22nd Australasian Transport Research Forum
Sydney, September 1998

Melbourne bus rail interchange strategy

Graham Currie
Booz Allen & Hamilton

David Willis
Department of Infrastructure, Victoria

Abstract:

This paper describes the results of a study undertaken for the Department of Infrastructure to develop a strategy to improve the quality and design of facilities at Melbourne's bus rail interchanges. The research focused on:

- reviewing national/international practices in developing and managing intermodal Public Transport interchanges
- passenger experiences and perceptions of interchanges
- passenger views and valuations of the amenities provided at interchanges
- the development of a hierarchy of interchanges and an investment framework to bring the terminals and their amenities up to a good standard
- assessment of investment required to implement the strategy.

The study included an international literature and practice review. A comprehensive passenger survey of 31 major terminals in Melbourne and on-site appraisal of terminal needs was also undertaken during March 1998.

The study found that about a third of Public Transport operators world-wide had intermodal terminal planning policies although most were "informal". Only 3 cases of system wide hierarchy approaches to terminal planning were identified. Research evidence supported the view that passengers perceive transferring as a negative experience and that the benefits of provision of well designed interchange facilities was potentially large. Surveys of Melbourne passengers identified significant differences between their expectations for amenities and the results of overseas experience. This was considered to relate to the basic nature of many facilities provided in Melbourne. A hierarchy of Melbourne terminals was developed including 4 main types of terminal with a "sub-category" defined for terminals which were separated from rail platforms. An indicative program including provision of shelters, canopies, seating, information and security measures was developed for consideration by the Department of Infrastructure and stakeholders.

The views expressed in this paper are those of the authors and do not necessarily represent those of the Department of Infrastructure.

Contact author:
Graham V Currie
Booz Allen & Hamilton
101 Collins Street
MELBOURNE Vic 3000
Telephone: 03 9221 1907 Fax: 03 9221 1980
Email: currie_graham@bah.com.au

Introduction

"Travellers dislike the time and cost required for transferring, but they also dislike the need for added trip planning, the possibility of a missed connection, the uncertainty of arrival time at their destination, exposure to weather and crowding, the need to find the next vehicle, difficulty of baggage handling and waiting in unfamiliar or hostile surroundings. A good intermodal transfer facility can decrease the unpleasantness of the transfer by directly addressing the reasons why travellers avoid transfers.
Horowitz and Thompson (1994)

This paper describes the findings of a study to develop a strategy for upgrading Melbourne's bus rail interchanges. The study was commissioned by the Victorian Department of Infrastructure to assist in defining its priorities for improving the quality of Public Transport services and facilities in Melbourne. The strategic context for the study lies in the Government's Metropolitan Transport Plan *Transporting Melbourne* which highlights the need for improved intermodal connections within an integrated metropolitan Public Transport system. Key aims of the research were to:

- investigate research and practices in interchange planning;
- develop a hierarchy of Melbourne's terminals as a basis for targeted investment;
- recommend a framework for the provision of appropriate facilities and amenities at terminals in the hierarchy; and
- estimate costs of implementing the program.

This paper is structured to describe the key findings of the research undertaken, including:

- National/international perspectives on interchange planning - which reviews the findings of an international research and practice review;
- Melbourne bus rail interchange surveys - which summarises the findings of a range of passenger surveys undertaken as part of the study;
- Interchange hierarchy development - which describes the hierarchy of terminals developed and the associated rationale;
- Amenity planning framework - which outlines the basis for provision of amenities to types of bus rail terminals; and
- Program implementation costs and benefits - which reviews likely program costs and wider financial and economic benefits.

National/international perspectives on interchange planning

Passengers dislike transferring between Public Transport modes. In passenger preference analysis, Golob, Cantry, Gustavson and Vitt (1972) found that the 'no transfer trip' was ranked the 3rd most important factor out of 32 possible Public Transport trip features. Horowitz (1981) explored the negative features of passenger perceptions of transferring and identified a 'transfer penalty' which passengers attributed to the act of transferring valued between 23 mins and 46 mins of travel time in addition to the actual time (or cost) of making a transfer.

Table 1 : Passenger perceived travel time penalty for transfers in alternative transfer circumstances
Source: Horowitz and Thompson (1994)

Transfer Circumstance	Transfer Penalty
Unprotected Environment (open air)	32 Minutes
Protected Environment (with cover)	16 Minutes
Unprotected Environment with Services Coordinated	8 Minutes
Protected Environment Services Coordinated	4 Minutes

A more in depth analysis of the 'transfer penalty' by Horowitz and Thompson (1994), found that the design of transfer locations and their management could significantly alter passengers perceptions of the transfer penalty. Table 1 summarises key results. This suggests that the provision of weather protection at transfer locations could benefit passengers by as much as 16 minutes of perceived travel time benefit. Service coordination could benefit passengers by as much as 24 minutes

Table 2 summarises a range of international research evidence concerning passengers valuations of the amenities provided at transfer locations, mainly railway stations. Most of this evidence is from surveys where passengers were asked to rank or value various amenities. Our analysis has ranked each of the findings (from 9 data sets) and identified an average ranking shown in Table 2.

Results in Table 2 suggested facilities such as escalators and snack kiosks/vending machines were more important than safety/security features. However the data showed much variation between sources. It was clear that the circumstances, quality and quantity of existing amenity provisions affected passengers perceptions of what was important. A significant variation was found between the international evidence and passenger preferences for amenities at rail stations in Melbourne (PTC surveys - 1991 at Clifton Hill, Caulfield and Footscray Stations). In particular it was clear that needs in Melbourne were more basic and that international evidence showed a higher level of 'sophistication' in passenger's desires for amenities.

A survey of North American Public Transport Authorities examined alternative approaches in the planning of interchange sites (Booz Allen & Hamilton, 1996). This research found that 81% of authorities had formal policies for transfer locations, however most were simple rules rather than defined standards. Just over a third of authorities claimed some form of hierarchy approach was used in prioritising interchange locations. Passenger travel volume was the main performance measures used to determine priorities however location of facilities e.g. in town centres, was also important.

Table 2 : Passenger ranking of the importance of amenities provided at interchanges - average ranking from 9 separate international surveys

Interchange Amenity/Design Feature	Average of 9 Rankings 1 = Most Important
Escalators	1.7
Snack Kiosk/Vending Machines	5.8
Rubbish Bins	3.0
Remove Graffiti	6.0
Lighting	6.3
Seating	7.0
Staff	7.0
Clocks	8.0
Safety/Security	8.6
Cleanliness	8.8
Waiting Rooms	9.0
Telephones	9.5
Newsagent/Newspaper Stands	9.8
Shelter From Weather	10.3
Real Time Information Displays	10.5
Car Parking	11.3
Audible Announcements (PA)	11.6
Toilets	12.8
Directional Signs	13.8
Video Surveillance	16.0
Easy Access to Terminals	16.0
Timetable Displays	16.2

Sources: British Railways Board (1990), Copley, Bouma and de Graff (1994), Cuthbertson, McGrath and Preston (1991), Douglas (1985), Pearmain (1994), Symonds Travers Morgan (1996), Travers Morgan (1995).

Most authorities (96%) said they provided special facilities at interchanges however only a third said they had formal standards which determine types of amenity to provide at given locations. Of the facilities provided most of the authorities responding said they provided weather protection for major interchanges, however information provision and off street passenger loading/unloading facilities were also important (Figure 1).

Only three detailed cases of interchange planning using a hierarchy of interchanges and associated amenity provision standards were found in the international review PPK (1992), OCTD (1979) and US DoT (1989). Of these all identified a hierarchy of 5 interchange centre types based mainly on location, the type of local activities, the

volume of passengers and types of intermodal connections provided. Amenities provided focused on a range of types including

- shelter (notably full canopy provision between interchange sites at major terminals),
- information provision with wider inter-regional information a focus for major sites.

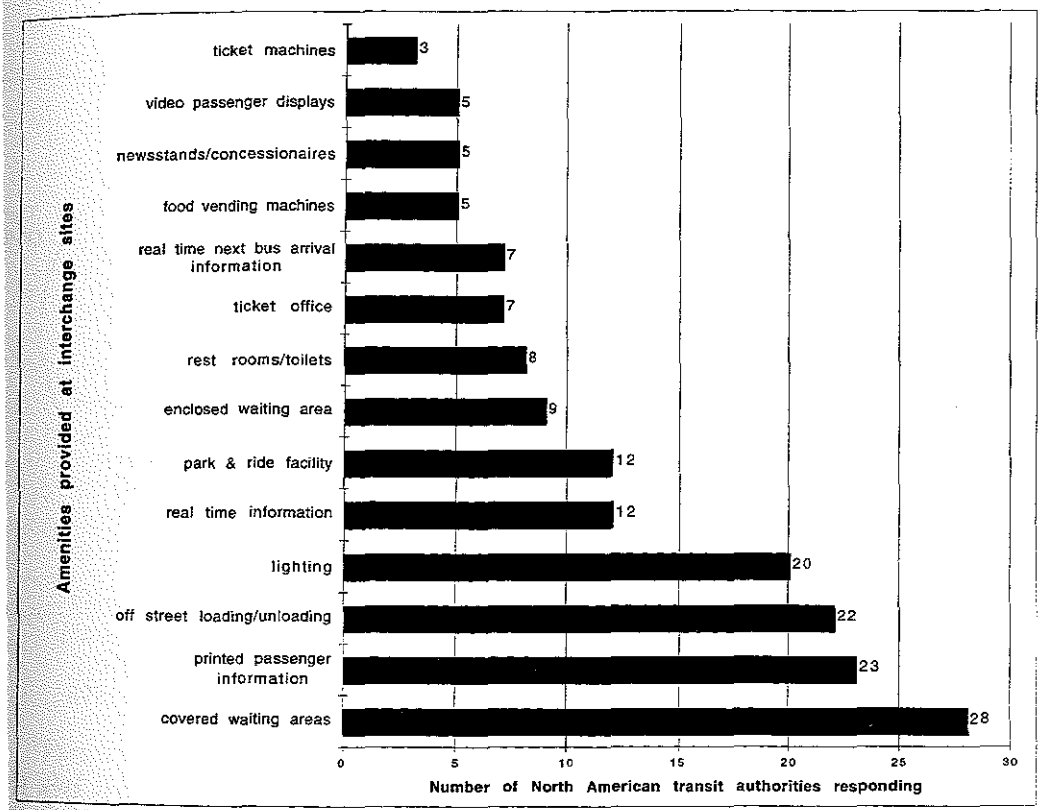


Figure 1 : Types of amenities provided at North American interchange locations
Number responding from a survey of North American Public Transport Authorities
Source: Booz Allen & Hamilton (1996) for U.S Federal Transit Administration

Melbourne bus rail interchange surveys

Passenger surveys of 31 major bus rail interchanges were undertaken in Feb.-March 1998 including counts to establish volumes of transfers between bus and rail and a passenger intercept survey to establish their views regarding amenity improvements to interchange sites.

Counts identified 93,000 weekday bus passenger movements (boardings and alightings) at the 31 sites. This represents around 8% of all daily Public Transport trips in

Melbourne. Figure 2 illustrates the key types of intermodal transfer behaviour identified. While train-bus transfer was the most important single access mode to bus (36% or 33,000 boardings), bus-bus transfer and walk access to bus together accounted for more than 50% of the surveyed trips. This indicates that bus rail interchanges in Melbourne perform a range of transport functions which facility planning needs to take into account.

Bus access mode	% Total
Train	36%
Bus	29%
Walk - other	15%
Walk - home	8%
Walk - shopping	6%
Walk - work	2%
Tram	2%
Car passenger	2%
Car driver	1%
Other	1%
Bicycle	0%
Taxi	0%
Walk access - all types	31%

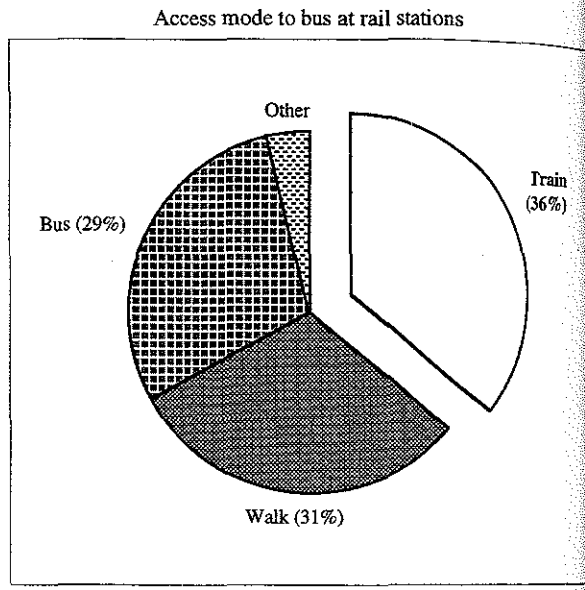


Figure 2 : Inter-modal access and transfer behaviour to bus
Source: Melbourne Bus Rail Interchange Survey - Feb.-March 1998

Key findings included:

- a number of major terminals dominated bus rail transfers in Melbourne; Box Hill had the highest volume of bus rail transfers at 3,700 each weekday;
- major terminals of Box Hill, Footscray, Broadmeadows, Frankston, Essendon, Glen Waverley and Dandenong accounted for over 16,000 bus rail transfers each weekday or almost half of all transfers made;
- interestingly while bus rail travel volumes were high at major terminals, the proportion of boardings made from rail was relatively low. Other bus functions such as bus-bus transfers were also important; and
- there was a distinctive group of interchanges where the proportion (rather than the volume) of bus rail transfers was over half of all bus boardings. These were suburban locations where the main function of local buses was rail access.

Some 10,000 passenger surveys were also undertaken asking *'If there was any one thing about this bus stop/terminal area which could be improved, what would you like it to be?'* Figure 3 shows the results for the 31 Melbourne terminals as a whole.

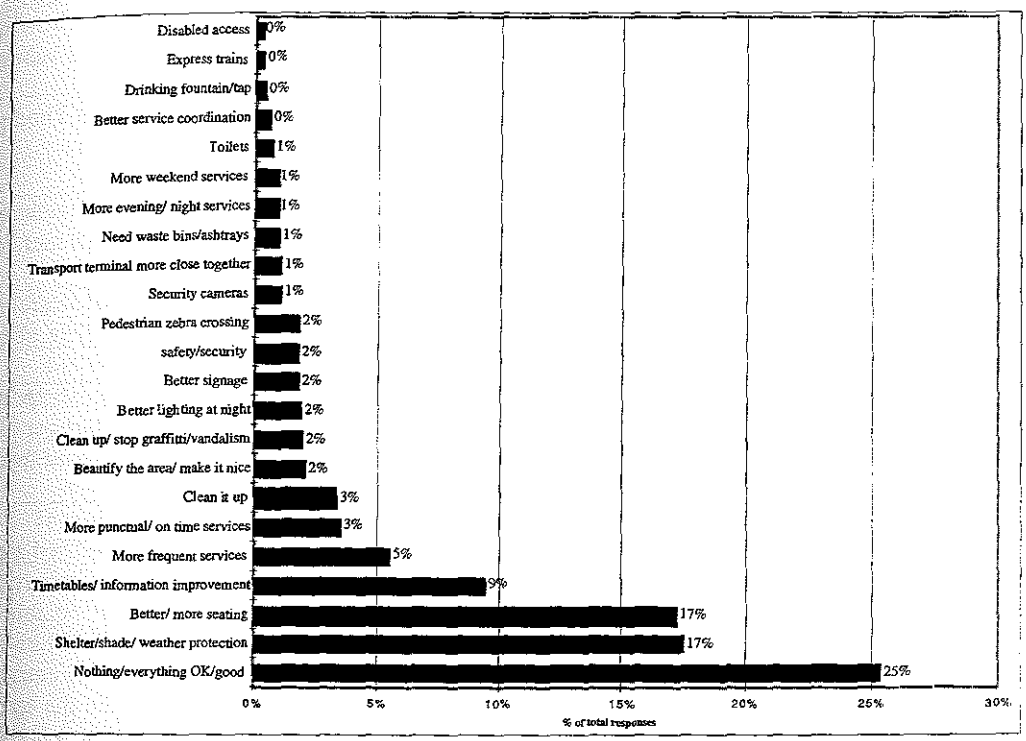


Figure 3 : Melbourne passenger preferences for bus rail interchange improvements
'If there was any one thing about this bus stop/terminal area which could be improved, what would you like it to be?' Average response for all 31 terminals surveyed.
Source: Melbourne Bus Rail Interchange Survey - Feb.-March 1998

Passengers displayed a consistent preference for improvements to basic amenities; shelter and seating. Improved timetable/information provision was next most important followed by concerns about service frequency/punctuality. Requests to have the terminals cleaned up were also important as was safety and security at some locations.

Results for some terminals displayed a unique set of passenger preferences, e.g. safety/security concerns were more important in Sunshine, Footscray and Broadmeadows. These preferences allow the targeting of specific improvements to terminals where passengers have particular concerns.

Interchange hierarchy development

The international practice review identified the following key criteria for determining a hierarchy of terminals:

- ***Level of Patronage*** - This was the main method used to allocate funding to interchanges

- ***Location/Nature of Activity*** - All interchange planning focused on city centre/major regional and sub-regional centres as important sites. Local sites and suburban locations were treated as separate cases.

  Sourced from Booz Allen & Hamilton (1996), Horowitz and Thompson (1994), OCTD (1979), PPK (1992), US DoT (1994)

The passenger surveys reported in this paper also identify some important features of Melbourne bus rail interchanges which should be considered in determining a hierarchy:

- ***High Bus-Bus Locations*** - Bus terminals with high volumes of bus-bus interchange present 'special' challenges for terminal planning. Interestingly these are also the larger terminals.
- ***High Proportion Bus Rail Interchanges*** - Although passenger volume is important, sites with more modest volumes but where over 50% of all bus passenger come from rail clearly have a rail focus. A series of suburban stations with these features are identified for special consideration.

In addition to the above, a study of site circumstances of each terminal identified a good case for a focus on the structural nature of bus rail interchange facilities, in particular the ***Separated and Integrated Nature of Bus Rail Interchanges***. It is notable that circumstances were very different at Footscray, where bus terminals are separate from the station, compared to Blackburn, where bus bays are adjacent to station entrances. Where terminals are separate, planning must focus on measures to make the transfer between terminals easier. Management of measures to achieve this may also involve a wider set of agencies and considerations. In addition the study noted many examples where bus services operated near to stations hence interchange was possible and took place, however it was not 'planned' since the bus stop was quite separate from the station area.

On the basis of the literature review reported above, the Separation/Integration criterion does not appear to have been used elsewhere for Hierarchy definition. However we view it as a key factor since it isolates a major planning requirement for good management of transfers.

Table 3 shows the bus rail interchange hierarchy developed from the above criteria. Four types of interchange types were identified, however each would be divided into separate and integrated types suggesting 8 categories in total.

The highest category of interchange is ***A - Premium Interchanges***. These are located in the middle of an important activity centre. All bus routes operating to the terminal terminate there. Walk access to the terminal is heavily based on local shopping and commercial areas. Bus access to/from the terminal is difficult and often congested. The bus terminal function is mixed & includes bus-bus as well as bus rail access and access to local activity.

Table 3: Framework for Melbourne bus–rail interchange hierarchy

	A. PREMIUM Interchange	B. REGIONAL Interchange	C. NEIGHBOURHOOD Access Hub	D. LOCAL Interchange
Bus terminal type	Major terminus	Regional terminus/ some through routes	Some local terminus/ Mainly regional through routes	Mostly through services
Bus network form	Major regional	Major sub-regional	Local network	Various
Location	Town/city centre	Town centre	Residential suburb	Suburban
Walk access	Development oriented	Development oriented	Mixed but resident oriented	Residential
Ease of bus access	Often congested	Often difficult	Little difficulties	Not an issue
Type of rail station	Premium station	Often premium station	Usually lower order	Lower order
Function of bus connection	Mixed local access/bus bus/bus rail	Mixed local access/ bus bus/bus rail	Mixed but bus rail access high	Local access

B - Regional Interchanges are also at important sites but do not have the city-wide/CBD importance of A - Premium Interchanges. The bus network includes some through routes. The main differences between Regional and Premium Interchanges are the relative size and level of activity.

C - Neighbourhood Access Hub The bus network to these interchanges focuses on local residential suburbs with access to rail a major function. Locations are suburban. Bus vehicle access has little congestion problems.

D - Local Interchange Here bus services are almost entirely through routed. These buses cater for local residential access mainly and the possibility of access to rail is often not planned in timetables or maps. Stations are predominately low order Met Train Stations and in most cases, the bus stop is separated from the rail terminal.

Separate/Integrated Interchanges A terminal is separated if some or all of the bus bay areas are not adjacent to station entrances. For most terminals this is easy to designate. For others, such as Box Hill, this is difficult (we believe Box Hill to be separate due to the long walk distance and grade separation).

Figure 4 shows the designation of hierarchy classes to the 31 stations which the study focused on. In total the study defined 161 Melbourne stations where bus rail interchange was possible, most were designated as lower order category D - Local Interchanges.

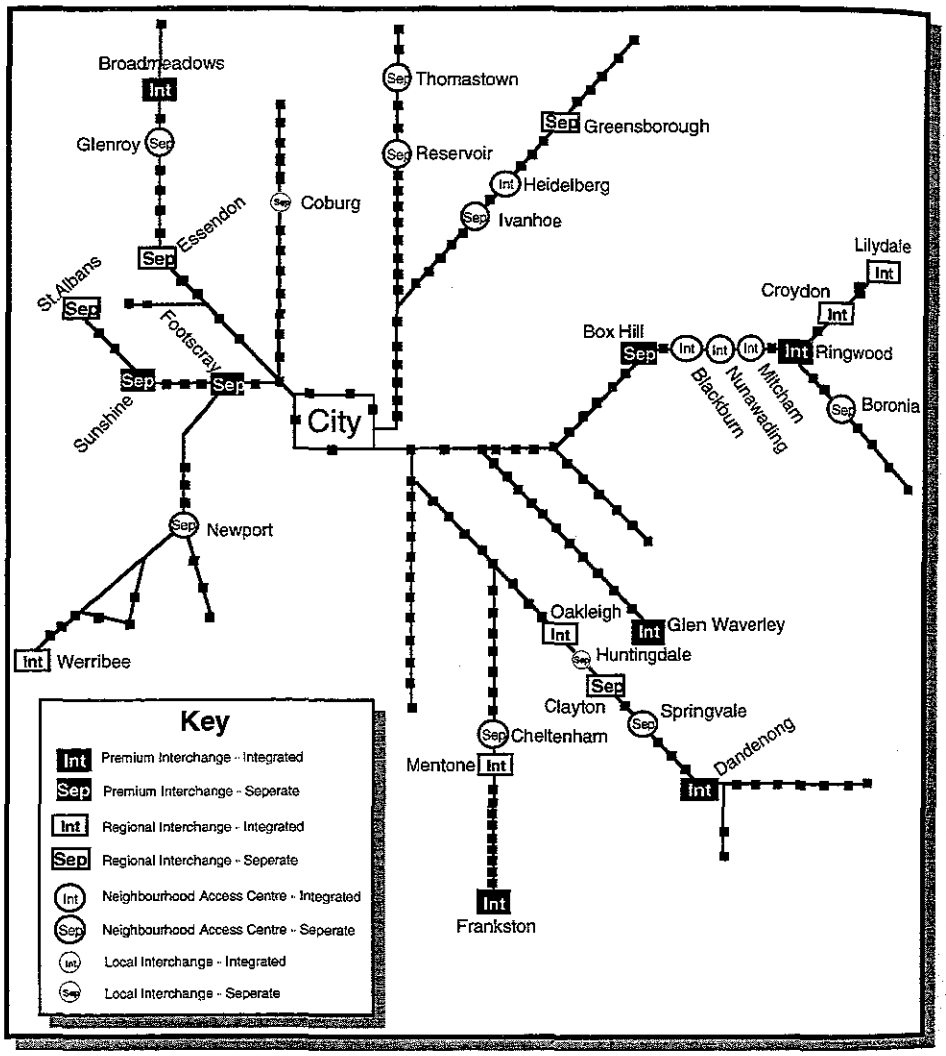


Figure 4: Bus rail interchange hierarchy - major Melbourne interchanges

Amenity planning framework

A number of key conclusions emerged from the study in relation to passenger amenities at bus rail terminals which were critical in determining amenity standards:

- ***Passengers lack basic amenities*** - Shelter and seating are very basic needs for interchange planning. Passengers placed great emphasis on these facilities which indicates a lack of basic need provision and also a lack of sophistication of passenger perceptions of what is possible in terms of terminal planning and design. Evidence from interstate/overseas shows different passenger perceptions (and amenity provision),

- ***Planning should aim to world standards*** - While passengers perceptions, and the provision of amenities to passengers may lack sophistication, the strategy should seek to reach high quality standards, particularly for Premium Interchanges.
- ***The priorities for basic amenities are clear*** - Passengers priorities are for Shelter, Seating, Information Provision and Clean/Attractive Interchange Environs.
- ***Safety/security should also have priority*** - Although not a major passenger priority in the survey, safety/security should be a major concern for planning.
- ***Sites with particular issues/concerns should be targeted*** - A range of localised issues were highlighted by passengers. For example at Box Hill passengers highlighted cleanliness and general appearance in their responses to the survey.

Table 4 : Amenity provision standards by interchange group

	A. PREMIUM	B. REGIONAL	C. NEIGHBOURHOOD	D. LOCAL	Higher priority for Separate Interchanges*
Key	√ = Amenity Warranted # = Dependent on Demand				
Bus shelters - quality design incl.lighting	√	√	√	#	-
Canopies - cover/ lighting for bus-rail walk	√	√#	#	#	√
Seating	√	√	√	√	-
Information provision					
Bus stop timetable/map unit- incl. rail schedule	√	√	√	√	-
Regional bus map (incl lighting)	√	√#	#	#	-
Local area street map	√	#	#	#	√
Bus terminal bay map	√	√	#	#	√
Real time rail departures display (PIDS)	√	#	#	#	-
Real time bus departure displays	*Investigate*	-	-	-	-
Signage					
Bus stop flag/id.	√	√	√	√	-
Bus-train path signage - Incl. pathway signs	√	√	#	#	√
Security/safety					
Interchange lighting - Incl bus to rail paths	√	√	#	#	√
CCTV	√	√	#	#	√
Safe areas - 'panic buttons'/'hot line'	√	√	#	#	√
Other					
Bus-rail coordination technology	√**	√#**	√#**	#	√**
Clocks	√	√	√	#	√
Waste bins.	√	√	√	√	-
Vending machines	√	√#	#	#	-
Telephones	√	√	√	√	-

**Interchanges which are separate are given priority in warranting some facilities as indicated*

***PIDS rail departure displays to be preferred at interchanges where bus drivers can see the displays*

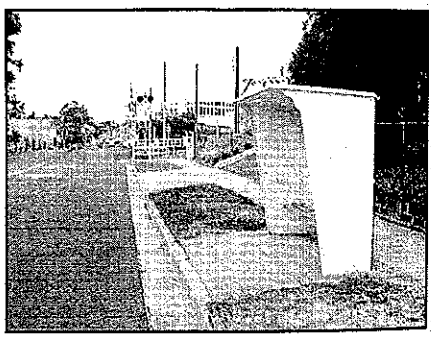
Table 4 is the amenity provision framework developed for interchange types in the hierarchy. The framework was developed from the international practice review, and from passengers own preferences for improvements to amenities. A workshop was also held with regional bus operations managers of the Department of Infrastructure to assist in identifying the priorities for amenity improvements by site.

Table 4 indicates which types of amenity are warranted for each interchange type. Standards for Shelter (including canopies), seating, information provision, signage and safety/security are detailed for terminal types A to D In addition, the last column indicates where certain amenities should be provided to interchanges designated as separate in the hierarchy. Separate terminals have amenity provision priority for:

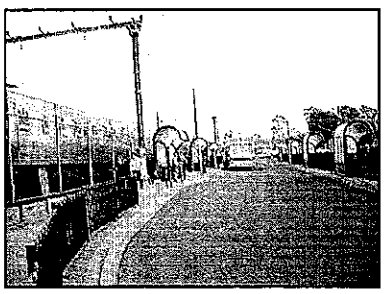
- canopy coverage between bus and rail terminals
- types of information to assist finding the terminals at separate locations
- security measures to protect passengers travelling between bus and rail terminals
- information provision to assist coordination between bus and rail services.

Figure 5 shows some of the features of the design standards for shelter at each bus rail interchange. This includes a requirement to replace older shelter designs with new designs incorporating better lighting and surveillance qualities to improve security/safety. Canopy provision at major interchanges is a major feature of the strategy. These incorporate coverage for all walkways between bus and rail terminals.

Good designs e g 'Adshel' design
Transparent glass throughout enhances surveillance Lighting is provided to increase night security



The 'bad/ugly'
Walls reduce surveillance and make it difficult to see the bus while seated This area has poor street lighting making it insecure at night.



Glen Waverley Station
The strategy recommends canopy provision at all major terminals for all bus waiting areas and for walkways between bus and rail stations

Figure 5 : Key features of weather protection measures in amenity standards

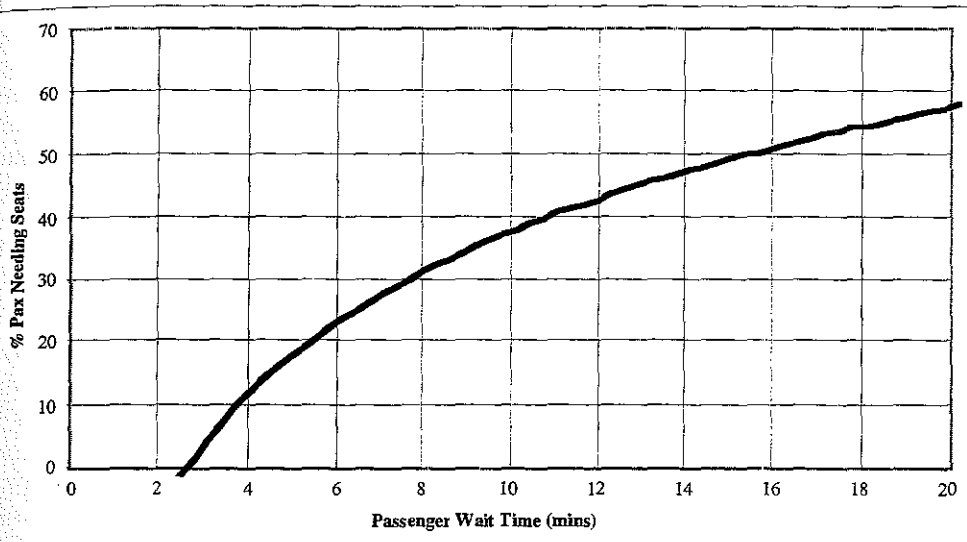


Figure 6 : Possible design standard for seats provided at bus-rail interchanges
(based on workshop with D o.I. regional bus managers)

A new standard for seating provision was developed as part of the study, largely as a result of the importance which passengers placed on seating. International evidence on seating standards was limited; some US authorities suggested a standard whereby the number of seats provided should be 5% of peak hour passenger loads (US DoT 1989). The study found this standard to be well below passengers expectations for seating in Melbourne. The following key drivers of seating needs were considered relevant:

- more seats would be required if waiting times were longer;
- some types of passengers e g. the elderly, would need more seating; and
- it is important to spread seating provision over a wide area such that passengers have choices as to whether they sit next to other passengers.

Figure 6 shows the design standard for determining the number of seats that was developed for the strategy. This suggests the number of seats is related to the average scheduled passenger wait times at each terminal. These were calculated on a terminal wide basis using average scheduled wait times by bus bay area.

In practice the application of this standard included a minimum seat requirement of 5% of passengers who wait and a maximum of 50%. The actual number of seats to provide was based on the average volume of passengers using the interchange as identified in the survey.

Information Standards included provision of quality maps and timetables to reassure passengers making transfers. 'Higher order' maps showing city wide information is to be provided at larger terminals. Priority is given to provision of maps showing local street layouts and pathways between bus and rail areas at separate interchanges

Information provision also includes the provision of real time train departure displays at bus terminal areas and an investigation program to develop real time bus departure displays

A technology based information initiative within the strategy is *Bus Rail Coordination Technology* in the form of a real time radio broadcast of train departure information on a localised FM radio system surrounding key stations. Broadcasts would be received by buses in the vicinity of stations. Feeding off rail timetable display data, this system provides bus drivers and local passengers with useful information upon which to base bus rail transfer decisions. It is targeted at ensuring better coordination of buses with trains, mainly by giving bus drivers the information upon which to make station departure decisions when rail services are running late.

Program implementation costs and benefits

Table 5 summarises the estimated resource implications and costs of upgrading all of Melbourne's 161 bus rail terminals to the standards identified. Some $11M is required in total, most of this is targeted at the A-Premium Interchanges and B-Regional Interchanges. The highest costs ($7..3M) are associated with area canopy coverage for major terminals. In addition to these costs, on-going maintenance needs were identified in the strategy. These need to be agreed between the many authorities involved in interchange planning. Identifying the responsible agencies will be important in achieving an on-going standard of cleanliness and general maintenance.

Assessing the potential benefits of the bus rail interchange upgrade program is uncertain since improvements are related to passenger amenities and their perceptions of transfers rather than direct travel time savings.

The research results quoted earlier, Horowitz and Thompson (1994), suggested passengers perceptions of transfer penalties reduced by as much as 16 mins between cases where interchange was undertaken in terminals with and without weather protection. Given the volumes of bus rail (and bus-bus) transferring occurring in Melbourne, weather protection could be worth up to $31M[1] p a. in perceived benefits to passengers. Such a figure would suggest an economic payback period for upgrade investment of $11M in only a few months. However in practice many existing Melbourne terminals already have some weather protection and application of the Horowitz research to Melbourne may require more careful consideration. It could be that passengers value weather protection highly in poor weather conditions, particularly North American winters, however Australian weather conditions are generally more temperate (even in Melbourne!). In addition not all of the $11M of upgrade investment is associated with weather protection.

From an alternative perspective, the $11M of investment would require annual economic benefits of around 135,000 passenger hours of perceived time savings to

[1] *Assumes 16 minutes perceived benefit for 16.8M transfers p.a. at a value of time of $7/hour*

justify investment over a 20 year evaluation period[2]. Based on the passenger transfer volumes surveyed in Melbourne (16.8M p.a.), this would require less than 0.5 of a minute of perceived passenger benefit per trip to be generated. Since Horowitz and Thompson are suggesting benefits may be more than 32 times higher than this (for weather protection alone), the case for investment on economic grounds appears excellent.

Table 5 : Bus rail interchange upgrade program costs
All Melbourne terminals

Amenity area	Facilities provided	Costs by terminal type ($000)				
		A	B	C	D	Total
	Number of interchanges->	8	11	62	80	161
Weather protection						
Refurbish/upgrade existing shelters	• 94 existing shelters replaced, 10 sites refurbished	11	45	839	-	896
New shelters to cover all major areas	• 54 new shelters required	18	37	429	-	484
Canopies	• 11 Premium Interchanges have full/part canopy cover	5,892	1,420	-	-	7,312
Seating						
Seating	• 448 seating units required at all sites	35	20	73	28	157
Information						
Regional bus map	• 19 new regional bus maps at 57 displays	98	110	-	-	208
Local area street maps	• 90 new local area street maps at 226 displays	30	14	105	143	292
Bus terminal bay map	• 74 new local area street maps at 190 displays in 74 terminals	34	42	41	83	200
Real time rail displays	• 22 new display at Premium Interchanges	165	-	-	-	165
Signage	• 348 sets for display at major and segregated terminals	19	11	62	80	172
Security/Safety						
Lighting	• 23 new sets of area lighting for bus terminal areas at major terminals	120	110	-	-	230
CCTV	• 256 new camera units at Major and Segregated sites	99	111	229	-	439
Safety Area Intercom	• 206 units at Major and segregated interchanges	16	18	42	-	76
Other Amenities						
Bus rail coordination radio	• System Development & Provision at 18 stations	103	127	-	-	230
Clocks	• 215 new clocks	10	11	21	35	76
Waste bins	• 167 new bins	5	4	13	3	25
	TOTAL	6,655	2,080	1,854	372	10,962

[2] *Assumes a 7% discount rate over 20 years. The Value of Time is $7/hour*

From a financial perspective, reductions in passenger perceptions of generalised travel time are likely to result in generation of new trips and associated fare revenues. Assuming an average weighted bus rail trip generalised cost of 100 minutes, passengers would have to perceive travel benefits of more like 6 minutes to make fare revenues grow enough to cover an $11m investment[3]. While this is well within the ranges of the Horowitz and Thompson evidence the case for investment is less strong than in economic terms. Furthermore the financial costs of carrying additional passengers must be considered. Overall it is clear that the financial case is less strong than the economic case.

Conclusions

This paper has summarised the findings of a study to develop a strategy for upgrading Melbourne's bus rail interchanges using international evidence on planning methods for interchanges, and the results of a passenger survey of 31 terminals in Melbourne.

International practice has shown that passengers dislike transfers between Public Transport modes and that good interchange design can assist in reducing negative passenger perceptions. Evidence of planning of interchanges demonstrated that around a third of US agencies used a hierarchy approach in planning, however this was usually an informal practice and only 3 detailed cases of interchange amenity planning using a hierarchy approach could be identified.

Melbourne passenger surveys (March 1998) identified that over 33,000 bus rail transfer occurred each weekday and also noted that bus-bus transfer and walk access to bus at interchanges were important. Passengers demonstrated a clear preference for improved shelter and seating facilities at terminals.

A hierarchy of 4 key interchange types was developed for Melbourne interchanges based on patronage, location and type of intermodal connections provided. In addition a sub-category for each type of interchange was defined considering the physically separated or integrated nature of the bus bay and rail platform facilities.

Standards for amenity provision were developed to best target the types of amenities required to higher order interchanges and to sites where these amenities are needed. This has included standards for shelter, seating, information, safety/security and a range of other amenities.

The costs of implementing the upgrade strategy has been estimated at $11M for all of Melbourne's 161 bus rail interchange sites. The economic case for this investment, based on passenger benefits derived from better amenity and weather protection appears good. The financial case, based on additional fare revenue generated by passengers

[3] *Around $1M p.a. of additional fare revenues would be required p.a. to justify an $11M investment (at 7% discount rate over 20 years). Assuming an average fare of $1 this requires about 1M passengers p.a. to be generated or a 6% increase on the 16.8M passenger transfers p.a. Using a generalised cost elasticity of -1.0 a 6% decrease in total generalised cost would be required for a 100 minute average bus rail generalised cost trip*

encouraged onto Public Transport is less clear. Provision of maintenance of facilities and assignment of responsibilities for maintenance are also critical issues.

Overall the upgrade strategy represents a targeted investment program which, with appropriate marketing, should reduce negative passenger perceptions of interchanging between modes of transport. Better transfer experiences can encourage greater transfer activity making a wider choice of Public Transport services and destinations available to passengers. The larger interchanges are also integral parts of major urban centres and their improvement can be seen as an opportunity to improve the wider urban fabric, notably often significantly unattractive community 'black spots' into which bus and rail passengers must venture to use Public Transport.

References

Booz Allen & Hamilton (1996) Passenger transfer system review *Transportation Research Board* for US Federal Transit Administration 1996 TS019 1996 37pp

British Railways Board (1990) *Demand forecasting handbook*

Copley, G, Bouma, A and de Graff E (1994) Station investment : priorities and values *Special Session Energy, Transportation and the Environment*, from MVA consultancy London UK

Cuthbertson T, McGrath, F and Preston J (1991) *Assessing the commercial benefits of improving station facilities and information provision*

Demetcky, MJ, Hoel, LA and Virkler, MR (1976) Methodology for the design of urban transportation interface facilities *US Department of Transportation* DOT/TST-77/46 final Rpt 119pp

Department of Infrastructure (1996) *Transporting Melbourne A strategic framework for an integrated transport system in Melbourn*, Information Victoria

Douglas, Dr N. (1995) *Value of rail service quality* Pacific Consulting Infrastructure Economists Ltd for Cityrail Planning and Business Development Oct 1995

Dolob, Cantry, Gustavson & Vitt (1972) 'An analysis of consumer preferences for a public transportation system *Transportation Research* Vol 6. No.1 March `1972

Dill, KM and Turnbull, KF (1994) Design guidelines to enhance pedestrian and transit interaction *Texas Transportation Inst.* Report No. TX-94/1975-1;Res Rept 1975-1TI:7-1975 Page: 62

Horowitz, AJ (1981) Subjective value of time in bus transit travel *Transportation Vol No.2* June 1981: 149-164

Horowitz, AJ and Thompson, NA (1994) *Evaluation of intermodal passenger transfer facilities* Federal Transit Administration DOT-T-95-02

Orange County Transportation Department (1979) *Transfer centre needs*

Pearmain, D. (1994) *The measurement of users willingness to pay for improved rail facilities* Steer Davis and Gleave 1994

PPK (1992) *Cityrail interchange policy* for Cityrail NSW.

Public Transport Corporation (1991) *Customers perceptions of stations*

Public Transport Corporation (1994) *Station investment strategy*

Rabinowitz, H, Beimborn, E, Lindquist, P. and Opper, D, (1989) *Market based transit facility design* URT-33 - Urban Mass Transportation Administration

Symonds Travers Morgan (1996) *Porirua station development - review of international experience in passenger amenity valuations* - Work Note, contact Booz Allen New Zealand for a copy

Transportation Research Board (1986) *Transit terminals: planning and design elements*

International Road Federation Conference (1994) *Intermodal passenger facilities in Western Canada: some experience and lessons*

Transit Cooperative Research Program (1996) Guidelines for location and design of bus stops *TCRP* Report TC0019 211pp

Transit Cooperative Research Program (1981) Guidelines for design of rapid transit facilities *TCRP* Report TEC-009

Travers Morgan (1995) *Porirua Station Surveys - Passenger valuations of station amenities*

UITP *Location and design of interchanges, rail, bus and car*

US Department of Transportation (1994) *Intermodal passenger terminal facilities project summaries - A compendium of proposed, active and completed intermodal passenger terminal facilities* FTA-DOT-TTS-94-1 245p

Widlert, S. (1989) *A higher standard of public transport, the preferences of passengers commuting to work* FTB Meddelande Issue No. 91 33p. [Swedish]