and additional space often needs to be provided for catenary support or passenger storage. Often the main reason bus operators increase service frequency is to increase seating or loading capacity, this is a much more popular method with the travelling public than increasing the seating through added carriages or double-decking, on the same or less frequent services. Increased frequency on bus services often means that less footpath space is compromised for transport use by waiting passengers. The conflicts between moving and waiting pedestrians increase with the interval between arrivals of transit services with capacity to

take passengers on their way. Even modern light rail systems, need to assume that there are major stations loading platoons of passengers in order that their higher capacity vehicles are efficiently used. If these stations are on street, those loading and waiting functions either require more transit space or an intrusion into existing footpaths or open spaces.

In the lower density areas, the necessary peak capacity on bus based systems can be achieved through peak hour-only priority measures such as limited hour HOVs or even clearways instead of on-street parking. Bus capacity in the peak can be immediately converted to freight, general traffic, non-motorised or even parking. Peak period passenger loading areas can extend down a kerb, but immediately be converted to loading or parking once that peak demand has passed.

As bus routes converge on new centres, the stopping of the buses for passenger loading and unloading can act to calm speeds and manage traffic. It may be a mistake to provide bus bays in such environments as they use a lot of space, often inefficiently, just at those points where successful systems would want high quality passenger waiting facilities. They also give passengers a sense of a circuitous route as they weave along roads and invite illegal use if bus services are not frequent enough to enforce the exclusion of cars from their stops. They can also add more steps for the passengers due to taper requirements and distance from signals for crossing the street.

A common belief I have heard urban designers promote is the value of on-street car parking for better town centre environments. I am not persuaded this is the case. Yes, it can be intimidating to have a large vehicle like a bus travel along the kerbside lane, but using parked cars as a shield has several inefficiencies:

- If it is short stay parking, then the manoeuvring into and out of parking spaces disrupts the adjacent lane where buses are operating,
- If it is long stay parking, then the capacity of the pavement is woeful and unsustainable.
- Parked cars and cars being parked are much more likely to be involved in pedestrian or cyclist crashes than buses.
- Parking clearances restrict street landscaping and other improvements to the pedestrian environment.

Competition for kerbspace is the keenest of all transport demand conflicts as you can widen to add lanes, but it is very difficult to increase the supply of kerbspace. It is an essential part of bus service, delivery services, passenger drop-off and collections, cycle space and where we want clear visibility of our pedestrians entering road space.

We have to manage it better, recognising the importance of the asset. On-street parking is an extravagance we cannot usually afford, especially along

bus routes when the services are operating. To screen footpath users, ensure footpaths are wide enough so pedestrians are not forced to the kerb face where conflicts can occur. Plantings at regular intervals can aid speed reduction, and if full sized lanes are provided for buses, not just narrow, converting parking lanes, the buses will not intrude into the kerb face zone. Wider kerbside lanes also reduce the need for pruning street trees and contribute to improvements in their health.

While there are great efficiencies in the use of transit space by buses, there are some actions to be avoided. For instance, do not over-restrict access to road space for other users. If bus lanes are reserved for services on 10 minute headways, the lanes will appear, and will be, vacant, although the persons carried/lane kilometre may be higher than adjacent general purpose lanes. If congestion, or poorly managed traffic, starts to impact on service performance, bus operators receive an almost real-time feedback from reported late operations, driver overtime and customer complaints. Bus priority can be retrofitted into the road network, although this cannot be said for rail modes.

Another common oversight in allocating space to transit systems is focussing on the vehicle requirements and failing to consider the comfort or needs of passengers. Passengers on board buses, especially standing ones, dislike the weaving in and out of kerb side bus stops. Little consideration is given to the waiting environment, with passengers often complaining of poor lighting, uneven ground and inability to see approaching buses. Safe and direct crossing of the road for 50% of the passengers is too often not considered in placing bus stops, which has an impact on travel time, safety and traveller attitudes. Transport systems that make it difficult for passengers to reach the service cannot value their customers, and they quickly pick up on that attitude as they are customers, not captives.

BUS BASED CENTRES ENCOURAGE WALKING TRIPS

Perhaps the most important contribution that a bus based transit service can offer a new centre is the promotion of walking as a mode of consideration. As bus passengers walk to their stops and from their stops, they should be exposed to a wide range of street level businesses and activities. They learn there are local suppliers of goods and services they may wish to purchase. They learn the pedestrian network and logic of their centres. People may walk the whole trip on fine days if they know a service is available to carry them when it is inclement, or the return trip is uphill, or you are carrying a heavy load. Buses support pedestrians.

The new urbanists have found, especially in the old neighbourhoods that developed around trams, but may now be served by bus like Paddington and Bondi in Sydney, or, that people are prepared to pay premium prices to live in residential areas where walking is planned for as these feel like “communities.” We will be barraged by public service messages to walk more

to fight obesity and promote environmental sustainability, but too many of our centres have designed out that option in favour of cars and their requirements. Bus based transit networks have the following advantages for pedestrians:

- Closer stop spacing to encourage activities and enliven a street environment.
- On-street running that reveals activities to passengers as they pass by in the vehicle or walking to and from the stops.
- Successful bus stops have to relate well to the footpath network, and they add structure and focus to the hierarchy of pathways.
- Half of bus passengers have to cross the street to use their service, and this leads to more and safer pedestrian crossing points along bus routes.
- The bus services do not obstruct the roads and footpath with structures that impede pedestrians.

Well planned interchange in transit oriented centres make pedestrian legs more attractive through mode choice. When centres feature opportunities to use travel options such as multiple bus services with common trunk routing, taxis and kiss and ride can allow over trip times to be reduced as pedestrians may be able to choose their mode upon arrival at the Interchange which gives them a feeling of greater choice, better service and more control. When the pedestrian is empowered through transport design being focussed on the human scale, the centre is transit oriented.

CONCLUSIONS

We affirm that bus based transit oriented development can achieve the same objectives and replicate the success of rail based developments, although there are more developments in the planning stage than demonstration projects around. In some instances, well planned transit systems are waiting for growth to return to their regions such as Adelaide and others failed to hold their nerve when parking started to push passenger facilities from the centre to the edge of activity hubs such as Rouse Hill. Yet, there have been successes such as the early examples in Ottawa, Curitiba and Bogota to some of Australia's recent experience in Brisbane, Western Sydney and Christchurch.

Bus based transit has the potential to serve new centres well as:

- Bus routes naturally forms centres from crossroads to radial hubs, and the centralising tendency improves the performance of the bus business.
- Buses perform well in a mixed use environment as they require the least intrusive infrastructure so roads can multi-task better, they offer more destination doorstep choices as lower capacity vehicles they can be more demand responsive, and their business works best when there

are many potential trip purposes served by a route balanced in time and direction.

- Bus services can penetrate the communities to minimise access times and be local connectors to regional centres.
- Bus services maximise the capacity of the transport infrastructure as they branch to suit their catchments like other circulatory systems such as blood supply or rivers and their tributaries, and
- Bus services compliment the planning and provision for pedestrian travel.

Yet it is not enough to just say buses will serve a new transit oriented centre, there are principles that have to be carefully worked out and realised in order to successfully achieve the benefits listed above. We believe they are:

1. The bus network must supply high accessibility to new major centres, but not treat that hub as a terminus as that takes to much valuable passenger space with bus operational requirements. At the same time, half the route terminals cannot be too far from the centre so that bus schedules can be efficiently developed.
2. The route structure and service interface has to be kept as simple as possible for passenger comprehension and to reduce dwell times for loading, and this is achieved through concepts like vehicle colours to distinguish service characteristics, consistent service intervals across the week and year, ITS support for passengers.
3. Service planning has to be passenger focussed from the comfort, security and capacity of the bus stops and vehicles, to the placement of stops, to the ticketing system, fare calculations and traveller information support systems which is why it compliments the pedestrian focus of transit-oriented development.
4. The bus network has to allow for blended travel objectives as this is a critical choice factor cars have exploited to gain market share. In order for people to want to be part of our new integrated transit developments, they need to be able to do complex tips like to drop the kids at school before getting their paper and catching the rapid bus service into the CBD for work. Or they want to go to beach, collect an easy to prepare meal and their laundry on the way home. To provide this capability, the land use and transit service have to be integrated, dense at nodes and easily navigated. When this happens not only are users and supplying businesses better off, but we have reduced

total kilometres travelled and delivered on the triple bottom line.

5. The bus service corridors have to be managed to achieve performance levels that match their service objectives. The corridor that links to the nearest CBD has to be segregated as much as possible for rapid travel. The corridors that links to other centres need to be direct and anchored well in each direction for balanced demand, and local collector services need to get as close to trip destinations as possible to minimise access effort and time. It is only with bus transit that all these corridors can be accessed, and the benefits of each realised, by a single vehicle.

The overarching principle in all of these is never to lose site of minimising the travellers' door-to-door trip time. By just getting one aspect wrong, such as low bus priority in congested arterials, ticket systems that create barriers to transfer, bus stops that are inaccessible from across the road, or interchanges that spread the passengers out rather than the buses, we undermine the performance of the bus service and the centres it serves.

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