

INTERCHANGE FACILITIES IN URBAN PUBLIC
TRANSPORT

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ABSTRACT

Interchanges are an integral part of an efficient and cost-efficient urban public transport system. The nature of Australasian cities means that the proportion of interchange journeys is higher than found in many other parts of the world. Consequently the planning of interchange facilities assumes considerable importance. The views and needs of transport users and providers, interchange management and property developers are considered in determining the priorities in interchange design. Recommendations are made based on a combination of research and experience of developing improved bus stations and bus/rail interchanges in New Zealand, Britain and Ireland. Deregulation of urban public transport can have either a positive or negative influence on the operation of interchanges, but well-sited locations which represent a focal point for the area are unlikely to diminish in importance.

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1. INTRODUCTION

In an idealised public transport system there would be no need for interchanges at all. All passengers would have a direct route from their origin to their destination and be able to board their bus, coach or train close to their office, factory or the shops. In a less than ideal world, where economics play a major role, interchanges are a necessary evil in efficiently providing for a large proportion of the journeys which individuals wish to make.

This paper considers the factors which influence the demand for interchange; the organisation, ownership and management of interchange facilities; and the principles of successful interchange design from the point of view of passengers and operators.

2. THE NATURE OF INTERCHANGE

The level of intra and inter-modal interchange which takes place is a product of many local socio-political, demographic and topographical factors as indicated in Table 1. The low residential density and dispersed nature of Australasian urban areas, compared to European and Asian cities, means services between many generators and attractors can only be economically provided at low frequencies or by transfer connections. Interchange is, therefore, a relatively more important feature of public transport provision in this part of the world than elsewhere.

This situation is well illustrated by the contrast between the prevalence of interchange in Auckland and the Scottish city of Edinburgh, revealed by recent surveys. In Auckland 27 percent of bus passengers and 23 percent of rail passengers on main arterial routes needed to interchange during their journey. In the more centralised and densely populated city of Edinburgh the proportion of transfer trips falls to 9.5 percent among bus users and 16.5 percent for rail users. Even in major British conurbations, such as Greater Manchester, where several purpose-built interchanges have been constructed in recent years and a ticketing system exists to encourage transfers, only 23 percent of trips by bus involved interchange (Scantel, 1979).

Facilities for modal interchange such as bus/rail connections attract a high level of interest from planners and politicians, often seen as symbols of commitment to an integrated transport policy (Kilvington, 1986). However, their importance is often overstated. Taking Auckland as an example again, some 22 percent of all public transport trips involved a bus/bus connection and only 1 percent bus/rail interchange.

Nevertheless, interchanges can act as a considerable stimulus to public transport usage. The construction of Altrincham (Greater Manchester) in 1976 combined good quality bus/rail interchange with easy access to the local shopping centre. Patronage increases of 13 percent on the bus network and 16 percent on suburban rail services were observed 2 years later, giving a positive return on additional operating costs. Capital costs were not fully recovered but the scheme was shown to be justified in social cost-benefit terms (Tyson, 1978).

It must also be borne in mind that in most areas a majority of people passing through an interchange may be either starting or finishing their public transport journey rather than making a transfer connection. The needs of this group must remain a priority. Many interchanges in reality often become a focus for commercial activity. They are by definition a high point in terms of accessibility, stimulating economic and physical development well beyond the nominal boundaries of the site. Their status has been recognised in a number of prestigious redevelopment schemes which have been advanced with private sector funding. Such construction can, of course, also defray the capital costs of the infrastructure.

In transport terms interchanges for road and rail passenger services come in a variety of sizes and layouts from major transportation centres to wayside railway halts and on-street bus stops. This paper concentrates on the provision of purpose-built facilities serving centres of population. These interchanges can be divided into three main categories:

1. **Hub & Spoke Interchange** - serving inter-lining traffic on inter-urban routes. This may be the intersection of two trunk routes or the focus of a number of secondary routes (or spokes).
2. **Terminal Interchange** - acting as the main terminal point for inter-urban services, feeding traffic into the local urban network.
3. **Urban Interchange** - acting as a central terminus and boarding point for local bus and/or rail services.

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The operational requirements of each type and passenger expectations differ considerably. However, it is common for a single interchange to combine all these functions to a greater or lesser degree and so some kind of compromise solution is called for.

The standard of facilities which has traditionally been provided for rail systems has been an order of magnitude higher than that for buses and coaches. The development of the rail network in advance of the growth of road public transport, and the greater capital investment committed, have ensured that railway stations have often become a de-facto focal point for local transport as in Wellington, New Zealand (SDG, 1988). However, where the town grows before the development of railways and central area penetration is relatively weak, free-standing bus and coach stations have often grown up, as in Auckland.

2.1 Effect of Deregulation

The proposed deregulation of passenger transport in New Zealand will mean the end of traditional territorial monopolies and the abolition of effective boundary restrictions. The resultant increase in opportunities for through-running of services may mean that any badly sited and hence largely artificial, interchange points will decline in importance and ultimately disappear. Conversely, well-placed natural interchanges will grow as transport operators compete to serve these major traffic generators.

Although such patterns take time to evolve, this is clearly occurring in the British context where deregulation became effective from October 1986. In Tyne and Wear for example the public transport system was heavily founded on several purpose-built bus-metro interchange points. At the time of writing the fortunes of these interchanges have been very mixed. Some have witnessed increases in traffic as bus operators recognise the benefits to themselves of feeding passengers to and from the metro and/or local shopping and commercial centres. Others have suffered greatly, with bus operators deliberately re-routing services away from the interchange to maximise their own revenue and avoid the need for 'forced' interchange.

A further development, albeit interlinked with property speculation has been the closure and redevelopment for other purposes of a small number of allegedly poorly sited bus stations.

Paradoxically the greater instability in service provision which must inevitably follow deregulation has led the public to place greater reliance on interchanges, both as a source of information and for the reassuring sense of continuity which they provide.

TABLE 1: SOME FACTORS INFLUENCING THE DEMAND FOR INTERCHANGE

	Probability of Journeys Involving Interchange	
	Low	High
SOCIO-POLITICAL FACTORS		
Variety of Modes	Single mode network, usually bus based.	Multi-mode networks. Combination of bus, rail, and ferry services
Regulatory Structures	Completely deregulated with no restrictions on service functions	Highly regulated and fully coordinated network of services
Fares & Ticketing Policy	Uncoordinated system with independent fares structure and no through ticketing	Highly integrated system. No financial penalty associated with interchange.
DEMOGRAPHIC/ TOPOGRAPHIC INFLUENCES		
Urban Form	Development in concentric zones with concentration of shops/offices in single downtown centre.	Clustered development with series of independent nuclei. Dispersed pattern of commercial development.
Residential Density	High density supporting public transport services serving a range of destinations.	Low density only capable of supporting a single service.

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2.2 Ownership and Operation

Traditionally railway stations have been almost exclusively the property of the railway company. In contrast the ownership of bus interchange facilities, at least in the main centres, normally rests with local or regional government, or a commercial property company rather than the transport companies, although space may be leased and day-to-day responsibility delegated to the principal bus operator.

Moves towards transport deregulation may serve to encourage the severance of links between transport provision and terminal ownership/management. Operators with exclusive or majority rights to terminal facilities have an important competitive advantage and have been known to exploit their monopoly position to deter new entrants.

2.3 Charges

The managers of terminal facilities in a deregulation environment are faced with a dilemma. Departure charges necessary to cover running costs to maintain the interchange may deter operators from using the facility and undermine its viability. Experience to date in the UK has indicated that the value of benefits to operators of using bus stations generally exceed the cost, but there has been strong resistance to proposals for increased charges. There has also been some experience of operators changing to on-street pick-up/set down points as a consequence of higher departure charges.

Whilst the option to park free of charge on nearby streets remains available to operators the concept of levying 'economic' charges remains difficult. In some cases the local authority has elected to provide the facilities free of charge because of the perceived benefits to the community in having a concentrated departure point and avoiding traffic conflict which would occur in the event of a return to on-street stands.

2.4 Through Ticketing

The disbenefits of interchange are significantly increased for travellers changing from one public transport service to another if they are required to purchase another ticket at the point of interchange. This can involve time spent in queuing and, in cases where the time available for transferring between services is short, will heighten travellers' anxiety as to whether they will make their connection. A system of 'through ticketing', which provides one ticket for all stages of a journey will reduce these disbenefits.

The need to buy another ticket may also increase the total cost of the journey. More importantly, the process of purchasing a second ticket emphasises to the traveller the direct cost of using an interchange. This last point is important because it provides some explanation as to the success of facilities such as area 'travelcards', which extend the through-ticketing principle from single journeys to journeys over specified geographical zones. With such a system public transport users pay for their travel in advance, so they are less likely to equate their lump sum payment with any specific journey or transfer facility.

2.5 Coordinated Timetables and Service Integration

Where travellers are using public transport for the whole journey and services are infrequent, waiting time at interchange can be substantially reduced by timing connecting services so that sufficient time is available for travellers to transfer from one to another. For those accessing a public transport service by car or on foot, reliability of the service is particularly important, so that they can time their access journeys to minimise time spent at the interchange.

Coordination of public transport services is well established, but by no means universal, among services belonging to the same operator. It is less frequent between services belonging to different operators, but there is scope for cooperation, with potential benefits for all parties involved. An example might be a bus company providing distributor services for a rail operator.

Public perceptions of a cohesive public transport system will be enhanced by adopting a consistent image for different public transport services. Such an approach might include the publication of 'all-in-one' timetables for buses and local trains, or the use of a common brand name, logo or even livery.

3. THE PASSENGER'S VIEWPOINT

Few people would, out of choice, choose to spend any length of time in an interchange. It has been demonstrated repeatedly that passengers actively dislike the concept of interchange and attach significant penalties to it, over and above the actual waiting time. The scale of these penalties is based on a combination of factors:

- o **Mode Change** - giving rise to uncertainty and anxiety. Bus to bus changes are less predictable and more likely to give rise to the problem than advertised rail connection.

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- o **Journey Characteristics** - more stress is associated with a long distance journey made infrequently than a regularly made journey where the passenger is familiar with the pattern of service.
- o **Passenger Characteristics** - the age and sex of the passenger influences their confidence in and tolerance of interchange. Women are reported to be more tolerant but also more anxious about interchange. The elderly are particularly anxious and will sometimes go to considerable lengths and expense to avoid it.
- o **Interchange Facilities** - the design of the interchange and waiting conditions clearly affect passenger perceptions and willingness to use the facility.

The principal design objectives must be to facilitate the flow of passengers through the building and to reduce the disutility of waiting time. The period of waiting for an onward journey is a frustrating one for passengers. They are likely to seek guidance and reassurance about services requiring effective information on times, departure points, and likely delays for onward services. If these are unavailable stress and even hostility develop.

3.1 Penalties of Interchange

A recent study carried out by SDG on behalf of the Auckland Regional Authority (SDG, 1989) analysed the penalties associated with interchange. Trips from zones without direct public transport connections to work or shopping areas took an average of 16 minutes longer (within a range of 8 to 40 minutes) than a comparable journey on a direct service. A sample of point to point flows analysed suggested an additional financial penalty of NZ\$1.23 on an average adult single fare of \$2 for a direct journey. The penalty in terms of generalised cost would be even greater. It was concluded that considerable scope for improving the co-ordination of services and that the introduction of through ticketing would offer significant benefits to passengers.

3.2 Views of Users

A survey was undertaken of 1,800 users of the 11 main interchanges and terminal facilities in Auckland. A third of those interviewed were interchanging between two public transport modes, of which 84 percent were transferring between bus services. Respondents were asked about their perception of the quality of existing interchange facilities with a view to highlighting priority areas for improvement.

Overall almost two-thirds of passengers using the interchange facilities considered the provision of information to be adequate, but this figure masks a great disparity in views at different locations. At one interchange 90 percent of users considered information services to be satisfactory whilst at another almost half the sample perceived them to be very poor. The results reflect the journey characteristics of users as well as the existing standard of information provision

In the main passengers considered the basic level of shelter provided at the interchange points to be adequate for their needs. There were mixed opinions on the adequacy of seating, almost half the sample wanted to see an increase in the quantity of seating provided. In terms of other facilities, provision of telephones came high on the list of priorities, requested by 40 percent of respondents. Concern was expressed that even where telephones had been fitted they were frequently out of order.

A quarter of passengers would like public toilets to be available. Support for refreshment facilities varied according to the type of journeys being made and the expected length of wait. Passengers connecting with longer distance or less frequent services were more likely to patronise a cafe or drink vending machine.

4. DESIGN OF INTERCHANGE FACILITIES

The impact of a new interchange can be assessed in terms of its effects on the passengers who use it, the transport providers, the owners/developers of the site and the community at large. The type and nature of these effects are described below.

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4.1 Passengers Using the Interchange

Passengers can justifiably expect an improvement in waiting conditions and information services following development or re-development of an interchange. The aim should be to create a pleasing, attractive environment which will give a favourable image of public transport. The range of services should be enhanced, offering new travel opportunities, though this is dependent on complementary scheduling of services to provide reasonable connections in both directions.

The effects on overall travel time and walking distance to access the interchange are less certain, being critically dependent on the location of the terminal within its primary catchment area. Lavish facilities cannot compensate for a basically poor location.

4.2 Transport Providers

The effects on the organisations providing public transport services are also critically dependent on interchange location. Even small increases in mileage can have a large aggregate effect on costs, particularly where journey times and schedules are affected with no compensating increase in revenue. On the plus side, better facilities should help to retain or even generate patronage. A study following the opening of a district centre bus station in London suggested an increase in patronage of 5 percent was achieved (Kennard, 1984). Operators also stand to benefit from improved staff facilities and centralising services should improve operational control.

4.3 Organisations with an Interest in the Terminal

The owners or lessors of the interchange can expect to generate income from the sale of advertising space, rent from retail units and revenue through franchises and concessions. The scale of this potential income will depend on passenger volumes, themselves largely a function of the range of public transport services. A departure charge may also be levied on transport providers but this is rarely set at a commercial level. A trade-off must be made between the revenue which would accrue and the benefits from bringing all services into the interchange.

The costs, which must be set against income, include recurring cleaning, lighting and security charges plus the interest charges on construction costs for notional return on capital for a public sector project.

4.4 External Influences

Development of an interchange can also have an impact on road users through its effects on local traffic flow. There may be potential conflicts with existing parking and service access arrangements which need to be addressed at the planning stage. Commercial property values will also be affected with areas around a new or improved interchange tending to rise in value relative to those further away.

4.5 Competition

The value of a prime site which has been created as a result of the proximity of an interchange (or which would represent the ideal location for a new facility) means that there is strong demand for the land. Many established interchange points were built to cater for much higher levels of public transport services than are now required. This surplus capacity means that such sites are now ripe for redevelopment. Construction costs of a new facility more in keeping with today's needs and passenger expectations can often be offset by potential profits from commercial redevelopment. Plans are already at an advanced stage for such schemes in at least eight major UK towns and cities (Mellor, 1989).

However, whilst it is in the interests of the developer as well as the transport operators to have a successful and viable interchange, there will inevitably be pressure to minimise the space given over to departure stands, platforms and layover areas. The loss of development profits associated with provision of one extra bus departure stand and its associated roadway can amount to NZ\$200,000. Ground level retail space commands a substantial premium over that at first (or second) floor level achieved by building over. It is therefore essential to obtain sound professional advice to optimise the design and layout.

4.6 Capacity

The passenger capacity of an interchange is governed by the capacity of access routes, the concourse circulation area and queuing space. However, the capacity is not a fixed limit but dependent on the acceptable 'level of service'. It would be uneconomic to expect to provide the same space standards for short periods at the height of the peak as in the off-peak. However, as the area becomes progressively more congested the waiting time cost (reflecting the passengers' perceived disutility) increases exponentially (LRT, 1988). Ideally, densities should not exceed one person per square metre for more than a few minutes.

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Interchanges are normally planned to cater for a particular volume of services. The practical throughput is determined by either the quantity and layout of departure stands/platforms, capacity of layover areas or capacity of the approach/exit routes. Constraints in any of these areas place an effective limit on overall capacity. The interactions between departures and arrivals and knock-on effects of potential disruptions to services make the analysis of any major facility a complex exercise which can only be effectively tackled by computer simulation. Simulation models enable a whole series of critical situations to be rapidly evaluated to test and refine proposed designs. It is possible to model aspects such as random disruptions to bus arrivals, variable layover times and a range of boarding times from sampled distributions. SDG have applied these techniques in the planning of new transportation centres in the United Kingdom and Ireland.

4.7 Access

Passengers using an interchange will seek the quickest route between their arrival and departure points. Safe, direct pedestrian access routes should be provided at-grade whenever possible. Many existing transport interchanges fail in this respect. If pedestrian/vehicle conflict cannot be entirely avoided steps must be taken to ensure crossing points are made as safe as possible. Provision of escalators and short flights of stairs with pram ramps may help to reduce passengers' natural disinclination to change levels. Escalators will be of particular benefit to disabled travellers but can be prone to vandalism.

The structural design should help to make the main access points and principal pedestrian routes obvious to users. If possible flows of arriving and departing passengers should be separated to minimise potential conflict. The maximum acceptable walking distance for passengers transferring between routes or modes at the interchange is 400m, less where a change in level is required or there are adverse climatic conditions. The layout should be optimised to minimise the walking distances for the highest volume movements.

4.8 Passenger Facilities

The level and standard of passenger facilities required at an interchange will depend on the level of use and the average waiting time.

Passenger facilities may be divided into two basic categories:

- i) protection from the elements; and
- ii) catering for personal needs.

In the first category comes shelter from rain and draughts by both roofing and screening the main concourse and waiting areas. Heating and/or air conditioning of passenger waiting areas may be justified. Where the vehicle running area is also covered, protection should be from noise and exhaust fumes with protected waiting areas.

In catering for personal needs, seating for waiting passengers is a high priority. Public toilets are regarded as a useful amenity, particularly at interchanges catering for longer distance services with journey times in excess of one hour. The problem with toilets is that they require almost full time supervision to keep them in an acceptable condition, adding significantly to running costs.

Telephones are becoming an essential feature at all transport centres. They are useful for passengers wishing to advise friends/relatives and business acquaintances of arrival times.

Refreshment facilities can take several forms. For long distance passengers with long waiting times a sit-down cafeteria may be desirable. Where a staff canteen is located in the same site the kitchens may be integrated. For shorter distance travellers wanting to grab a quick bite or drink on their way to the bus, a kiosk or vending machine is a more practical arrangement. Litter bins should also be provided.

There may be sufficient demand to justify additional amenities such as left luggage lockers and a lost property office. Some recent designs have incorporated a mother and baby room as an adjunct to the toilet block.

4.9 Security

Passengers using an interchange should feel safe at all times. Vandalism must be prevented and use of facilities by vagrants and adolescent gangs actively discouraged. Supervision of the concourse area will be necessary through the presence of uniformed staff and also remotely by a CCTV system covering access routes and main waiting areas. Without these measures it is possible for interchanges to become associated with high crime levels, discouraging potential users. In America there has been a trend to locate new coach stations outside the city centre accessed from expressways. Such barriers against walk-in traffic would probably not be acceptable in an Australasian context. A public address system would be advantageous from both an operational and security point of view. Good layout and design also makes a useful contribution, particularly features such as unobstructed visibility and high standard lighting.

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4.10 Information Systems

Provision of information is the key to efficient interchange operation. Information needs tend to grow with the size and complexity of the terminal. A hierarchy of information provision is required to guide passengers to their destination in a series of stages.

A variety of methods are available and each can make an effective contribution. Indeed passengers are reassured if information is available from a variety of sources. Consistent signing provides both basic level information and reassurance for passengers as they pass through the interchange. The signing should be sequential, using the same terminology throughout. Repetition of the information such as directional arrows on successive signs is important for reassurance (Fruin, 1985). Pictorial symbols are to be preferred for legibility. The size and design of such signs should take account of the needs of the visually handicapped.

Reference boards help passengers unfamiliar with the interchange to identify the appropriated bus/train for their destination and its departure point. Timetables for individual services should be provided both in the concourse area serving the principal access routes and in the waiting area for each departure platform. Accurate clocks are essential to help passengers derive maximum benefit from timetable displays

The next departure from each stand or platform should be clearly indicated. This is particularly important for less frequent services where several routes may share the same stand or where services do not consistently leave from the same stand.

A travel information centre is essential at all major interchanges. Passengers making infrequent journeys seek assistance in planning their onward journey, particularly where a further change of route or mode is required. The information centre may also act as a ticketing facility and sales outlet for travel products. Where it is not possible to keep the centre open throughout the period of operation of the interchange provision should be made for the telephone enquiries.

Dynamic information systems which are capable of directing passengers, advising them of delays and changes to services, not only help to minimise passengers' anxiety and sense of frustration but improve operating flexibility. TV monitor units at stands and in waiting areas can provide this facility and also feature advertising/promotional material to help defray the cost. Scrolling dot matrix displays are an alternative. Such systems are already in use in a growing number of UK interchanges including Bournemouth, Exeter, Leicester and Nuneaton.

4.11 Interior Design and Finishes

It is important to ensure a good visibility to allow passengers to see buses/trains at their departure platforms, and to allow location of passenger facilities.

Surfaces should be bright, attractive and easy to clean. Consideration should be given to use of vandal resistant materials where this can be achieved without adversely affecting appearance. Coated aluminium/steel or enamelled wall panels and tiling are favoured for unglazed vertical surfaces though treated brick can give a warm effect. Flooring materials have included non-slip rubber, with brick tiles for more intensively used areas, although terrazzo tiles are a popular alternative at prestige locations.

Good lighting can greatly assist in providing a pleasant ambience with natural light used as far as possible. The lighting should be planned so as to highlight signing or information facilities. Provision for wall-mounted advertising panels should be made helping to make the interchange visually interesting as well as providing a useful source of revenue. However, the advertisements should not be allowed to detract from or create confusion with information signs.

5. CONCLUSIONS

Interchanges are a necessary component of an efficient and cost-effective public transport system. They represent a focal point in many urban areas and their importance is unlikely to be diminished in a deregulated environment, even though optimisation of location and cost to the transport undertaking becomes paramount to continuing viability.

It is an accepted fact that passengers attach significant penalties to interchange. The primary objective in the planning and design of interchange facilities must therefore be to minimise these penalties whenever possible, consistent with necessary efficiency and economy.

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Planners should aim to take advantage of the attractiveness of interchanges to developers (in terms of their accessibility), seeking a major financial contribution to provision of enhanced facilities since this can ultimately benefit all parties.

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