Intermodal Transit Stations

See end of document for a full list of resources.

Overview

This issue paper considers how to facilitate intermodal trips that involve public transit for at least a portion of the trip. It examines best practices for combining walking, cycling, driving, and carpooling and public transit. It also considers amenities that facilitate transfers between different ground-based modes and public transit—i.e., bus, tram, light rail, subway, commuter rail, etc.

For encouraging walking-transit intermodal trips, the focus is on the station environment rather the station itself. Characteristics of the station environment such as the mix of land uses, density, urban design, and the quality of pedestrian infrastructure are considered. The concept of Transit Oriented Development (TOD) is introduced as an approach to creating station catchment areas that encourage access to transit by foot.

For encouraging bicycle-transit intermodal trips, it is suggested that appropriate bicycle parking be provided. The location, type, and capacity of bicycle parking facilities appropriate for transit stations are considered. Bicycle sharing systems are also explored, as they are also another means of encouraging bicycle-transit intermodality.

Three types of automobile-transit intermodality are considered. These include access to transit by automobile as a driver, as a passenger, or by carpool. Amenities enabling all three of these modes of automobile access are considered separately.

Means for facilitating transfers between modes of public transportation are briefly considered. The focus is on best practices in station layout that allow for seamless transfers between different types of transit vehicles.

Finally, a set of general considerations for transit station design and intermodality are provided. These include in-station signage and wayfinding devices, user information, and aesthetics and comfort.

Selected Resources

Litman, T. (2010). Transit Station Improvements. TDM Encyclopedia, updated January 26, 2010. Victoria, BC: Victoria Transportation Policy Institute (VTPI) (http://www.vtpi.org/tdm/tdm127.htm).

Introduction

Intermodal trips are those that involve more than one mode of transportation. This report considers how to facilitate intermodal trips in that involve public transit for at least a portion of the trip. More specifically, the focus is on the provision of appropriate amenities at larger public transit facilities—i.e., stations on bus or rail rapid transit lines—to encourage intermodal travel. The report examines best practices for combining walking, cycling, driving, and carpooling and public transit. The report also considers amenities that facilitate transfers between different modes ground-based of public transit—i.e., bus, tram, light rail, subway, commuter rail, etc..

In Canada, the focus of transit station design has primarily been on facilitating transfer between different modes of transit, especially between feeder bus routes and mainline rapid transit routes, and on facilitating automobile access in suburban areas. Until recently, there has been comparably less emphasis on facilitating pedestrian, bicycle, automobile passenger and carpool access to transit.

Rationale

Improving the quality of public transit stations and facilitating intermodal travel with transit can be a means for encouraging public transit use (TRB, 1999; Brons et al,, 2009; Litman, 2010 b). In particular, it can help increase the number of non-captive transit users—i.e., individuals who could instead use an automobile for the entire length of the trip. The addition of appropriate amenities to transit stations and their immediate surroundings can also be a means for encouraging access to transit stations by alternative modes of transportation, especially walking and cycling and particular, allowing users to combine the benefits offered by those modes with the benefits of using public transit.

Walking to Transit

Historically, walking has been the *de facto* mode of access to public transportation. However, many contemporary rapid transit stations, particularly in suburban locations, are built along highway or rail right-of-ways that are removed from residential areas. Direct access by foot to such stations is inconvenient or impractical due to distance and the quality of the environment around the station. Motorized modes of transportation, including automobiles and local bus lines are the preferred modes of access to such stations.

Beyond providing adequate connections to the surrounding network of pedestrian paths, the design of a transit facility itself is not likely to strongly determine whether or not it will be accessed by foot. Rather, the quality of the environment around the station is likely to be a much stronger determinant. Environments conducive to walking have the following characteristics:

- **density:** high population and/or employment density
- **land use:** mix of residential and commercial land uses
- **urban design:** narrow, traffic calmed streets lined with buildings oriented towards and set close to the sidewalk
- **quality of pedestrian infrastructure:** wide sidewalks, clearly demarcated or raised crosswalks, pedestrian activated signals at signaled intersections

Efforts to encourage station access by foot should prioritize the improvement of the pedestrian environment within the station's catchment area. Most guidelines consider the catchment area to be within a 10-minute walking distance or a 750 m radius of the station. The Waterloo Region, for example, has undertaken pedestrian environment improvement around the station in its *iXpress* bus rapid transit system (RMW, 2009). The improvements have included interventions such as:

- extending sidewalks across driveways
- installing ladder crosswalks at busy intersections and adding other road markings
- improving landing areas with additional curb ramps and sidewalk in-fill
- paving the walkway over a set of railroad tracks
- installing a set of stairs with handrail where a worn path had previously existed.

Transit-oriented development (TOD) is a planning and urban design approach that aims to create environments conducive to walking around rapid transit stations. The concept applies primarily to station in greenfield areas but can also help guide redevelopment around stations in built up areas. There are numerous interpretations of TOD but most converge on the environmental characteristics listed above. A typical strategy for planning TODs is to focus commercial services and higher density residential uses closest to the station and to allow densities to decrease gradually with increasing distance from the station. A key precept of most TOD approaches is to create a mixed-use neighbourhood with a sense of place, where the transit station and its immediate surrounding act as a "town centre". Most TOD strategies include an effort to include a significant share of affordable housing units. A good Canadian example of guidelines for creating TODs has been created by the City of Calgary for use around its C-Train (LRT) stations (City of Calgary, 2005).

A number of Canadian communities have explicitly undertaken TOD in recent decades, with varying levels of success. One such effort is documented in Urban Transportation Showcase Program Village de la Gare: Transit-Oriented Residential Development Case Study.

Bicycle to Transit

As a feeding system for transit stations, the bicycle offers a number of advantages over other modes of transportation. These include:

- **faster:** reduced door-to-door travel time compared to walking and riding feeder bus routes
- **more space efficient:** bicycle parking requires far less space than automobile parking
- **less expensive:** lower cost than running feeder bus routes and accommodating automobiles at transit stations
- **more sustainable:** less energy intensive, less polluting than automobiles and feeder buses

Bicycles are in effect a means for extending the non-motorized catchment area for transit stations. An average pedestrian can cover about 750 m in 10 minutes. In comparison, a cyclist travelling at a relatively modest speed can cover 2 to 3 km in the same amount of time. That means that a transit stations 10-minute catchment area for cyclists in roughly tenfold larger than the pedestrian catchment area (Bracher, 2000).

Two types of amenities can be provided at transit stations to encourage bicycle-transit intermodality: (1) bicycle parking or (2) a bicycle sharing service. The former entails providing secure and convenient places to stow private bicycles whereas the latter entails providing docks for shared public bicycles. In terms of capacity and location, similar considerations apply to both types of amenities.

Bicycle Parking Amenities

Bicycle parking facilities range widely in terms of the level of service that they provide. As bicycles are likely to be parked at transit stops for relatively long-periods of time, a higher level of service, with features such as theft protection and weather protection, can encourage people to access transit by bicycle.

Facilities that consists of simple, outdoor bicycle stands or racks that do not offer any weather protection or any dedicated security measures, such as controlled access and surveillance, are usually categorized as *short-term* or *Class II* or *Class B* bicycle parking. Unsheltered bicycle stands or racks are inexpensive to provide, costing some $75 to $150 per bicycle (Gris Orange Consultant, 2010). Basic bicycle parking of this type is prevalent at transit stations in Canadian communities and are without exception free to use (Figure 1).

Figure 1. Bicycle parking at the Montmorrency terminus of the Montreal Metro in Laval, QC (photo: Bartek Komorowski)

Facilities located in partial or full enclosures or indoors, which offer some degree of weather protection and increased protection against vandalism and theft, are usually categorized as *long-term* or *Class I* or *Class A* bicycle parking. These can include:

- **bicycle shed:** a roof or partial enclosure over a bicycle parking area; can be freestanding structures or can be awnings or berths attached to a building
- **bicycle cage:** a fenced or walled full enclosure around a bicycle parking area; a key or combination code is usually required to access the cage
- **bicycle locker:** a fully enclosed container large enough to fit a standard bicycle; can also be used to store other belongings, such helmets and bags

There are only a few examples of such higher quality bicycle facilities at transit station in Canada. *Go Transit*, the regional transportation authority for the Greater Toronto and Hamilton Area, has recently constructed a number of bicycle sheds at on parking lots at its commuter train stations (Figure 2). The sheds can be used free of charge. They offer weather protection but limited security. Access to the sheds is open and there is no dedicated surveillance system; rather, the *park-and-ride* lots' surveillance cameras are supposed to be used to monitor the bicycle sheds.

Figure 2. Bicycle shed at a GO Transit commuter train station in Milton, ON (photo: Brian Main/GO Transit)

TransLink, the Metro Vancouver regional transportation authority, offers a number of bicycle lockers at several SkyTrain (light rail) stations. Users are required to rent a specific locker for $30 for three months. As they fully enclose the bicycles, the lockers offer a very high degree of weather protection and security.

Figure 3. Bicycle lockers at a SkyTrain station in Vancouver, BC (photo: [CycleSafe])

Over the last few years, several North American cities have implemented very large, high capacity bicycle parking facilities, many of which are adjacent to transit stations. A notable example is the recently opened (summer 2010) *Union Station Bike Transit Centre* in Washington, DC, located at the US capital's primary transit hub. The large, purpose-built glass-and-steel shed houses, resembling a bicycle helmet, has a 100-bicycle capacity. Two-tiered bicycle racks are used to maximize the bicycle parking capacity (Figure 4). The facility also includes 50 lockers, a change room, an air pump, and a bicycle repair shop. To access the facility, users must pay a US$20 annual service charge plus either US$1 for day use, US$12 for a month, or $96 per year.

Figure 4. Inside the *Union Station Bike Transit Centre* in Washington, DC (photo: [BeyondDC])

The only comparable facility in Canada is the *Union Bicycle Station* near Union Station in downtown Toronto. The first portion of the bicycle station was opened in May 2009 and currently provides 180 bicycle parking spaces. The facility is located beneath Union Station's commuter and inter-city train platforms, utilizing an existing structure rather a purpose-built structure as in the Washington, DC case. The station is to be expanded in two phases over the next decade, eventually bringing the total capacity to 600 bicycles. Like the Washington, DC station, two-tier racks have been used to cram 180 bicycles plus other amenities into a 200 m^2 space. The other amenities include a change room, washrooms, a repair stand and tools (for self-service), and an air pump. Currently, no lockers or showers are available at the facility, although members are entitled to use showers at a nearby gym. Memberships costs $20 for one month or $60 four months, in both cases only after paying a one-time $25 registration fee. Alternatively, casual users can access the facility for $2 per day. The station cost about $400,000 ($2,000 per bicycle space) to build and is expected to cost $50,000 ($280 per bicycle space) per year to operate.

Bicycle Sharing Amenities

Bicycle sharing systems are banks of bicycles distributed across numerous pick-up and drop-off points. A bicycle can be taken out any one of these points and dropped off at any other one. They are generally intended for short-term uses. For this reason, after paying a system access fee, uses under half-an-hour are free; for use in excess of half-an-hour, exponentially increasing usage fees are charged. A general overview of public bicycle sharing systems is provided in see Urban Transportation Showcase Program Self-Service Public Bicycle Systems Case Study.

Many transit users may be able to use their private bicycles for access or egress from transit at the home end of the trip. However, to use a private bicycle at the activity end of the trip, they would either need to transport their bicycle with them or have a second bicycle at the activity end transit station. Both options may be impractical or impossible. Bicycle sharing averts them both: the transit user can take out a public bicycle at the end transit station to complete the final leg of the trip.

Strategies to encourage transit-to-public-bicycle intermodality are not limited to merely providing sufficient bicycle sharing docking points at transit nodes. Deeper integration can be achieved through pricing incentives and coordination of fares. One strategy is to use the same payment system for transit and bicycle sharing, such as the same electronic fare card. For example, in Paris, the contactless *NaviGO* cards used for accessing public transit services in the city and surrounding Île-de-France region can also be used to access *Vélib* public bicycles, although charges for using *Vélib* and transit are separate.

In Montreal, the *OPUS* card, a single electronic fare card similar to *NaviGO* is now used by transit authorities across the region but cannot be used to take out *BIXI* bicycles. Instead, registered *BIXI* users must either obtain a small electronic key, similar in size and appearance to a USB memory stick, or use their credit cards to take out bicycles. However, despite using separate devices for system access, *BIXI*, which is run by the City's parking authority, and the *Société de Transport de Montréal* (STM), the transit authority, have been cooperating to create synergies between the two systems beyond merely placing large *BIXI* docking stations at metro stations across the city. As May 2010, as *BIXI* was beginning its second season of operation, STM annual transit pass holders can obtain a *BIXI* subscription for $19 instead of the regular $78. During July and August 2010, individuals who purchased a monthly STM transit pass were offered a 50% discount on monthly *BIXI* memberships ($14 instead of $28). As another incentive, individuals who do not possess an annual or monthly STM pass but who purchased a *BIXI* annual subscription were given a free *OPUS* card loaded with six single-journey transit tickets. These promotions have been prominently advertized on both the STM and the *BIXI* websites and have been featured on billboards in metro stations and at *BIXI* docking stations.

Capacity

There is no widely accepted methodology for evaluating demand for bicycle parking spaces or shared bicycle docks at transit nodes. Factors that are likely to affect demand for both at a given node include:

- **passenger volume:** the number of passengers who begin or end their transit trip at the transit stop
- **land use:** the mix and density of land uses in the vicinity of the transit stop
- **bicycle accessibility:** the bicycle friendliness of routes connecting the transit stop to its vicinity

At major central transit stations, through which many commuters access the downtown area, demand for shared bicycles can be very high—possibly outstripping demand for bicycle parking. For most transit users, centrally located stations are likely to be at the activity of the transit trip at which they are likely not have access to a private bicycle and may therefore wish to use a public bicycle.

A set of guidelines on bicycle parking from Denmark suggest that the number of bicycle parking spaces be equivalent to roughly 10% of the number of passenger boardings at the given station during morning rush hours (Celis and Bølling-Ladegaard, 2008), assuming that there is bicycle sharing system.

Location

Similar considerations apply to locating bicycle parking and bicycle sharing systems at transit stations. Most guidelines on bicycle parking emphasize that it should be placed as close as possible to the destination. In the case of a transit station, the destination is in essence the platform from which the transit vehicle will be boarded (Figure 5). Bicycle parking guidelines from Denmark state that a distance of 30 to 50 m between bicycle parking facilities and the platform area is acceptable (Celis and Bølling-Ladegaard, 2008). If a bicycle route is present, efforts should be made to place the bicycle parking facility along a direct path from the bicycle route to the platform area.

Figure 5. *Vélo'v* public bicycles near a light rail platform in Lyon, France (photo: www.velov.grandlyon.com)

Automobile to Transit

It is common for new rapid transit systems in suburban areas to be implemented within existing transportation corridors, especially highway or rail right-of-ways.

Stations along such rapid transit lines can be removed from residential areas. Furthermore, it is often difficult to provide effective feeder bus services in dispersed, low-density suburban residential areas. In this case, the private automobile or taxi is likely to be a much more attractive mode of access to a transit station. There are three distinct modes of automobile access to transit stations, each with distinct requirements in terms of amenities at the transit station: driver, passenger, and carpool.

Driver

To enable automobile access, the transit station must provide *park-and-ride* facilities—secure and convenient parking facilities at which transit users, especially commuters, can leave their vehicles for relatively long periods. Park-and-ride facilities are generally located at transit stations outside a city's core area. They are intended to capture suburban auto commuters and encourage them to complete their trip into the core by transit.

In terms of benefits, park-and-ride facilities are a means of mitigating roadway congestion and can help reduce parking congestion in core areas. However, they are likely to provide only a modest reduction in local traffic in the area around the station, pollution, and energy use given that automobile trip is still being made (Litman, 2010 c).

Park-and-ride facilities are largely targeted at non-captive transit users—i.e., people who own cars and could drive all the way to their destinations. To maximize the incentive to use transit, park-and-ride facilities do not charge parking fees or charge fees that are below cost. When parking fees are applied, they are usually relatively low so that they do not become disincentive to use of the park-and-ride facility.

Most park-and-ride facilities in Canada can be used free of charge. Where parking fees apply, they are relatively low. Examples include the following:

- **Calgary Transit:** $3.00 per day at all C-Train (LRT) stations applicable 2:00 AM to 6:00 PM weekdays only (see Case Study below).
- **Toronto Transit Commission (TTC):** from $2.00 to $7.00 per day at selected subway stations outside the downtown core applicable weekdays 5:00 AM to 3:00 PM

Given the high cost of providing park-and-ride facilities and steadily increasing demand, it is likely that more transportation authorities will begin charging fees. The City of Edmonton, for example, is currently considering fees for park-and-ride facilities along its LRT system (CBC News, 2010).

Case Study – Calgary Transit

Calgary Transit operates 33 parking facilities at C-Train stations and major bus terminals. Together, these facilities provide around 14,000 parking spaces, the majority of which (roughly 12,000) are at C-Train stations.

Fees are charged on weekdays for parking at all C-Train stations. Parking is free from 6:00 pm to 2:00 am on weeknights and all day Saturday, Sunday, and on statutory holidays. Most of the parking facilities feature two tiers of parking, short-term and daily parking, each with a slightly different fee structure. Short-term parking, which is typically located closer to the train platforms, can be used for $0.75 per hour for a maximum of four hours. Daily parking can be used for an entire day for a flat fee of $3.00. Alternatively, a monthly parking pass can be purchased for $60.00. At one of the lots, at the Fish Creek-Lacombe station, customers can reserve a parking stall for $90.00 per month. At the remaining stations, parking is available only on a first-come, first-served basis; possession of a monthly parking pass does not guarantee a parking stall.

To facilitate payment for short-term and daily parking, Calgary Transit provides self-service payment machines that accept cash and credit cards at all stations. Alternatively, it allows users to pay using their cell phones. The pay-by-cell phone system requires users to preregister online, entering their license plate, cell phone number, and billing information. To pay for their short-term or daily parking, users simply send a text message containing the parking lot number to a designated Calgary Parking Authority number. The short-term and daily parking areas for each station have different numbers.

Best practices in terms of the planning and design of park-and-ride facilities (Litman, 2010 c) include the following:

- **location:** where possible, lots should be placed within sight of businesses or homes to improve users' sense of security and minimize the risk of theft, vandalism, and assault
- **security systems:** ample lighting and camera surveillance on the lot and along pedestrian pathways leading into the transit station
- **signage:** clear signage on surrounding roads to help direct vehicles to the facility

Where capacity issues exist, another best practice is to provide users with real-time parking availability information (SAIC, 2008). This approach is used especially for park-and-ride lots along highway corridors. Electronic signs on the highway inform drivers in real-time of parking availability at the next few downstream park-and-ride lots. If one lot is full, drivers are directed towards the next downstream lot with available space. This approach has been shown to be successful in rationalizing the use of park-and-ride facilities in the San Francisco Bay Area (Rodier and Shaheen, 2005).

Passenger

Transit stations in automobile-oriented environments should include convenient drop-off/pick-up points for individuals arriving/departing in private vehicles or taxis as passengers. This type of amenity is commonly called a *kiss-and-ride* area. Kiss-and-ride areas are typically located close to station entrances. They allow vehicles that are dropping-off or picking-up passengers to stop for a short while without impeding traffic in the station area. Space is usually provided for several automobiles, allowing vehicles to stop for a short time if they need to wait for a passenger. For example, the intermodal De la Concorde transit station in Laval, QC, a suburb of Montreal, has no park-and-ride lot but offers 28 kiss-and-ride spaces.

Kiss-and-ride areas can also feature amenities for passengers disembarking from or waiting for their rides (Figure 6). These include:

- awnings for weather protection
- seating for passenger awaiting their rides
- security cameras or human surveillance for improved security, particularly at off-peak hours

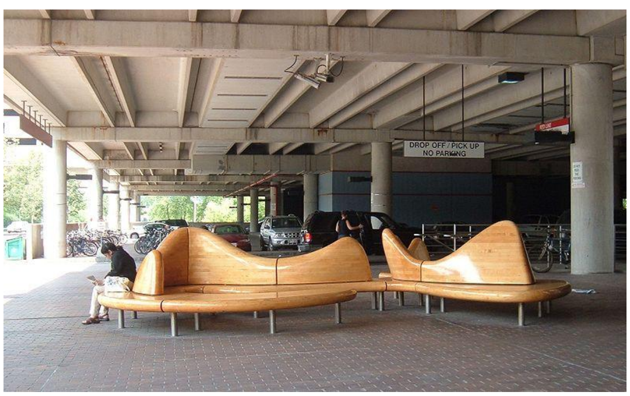

Figure 6. Kiss-and-ride area at Alewife terminus of Boston Subway in Boston, MA (photo: Arnold Reinhold)

Carpool

Carpools or vanpools are another potential mode of access to transit stations. Carpooling to transit stations is likely to be especially effective in low-density suburban areas in which it is difficult to provide cost efficient, frequent feeder bus service. It is worth encouraging carpool access to transit stations because it can reduce the number of single-occupancy vehicles and allows for more efficient use of park-and-ride space.

To encourage carpooling, transit authorities can offer priority parking for carpools on park-and-ride lots. For example, TransLink, Metro Vancouver's transportation authority, currently offers priority parking for members of its ridesharing program at the Scott Road SkyTrain (LRT) station in Surrey. There are a total of 27 parking stalls reserved exclusively for rideshare vehicles. To park their vehicle in one of the reserved spaces, a ridesharing group must register for a Scott Road Ride-Share Parking Pass, which is free of charge. Upon arriving at the parking lot, there must be at least two people in the vehicle in order to access the reserved spaces.

Transit to Transit

For users who are transferring from one transit vehicle to another, the key objective is to make the transfer as rapid and convenient as possible. This applies to transfers between vehicles of the same mode (e.g., bus to bus, subway to subway, etc.) or between vehicles of different modes (e.g., bus to LRT, LRT to subway, etc.). The ease of transferring between transit vehicles depends crucially on station layout and on the presence of appropriate signage and wayfinding devices (see Other Considerations).

In terms of station layout, the most basic strategy for facilitating transfers is to minimize distances between vehicle boarding platforms and to avoid grade changes.

Figure 7. Split level platform in Amsterdam, Netherlands allows transfers between high-floor metro (LRT) trains and low-floor trams using the same track (photo: Daniel Sparing)

Figure 8. Cross-platform transfer from high-floor subway train to low-floor LRT at Alvik Station in Stockholm, Sweden (photo: Peter Friestedt)

There are innovative designs that allow vehicles of different types to share the same platform. For example, in Amsterdam, there are split-level platforms, with a low section for standard tram cars and an elevated section for metro (subway/LRT) cars. Aside from allowing passengers to transfer between tram lines and the metro system merely walking a few steps along the same platform, it allows both types of vehicles to use the same track (Figure 8).[1] Another design that allows convenient transfers between low- and high-floor vehicles involves placing the high-floor track on one side of the platform and the high-floor track on the other side of the same platform. This enables passengers to transfer simply by crossing the platform. It is also possible to combine bus and rail lines in the same manner. Buses and low-floor (or any curb-level boarding) rail vehicles can potentially share one-sided platforms where tracks are embedded in a road surface. Alternatively, a two-sided platform could in principle accommodate rail on one side of the platform and bus on the other.

In many situations, however, shared platform configurations may be impossible. Where grade separation of pedestrian passages and infrastructure for different vehicles is necessary, it is a recommended practice to apply the principals of universal access to station design (Litman, 2010 b). This means providing elevators or escalators whenever a change of grade is required. Some public transit systems in Canada are currently retrofitting stations to allow universal access. The Société de Transport de Montréal, for example, has added elevators all of the major transfer stations on the Métro (subway) network, making all platforms at their station accessible to persons of limited mobility.

Other Considerations

Signage and Wayfinding

Signs and wayfinding devices play an important role in conveying vital information needed by riders to efficiently transfer between vehicles at transit stations. The design, content, and placement of signs and symbols critically affect how passengers will move through the space. Poor station layout combined with insufficient or inadequate signage can frustrate users and can dissuade non-captive users from using public transit at all. Research on transit station design has indicated that there is a need for consistency in design, content, and placement of signs and symbols across stations on a transit system (TRB, 1996). In response to such research, in the mid-1990s, the Transportation Research Board developed an exhaustive guide to transit facility signs and graphics (see TRB, 1996), still relevant today.

User Information

Whereas signs and wayfinding devices are needed to help passengers navigate the transit station itself, system maps and schedules should be provided at prominent locations to assist passengers in planning their transit trip. Maps and schedules for the transit lines serving the given station should be provided near station entrances and on boarding platforms. It is also an increasingly common practice to provide electronic displays that provide real-time information on transit vehicle arrivals. A large, centrally located display can show the next several arrivals for all lines serving the station, allowing passengers to choose different connections before proceeding to the appropriate vehicle platform. Displays can also be provided on vehicle platforms to indicate the next several arrival times for all lines serving the given platform.

Aside from providing user information within the station itself, it is also a common practice to provide information about stations on major transit lines online. For each station, clear and concise information about the availability of park-and-ride, kiss-and-ride, bicycle parking, and other amenities should be provided. There should also be information about all transit lines serving that station to allow the user to determine what transfers are possible. A good example is the recently overhauled website of the Agence Métropolitaine de Transport (AMT), the agency that runs commuter trains and major bus terminals in metropolitan Montreal. Webpages for each of the AMT's train and bus terminals clearly show park-and-ride, kiss-and-ride ("unloading area"), and bicycle parking capacities; a row of pictograms indicates

[1] All rail vehicles in the Amsterdam's public transit system use standard gauge and can therefore share tracks. Some of the metro lines have LRT-style train sets that equipped with both overhead and third-rail traction systems allowing them to use street-level tracks (with overhead catenary) and underground metro tunnels (with third-rail).

the available amenities at the given station; and a set of buttons—one each for train, bus, and metro (subway)—allows users to quickly determine what transfers are possible (Figure9).

Figure 9. Webpage for an Agence Métropolitaine de Transport Montreal-area commuter train station (Image: Agence Métropolitaine de Transport)

Aesthetics and Comfort

Research on transportation behaviour has shown that public transit users tend to dislike waiting for vehicles than spending time in the vehicles themselves (Horowitz, 1981; Wardman, 2003). Transfers therefore tend to entail a "waiting time penalty", which may dissuade non-captive users from using transit. Aesthetic improvements and amenities that increase passengers' level of comfort can help mitigate the waiting time penalty and generally improve the quality of services offered to all users. Aesthetic considerations should apply to interior and exterior of the station, as well as to the landscape around the station. Amenities to improve passengers' level of comfort include:

- **seating**: available at all vehicle platforms as well as at kiss-and-ride areas
- **space:** platforms and circulation areas (corridors, stairs, etc.) large enough to avoid crowding
- **noise:** acoustic treatments to minimize noise, especially noise from transit vehicles
- **ventilation:** air free from exhaust and other smells produced by transit vehicles and large numbers of passengers
- **climate control:** heating and/or air conditioning to maintain a comfortable ambient temperature; fully enclosed shelters on outdoor platforms
- **food and other commerce:** machines or staffed kiosks with snacks, drinks, and small merchandise such as newspapers and magazines
- **washrooms:** should be provided at all major transit hubs/transfer points

Sources

Bracher, T. (2000). Demand Characteristics & Co-operation Strategies for the Bicycle & Railway Transport Chain. *World Transport Policy and Practice* 6(4), 18-24.

Brons, M., Givoni, M. and Rietvield, P. (2009). Access to railway stations and its potential in increasing rail use. *Transportation Research A* 43, 136-149.

CBC News (2010). *Council mulls paid LRT park-and-ride spots*. CBC News online report posted March 17, 2010 (http://www.cbc.ca/canada/edmonton/story/2010/03/17/edmonton-lrt-reserved-parking.html).

Celis, P. and Bølling-Ladegaard, E. (2008). *Bicycle Parking Manual*. Copenhagen: Danish Cycling Federation (http://www.celis.dk/Bicycle_Parking_Manual_Screenversion.pdf).

City of Calgary (2005). *Transit Oriented Development Policy Guidelines*. Calgary: City of Calgary (http://www.calgary.ca/DocGallery/BU/planning/pdf/tod/tod_policy_guidelines.pdf).

Gris Orange Consultant (2010). *End-of-Trip Bicycle Parking Guide*. Ottawa: Transport Canada (http://www.tc.gc.ca/media/documents/programs/betf.pdf).

Horowitz, A.J. (1981). Subjective Value of Time in Bus Transit Travel. *Transportation* 10, 149-164.

Litman, T. (2010 a). Bike/Transit Integraton. *TDM Encyclopedia*, updated January 25, 2010. Victoria, BC: Victoria Transportation Policy Institute (VTPI) (http://www.vtpi.org/tdm/tdm2.htm).

Litman, T. (2010 b). Transit Station Improvements. *TDM Encyclopedia*, updated January 26, 2010. Victoria, BC: Victoria Transportation Policy Institute (VTPI) (http://www.vtpi.org/tdm/tdm127.htm).

Litman, T. (2010 c). Park & Ride: Convenient Parking For Transit User. *TDM Encyclopedia*, updated January 26, 2010. Victoria, BC: Victoria Transportation Policy Institute (VTPI) (http://www.vtpi.org/tdm/tdm27.htm).

Regional Municipality of Waterloo (RMW) (2009). *iXpress: Central Transit Corridor Express Project - Urban Transportation Showcase Program Final Report*. Ottawa: Transport Canada (http://www.grt.ca/web/transit.nsf/$all/F6DE7F8752F8C8C985257640004DC050/$file/Region%20of%20Waterloo%20UTSP%20Final%20Report%20Dec_09.pdf?openelement).

Rodier, C.J. and Shaheen, S.A. (2005). *Transit-Based Smart Parking: Early Field Test Results*. Paper presented at the Transportation Research Board Annual Meeting 2005 (http://database.path.berkeley.edu/imr/papers/UCD-ITS-RR-05-15.pdf).

Science Applications International Corporation (SAIC) (2008). *Evaluation of Transit Applications of Advanced Parking Management Systems – Final Evaluation Report*. Federal Highway Administration Report No. FHW A-JPO-08-052, Washington, DC: FHWA (http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/14460_files/14460.pdf).

Transportation Research Board (TRB) (1996). *Guidelines for Transit Facility Signing and Graphics*. Transit Cooperative Research Program (TCRP) Report 12, Washington: Transportation Research Board.

Transportation Research Board (TRB) (1999). *The Role of Transit Amenities and Vehicle Characteristics in Building Transit Ridership: Amenities for Transit Handbook and The Transit Design Game Workbook*. Transit Cooperative Research Program (TCRP) Report 46, Washington: Transportation Research Board.

Wardman, M. (2004). Public transport values of time. *Transport Policy* 11, 363-377.