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Urban Design Working Group

Transit Universal Design Guidelines

Principles and Best Practices for Implementing Universal Design in Transit

Abstract: This document advocates for inclusive design for transit facilities by promoting more equitable mobility services and making transit more accessible for all users. The goal is to enhance collective benefit to all users and reduce the bias in favor of typical users.

Keywords: Equitable, flexibility, intuitiveness, perceptible, tolerance, effort, transit, users, accommodations, implementation, inclusiveness, access, advocacy.

Summary: Because of demographics and improved healthcare, more of the population can benefit from universal design, whether from longer life spans, better outcomes for diseases or injuries that would not have been survivable in the past or mainstreaming of those with differing cognitive abilities. As these trends continue, universal design helps create environments that are usable by more and more of the population. Universal design makes transit stations more functional for a wider range of people, based not only on disability, but also factors such as age and size. It helps all users navigate unfamiliar environments. This document advocates for more inclusive design for transit facilities to enhance the collective benefit to all.

Scope and purpose: This document is intended to be an action-based handbook that provides a decision-making and prioritizing tool for transit agencies, design consultants and policy-makers in the implementation of universal design-based enhancements to accessibility accommodation within the transit station environment. Transit systems throughout the world have similar needs and requirements, as do all users. Therefore, the more intuitive, accessible, language-neutral and perceptible the transit environment becomes, the more it will benefit both the transit system and the population it serves.

This document represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any recommended practices or guidelines contained herein is voluntary. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit system's operations. In cases where this is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal advisor to determine which document takes precedence.

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Participants

The American Public Transportation Association greatly appreciates the contributions of the APTA Standards Urban Design Working Group which provided the primary effort in the drafting of this document.



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- industry leaders
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Introduction

The principles of universal design complement and go beyond governmental, jurisdictional and code requirements for accessibility. The guidelines presented in this document provide the means to maximize positive transit user experiences by implementing best practices in programming, designing and constructing transit stations.

All people have the need, from time to time, to utilize transportation systems. As the world's population becomes more mobile and globalization increases, the need for standardization within transit systems worldwide becomes evident.

People require similar accommodations and access when using transit systems, regardless of location. Furthermore, people possess a wide range of physical and mental abilities, and all those various abilities must be accommodated to the greatest extent possible. Thus, the need to apply the principles of universal design has become increasingly essential.

This recommended practice provides guidelines for the implementation of universal design principles and concepts into the design of new and existing transit stations. The intent is to enhance the transit experience for all users by creating transit environments that are enjoyable, understandable, easy to use and accessible to all.

Document organization

This document is organized into seven interrelated sections:

1. **Overview:** This section provides an overview of universal design and explains the critical need for transit agencies to adopt its principles.
2. **Universal design principles for transit:** This section describes the seven most commonly recognized universal design principles and how they can be applied to transit to extend and enhance the travel experience, making it enjoyable, convenient and accessible for all users.
3. **Transit stations:** This section describes the generic types of transit stations typically in use worldwide. In addition, this section illustrates the space-time sequential experience of movement throughout a transit station, as well as the process of utilization of the aspects of accommodation required to navigate a station by the various user groups.
4. **User groups:** This section describes the wide variety of transit users possessing various levels of ability and the elements required to accommodate their specific needs.
5. **Aspects of accommodation:** This section addresses the physical and environmental accommodations including equipment and systems required to provide a fully functional, operating transit station that enhances, through universal design, the experience of all user groups.
6. **Implementation:** This section provides guidance in ways and means for integrating universal design principles and concepts through public advocacy, information resources and partnering with ability-specific user groups. Also included are decision methodologies for assessing schedules and life-cycle costs in order to prioritize implementation of universal design features. This is supported with information regarding governmental regulations, best practices and case studies.
7. **Resources for further information:** This section lists several organizations and federal agencies that can provide further information on universal design for transit.

Appendix: Transit Universal Design Guidelines Multimedia Illustrations. To be published at a later date.

Many guidelines and concepts are demonstrated in multimedia form in the appendix entitled “Transit Universal Design Guidelines Multimedia Illustrations”.

Transit Universal Design Guidelines

1. Overview

Public transportation provides services to users with wide ranges of physical and mental abilities. Transit users come from diverse cultural, social and economic backgrounds. Furthermore, many users are new to using transit or are using a system for the first time. For example, even customers who regularly use transit in their own communities face unfamiliar environments when using transit while traveling. It has been decades since the inception of universal design approaches to public facilities and progress has been made in developing institutional standards for guiding universal design. Many industries have made significant advancements in implementing universal design, including hospitality, air travel and housing. The transit industry needs the guidance of universal design critically and urgently. This document is intended to fill that void.

“Universal design should therefore be considered a process rather than an end state. There is never any end to the quest for improved usability, health, or social participation, so attention to more than just the built environment is needed to achieve these three broad outcomes.”¹

Because of demographics and improved healthcare, more of the population can benefit from universal design, whether from longer life spans or better outcomes for diseases or injuries that would not have been survivable in the past. As these trends continue, universal design elements must take into account being usable for more and more of the population. Universal design makes transit stations more usable for a wider range of users, based not only on disability, but also factors such as age and size. Universal design can help all users navigate unfamiliar environments.

The built environment of a transit system is a linear and mostly open form that integrally connects with its surrounding environment. The impact from the surrounding environment results in significant challenges in creating and maintaining the quality of the environment required for safety and comfort of users. The guidelines in this document are aimed at addressing these unique challenges of universal design for transit systems.

Transit systems serve a great diversity of riders in spectra of physical conditions, mental abilities, and cultural and linguistic backgrounds. Implementing universal design in transit will have far-reaching impact to riders and society. It is evident that there is now a lack of guidelines for universal design in the transit industry, at least within the United States. Therefore, it is the goal of this document to provide the principles of universal design that are most applicable to transit.

It is important to design through engagement. An effort to ensure that all user groups participate in the design process from the very beginning is essential. Likewise, it is important that feedback loops are in place to make sure the input is heard correctly.

¹ Whole Building Design Guide Accessible Committee, Jordana L. Maisel, Ph.D., and Molly Ranahan, MUP Center for Inclusive Design & Environmental Access (IDeA)

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This document also introduces the current best practices of universal design applicable to transit. Readers are encouraged to apply these principles to their work related to transit.

While this document addresses the performance and functional features of facilities and equipment; an important part of universal design relies on good people-based service. Accomplishing this is integral to an agency's operational procedures and staff training. These are outside the scope of this document.

The desired outcome is to design transit facilities that are ideal for every user. When considered from the beginning of the design process, using the material contained in this document as a resource will minimize the overall cost of a project and can reduce costs resulting from change orders, costly retrofits and litigation.

1.1 Universal design general definition

Universal design is the design of equipment, environments and services to be usable by all people, to the greatest extent possible, without the need for adaption or specialized design regardless of gender, ethnicity, health, size, ability, disability or other factors that may be pertinent. Universal design is the implementation of a process that improves the quality of life and greatly improves independence by enabling and empowering a general, yet diverse, world population to achieve optimal human performance, health and wellness through equal access to all facilities and social participation.²



A transit station design that reflects the eight goals of universal design.
Brussels, Belgium

² This definition incorporates the definition by Ron Mace quoted on the Universal Design Project website, <https://universaldesign.org/definition>.

1.2 Eight goals of universal design³

1. **Body fit.** Accommodating a wide range of body sizes and abilities.
2. **Comfort.** Keeping demands within desirable limits of body function and perception.
3. **Awareness.** Ensuring that critical information for use is easily perceived.
4. **Understanding.** Making methods of operation and use intuitive, clear and unambiguous.
5. **Wellness.** Contributing to health promotion, avoidance of disease and prevention of injury.
6. **Social integration.** Treating all groups with dignity and respect.
7. **Personalization.** Incorporating opportunities for choice and the expression of individual preferences.
8. **Cultural appropriateness.** Respecting and reinforcing cultural values and the social, economic and environmental context of any design project.

As technology and automation evolve, so too will the elements of universal design. The physical manifestations of universal design, where users are integrated into how transit stations function, will facilitate further enhancement of user experiences as new technologies come into broad use.

1.3 Principles of universal design for transit

An ideal transit-built environment incorporates appropriate design elements that connect with users' senses, including touch, sight, hearing and smell in support of their use of the system:

- lighting
- color
- texture
- sound
- acoustics
- spatial dimensions
- boundaries
- operable barriers
- visual, audible and Braille messages
- temperature
- humidity
- air flow

Universal design should extend into the community around the station. As communities move toward “walkable” areas around transit, it is a natural fit to incorporate universal design into the door-to-door experience that includes transit. For example, adding disabled parking very close to transit increases access for differently abled people who drive to transit. However, care should be taken to not overly incentivize driving to transit, discouraging access by other modes between the community and the transit station. The absence of good sidewalk access could discourage nearby people from using transit and increase car traffic around transit. Designing access to transit needs to accommodate all people, including those who need safe sidewalks

³ Steinfeld and Maisel, 2012



Use of logo and pictogram for critical information.

Shanghai, China

2. Universal design principles for transit

The guidelines for universal design for transit were developed based on some of the seven most commonly recognized universal design principles:⁴ equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use.

When these principles are applied to transit stations, they extend and enhance the travel experience, making it more enjoyable, convenient and accessible for all users.

Implementation of principles of universal design is a continuous process of innovation targeted at creating transit stations that are easy to navigate while improving usability for everyone.

2.1 Equitable use

The design provides the same means of use for all transit customers:

- Provide identical features whenever possible, and equivalent features when not.
- Make provisions for privacy, security and safety equally available for all users.
- Make the design friendly to all users.

2.2 Flexibility in use

The design accommodates a wide range of individual preferences and abilities:

- Provide choices in methods of use.
- Accommodate right-handed or left-handed access and use.

⁴ NC State University Center for Universal Design, Raleigh, North Carolina, with a consortium of universal design researchers and practitioners from across the United States, developed the Seven Principles of Universal Design.

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- Consider equipment control features that can accommodate users with uncommon needs (such as installing elevator foot pedals in addition to push buttons, motion sensors and voice-activated controls).
- Provide information and equipment controls that are more forgiving of the users whose abilities are less accurate and precise.
- Provide adaptability to the users' pace.

2.3 Simple and intuitive use

The design is easy to understand, regardless of the user's experience, knowledge, language skills or concentration level:

- Eliminate unnecessary complexity.
- Be consistent with user expectations and intuition.
- Accommodate a wide range of literacy and language skills.
- Use graphics (standardized where possible) and colors/texture/shapes for system elements.
- Arrange information consistent with its importance.
- Provide effective prompting and feedback during and after task completion.

2.4 Perceptible information

The design communicates necessary information effectively, regardless of ambient conditions or the user's sensory abilities:

- Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
- Maximize legibility of essential information.
- Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
- Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

2.5 Tolerance for error

The design minimizes hazards and the adverse consequences of accidental or unintended actions:

- Arrange elements to minimize hazards and errors, ensuring that hazardous elements are eliminated, isolated or shielded.
- Provide warnings of hazards or errors.
- Provide fail-safe features.
- Discourage unconscious action in tasks that require vigilance.

2.6 Low physical effort

The design can be used effectively, comfortably and with a minimum of fatigue:

- Allow user to maintain a natural body position.
- Use reasonable operating forces.
- Minimize repetitive actions.
- Minimize sustained physical effort.

2.7 Size and space for approach and use

The design provides appropriate sizes and shapes for approach, reach, manipulation and use regardless of a user's body size, posture or mobility:

- Provide a clear line of sight to important elements for any seated or standing user.
- Make reach to all components comfortable for any seated or standing user.
- Accommodate variations in hand grip and size.
- Provide adequate space for use of assistive devices or personal assistance.

3. Transit stations

Transit stations and stops come in many shapes and sizes, depending on the mode, level of ridership, context and age of the system. This document is intended to be relevant to all transit stops.

3.1 Transit station types

3.1.1 Bus stops and platforms

Bus stops and platforms consist of a fixed waiting area integrated into a public right-of-way, usually as part of a sidewalk. At a minimum, a bus stop includes a boarding pad and a sign. Higher-quality stops also include seating, shelters, wayfinding signage and real-time displays showing the arrival times of buses.

3.1.2 Bus rapid transit (BRT) stations

A bus rapid transit line provides faster, more reliable and more convenient service than a typical bus route. One of the key upgrades is better stations. Bus rapid transit stations usually include larger boarding platforms and shelters than a typical bus stop. Many provide level boarding, with platforms raised to the level of the bus, facilitating the loading and unloading of users in wheelchairs. Fare collection is frequently done at the platform, rather than on the bus, shortening loading times. On-street BRT can operate at the curb or in the median, resulting in a wide variety of station configurations. Where bus transit uses off-street busways, BRT stations can be as elaborate as heavy rail stations, with multilevel circulation and major structures; some systems have elevated, depressed and underground stations. BRT platforms are generally less than 100 ft long, accommodating 60 or 40 ft buses, but some systems have longer platforms that allow more than one bus to stop at a station at once.

3.1.3 Streetcar stations

Other than the steel rails, streetcar stations resemble BRT stations.

3.1.4 Light rail (LRT) stations

Like a bus, light rail can mix with cars and pedestrians. Thus, a light rail station does not need to be more elaborate than a BRT station. However, light rail vehicles are longer—up to 136 ft—and can operate in trains of up to four cars. This means that platforms are typically 180 to 400 ft long. Except for a handful of legacy systems, light rail systems use level boarding, with either low (typically 14 in.) or high (up to 36 in.) platforms. Light rail can operate on-street; in transit malls; in at-grade off-street rights-of-way; or grade-separated on elevated structures, embankments, cuts or tunnels. This leads to a wide variety of station configurations, from simple on-street platforms to complex multilevel stations.



A light rail station

Zurich Metro, Switzerland

3.1.5 Heavy rail stations

Heavy rail is defined by having the rails separate from other types of traffic by defined rights-of-way. Users are banned from entering the trackway due to the presence of third-rail power. Thus, heavy rail stations must have circulation levels above or below track level; many have a mezzanine in addition to platform level and entrance level. Heavy rail stations can be at grade (but fenced off), below grade, in a subway, elevated or in the median of a freeway. Heavy rail trains are usually longer than light rail trains, with up to 10 cars, making for long platforms and large stations that often have multiple entrances and exits.



A heavy rail station

Washington D.C., USA

3.1.6 Commuter rail stations

Like heavy rail, commuter rail does not run in streets and has long trains. However, it is possible for pedestrians and cars to cross commuter rail tracks at grade. Some commuter rail stations are quite simple, with minimal platforms, shelters no more elaborate than those at bus stops and walkways at track level. Others may be completely grade-separated and resemble heavy rail stations.

3.1.7 Bus transit centers

Bus transit centers are off-street facilities where multiple bus routes converge, offering transfers between lines. They include multiple platforms with shelters, bus drives and off-street pedestrian circulation. Many offer multiple modes, including on-demand transit, bike storage, bikeshare and rail connections. Some have enclosed waiting rooms, concessions and customer service offices. Transit centers can have multilevel circulation, and some are integrated into buildings.

3.1.8 Ferry docks and terminals

Ferry docks are waterside facilities that accommodate ferries. They pose unique challenges for user access, usually requiring long or steep ramps to accommodate changing water levels due to tides and other fluctuations. Exposure to weather and protection from the effects of tides, waves and water levels are important factors. Generally, these facilities connect to other land-based transportation options.

3.1.9 Intermodal terminals

Intermodal hubs include a variety of stations and terminals that provide key transfers between transit modes, including bicycle routes. Such facilities may have a variety of other services and connections, including parking, pickup/drop-off locations, ticket vending and information booths, and may be integrated with retail shopping, services and entertainment.



An intermodal terminal

MTA South Station Ferry Terminal, New York, USA

3.2 Station functional process

The process of station utilization varies with each user group as they navigate the station environment and access the transit system. For the simplest of stations, such as a bus stop, this process is truncated because fare

purchase or validation may be made on the vehicle. This list illustrates the sequential movement of each user group through the station with the mode of access required and choices available:

- station entry
- information assimilation
- fare purchase
- fare gate entry
- arrival at platform

4. User groups

Transit systems are conceived as a means to provide transportation for all, regardless of specific needs or desired destinations. Individuals using transit systems vary greatly in their needs and their abilities to use these systems. To aid in the integration and implementation of universal design attributes (features, elements, parts) at transit stations, these guidelines identify the accommodations required to satisfy the needs of specific user groups defined in this section.

4.1 Frequent users

Frequent users who are familiar with a specific transit facility understand how to negotiate that location. However, every person's ability varies, and familiarization does not compensate for deficiencies in any given facility. All users expect and deserve a safe and pleasing facility that does not discourage transit use.

Even if a person has no physical or cognitive concerns that impede the ease of movement from place to place, he or she may still face challenges in negotiating an unfamiliar station or system.

4.2 First-time users

Design of stations should consider first-time users, whether the person is a first-time user of a particular station, of a particular system or of transit systems in general. Consideration of first-time users challenges designers to craft every aspect of the experience, including clarity of station entrances, wayfinding and parking rules; accessibility of schedules, transit system maps and information regarding other intersecting transit lines and systems; and fare determination and collection. In addition, first-time users should be able to determine the location of vertical circulation most suitable for their abilities, whether stairs, escalators or elevators.

Many users can now choose to become familiar with a new transit system prior to arriving at their destination. Online information may be provided to first-time users. This style of information typically includes the following:

- reservations, prepaid ticketing and prepaid parking, as available
- advance information in various languages
- cancellation policies
- customer assistance
- service hours and schedules
- transit system maps and station diagrams
- information for people with disabilities

Internet-based information can be downloaded and printed before travel, or accessed during travel via a mobile device. Online resources can be readily updated, and formal/informal real-time information can be disseminated via social media to address orientation, wayfinding (GPS) and interpretation services.

4.3 Bicyclists

Encouraging people to bike to bus or rail transit facilities supports first/last mile connections and reduces the need for private vehicle use and parking near transit properties. Integrating the needs of bicyclists requires transit agencies to address issues such as the following:

- coordination with local stakeholders to support the provision, enforcement and maintenance of bike lanes and trails providing access to and from stations and stops
- provision of secure bike parking, signage, ramps, bike channels and elevators
- any restrictions for carrying bikes on escalators or stairs
- signage regarding restrictions and signage to guide bike users to elevators
- wider fare gates to accommodate bicycles
- provisions for allowing bikes on rail and bus transit vehicles and any associated restrictions on the time of day, what car to ride in, or size and type of bicycle permitted (e.g., folding/electric-powered)

4.4 Users with luggage

A user may carry just a briefcase, backpack or toolbox—or may be burdened with a five-piece luggage set for a long-term vacation or move. A user with luggage moves considerably more slowly than an individual unburdened with luggage and is much more distracted trying to juggle and guard luggage and negotiate the intended embarking or alighting location at the transit facility.

The amount of luggage a person carries increases the physical space of the user. Users with luggage must be considered in the design of local transit systems that connect to and from airports, interstate buses and train terminals. Provisions for users with luggage may include the following:

- use of ramps and elevators where changes in level are required
- use of stairs and escalators of larger widths
- adequate storage space on transit vehicles to accommodate luggage and personal equipment of varying sizes

4.5 Users with personal mobility equipment

In larger cities, public transit is the sole method of transportation for many households, because personal vehicle ownership is impractical. For families with young children, ensuring their safety and security is critical. Ramps and elevators accommodate strollers and small children more safely than stairs, which are difficult for children to negotiate with the speed and dexterity of an adult. For individuals who rely on transit to do their shopping, accommodating their ability to safely carry groceries or packages in the transit environment also needs to be addressed. Provisions for these groups in a transit environment include the following:

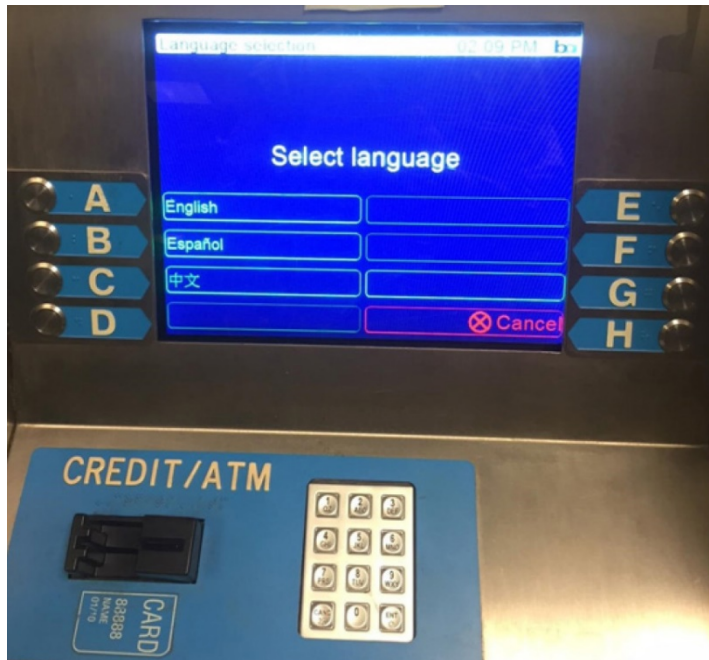
- Elevators and ramps required for wheelchair users also aid users traveling with packages, carts, strollers and young children. Consideration should be given to increasing the size of elevators to accommodate more users in these groups.
- Adequate accommodation should be provided for strollers and shopping carts on vehicles and policies for traveling with folded/unfolded equipment.
- Accommodating strollers for twins is especially important. Rules that require folding the stroller and holding a baby may be difficult for one parent traveling with an infant and cannot be followed by a parent with twin babies.

4.6 Users with limited English proficiency or literacy

It has been documented that up to 400 languages are spoken in the United States. The United States is a diverse multicultural society, and while many residents speak and read English, not all of society has mastered it enough to use it as their primary language.

Additionally, visitors from all over the world arrive daily to experience life in the United States. Often these travelers use transit stations to travel from one location to another.

The prevalence of learning disabilities means some users may be unable to read written signage well. Many rely on visual cues (pictograms), or the assistance of fellow users, instead of reading to be able to effectively negotiate their environment.



Fare vending machine with language selection and braille

San Francisco Bay Area Rapid Transit District, USA

4.7 Users with mobility impairments

Users who have physical impairments that limit mobility include not only those who use wheelchairs but also those who walk with some difficulty or with the assistance of a scooter, walker, crutches or cane. Mobility impairments also include lack of stamina, loss of limbs and paralysis. Mobility impairment may be temporary, such as in the case of those recovering from injuries. Accommodations for the mobility impaired may include the following:

- Use of ramps and elevators where changes in level are required. Use of escalators for changes in level depending on the type of mobility impairment.
- Adequate wayfinding tools for accessible routes, for example locating elevators and ramps.

- Information regarding which elevators and escalators are operational and the travel direction of each escalator (up or down).
- Use of wider accessible routes, including stairs, passageways and escalators. Wider stairs, passageways and escalators accommodate users in groups and permit users who are moving quickly to pass slower users.
- Access to spaces for wheelchairs on platforms, onboard buses and trains, and in waiting areas.
- Minimal use of rough surfaces, as vibrations irritate wheelchair users, particularly those with spinal conditions.

4.8 Users with hearing impairments

Hearing loss is an invisible health issue. It is the third-most-common physical condition after arthritis and heart disease and affects nearly 20 percent of the population. Accommodations for users with a hearing impairment include the following:

- critical announcements provided over both the public address system and on the visual messaging system
- hearing assistance systems
- sound enhancement systems using assistive listening devices that interface with hearing aid telecoils
- smartphone apps that provide information in a graphic or written language format
- video relay services to capture and translate sign language
- text-for-safety and text-for-customer-service options that allow hearing-impaired users to easily communicate

4.9 Users with speech impairments

Users who have a speech impairment may experience substantial limits on communication. Provisions for the speech impaired include the following:

- Provide telecommunications devices for the deaf (TDDs) on each platform and in each concourse. Include means of communicating with station agent, agency's central control and police.
- Implement video relay services to capture and translate sign language.
- Implement text-for-safety and text-for-customer-service. Speech-impaired users can easily communicate with these services. For all users, text-for-safety and text-for-customer-service can ensure that the user is not overheard when reporting a crime or similar sensitive message.

4.10 Blind/visually impaired users

The guidelines for visually impaired transit users are developed based on the critical sensory input the users rely on. The design features should incorporate elements that are recognizable by touch, sound, light and smell. Key strategies and accommodations for users who are blind or have low vision include the following:

- Provide an agency accessibility web page verbally describing station features and training schedules.
- When possible, provide consistency of station layout, including location of agent booths, fare gates, ticket machines, restrooms, escalators and stairs.
- Conduct regular outreach training to help users learn the system and where things are.
- Use beacons and GPS.
- Integrate smartphone apps that provide navigation information.
- Provide raised-letter and Braille signs, stationary Braille maps and personal paper Braille maps. In theory, Braille may help blind users, but not all visually impaired users read Braille or attempt to find Braille signs, as their hands become dirty exploring and finding the sign locations. Work with other agencies to standardize Braille sign mounting locations.

- Consider tactile paths to help cane users move about the location. Refer to Section 5.5.7, “Tactile paths.”



Tactile and braille signage at key locations
San Francisco Bay Area Rapid Transit District, USA

4.11 Individuals with cognitive disabilities

Cognitive disability results in a physical or mental impairment that substantially limits one or more major life activities, including difficulty with orientation, concentration, judgment, problem-solving skills and coping skills. In addition, individuals with cognitive disabilities may have compromised short-term memory, and may lack the ability to seek and act on directions, to process information, and to communicate their needs. All these issues require an environment that does not jeopardize the safety of such individuals. Accommodations for individuals with cognitive disabilities include the following:

- easy access to assistance by transit agency personnel
- use of an easily identifiable wayfinding system using symbolic communication (i.e., pictograms) both in the transit facility and on trains
- availability of transit station maps at numerous locations throughout the station

4.12 Individuals of varying sizes

Consideration should be given to how station design can successfully accommodate those of below- or above-average height or above-average weight.

5. Aspects of accommodation

5.1 Acoustics

When possible, establish an integrated, system-wide or station-wide approach using artificial sound and the acoustical effect of the materials and spaces as means to aid visually impaired users in recognizing spaces and in orientation. For example, design spaces to produce a sound reverberation effect to help the visually impaired perceive the shape and orientation of the space. When laying out a station, also consider the sound of fare gates, escalators, and other artificial items like fountains and speakers. Avoid noise interference.

5.1.1 Quiet spaces

Continuous and intense ambient noise may discourage users from using the transit system. One of the mitigation methods is to provide defined spaces, inside which users can experience a much lower noise level.

- Such spaces will provide hearing-impaired and noise-sensitive users a respite and may encourage them to use the transit system.
- In addition, quieter spaces allow users to talk with friends and family.
- Quiet spaces or “sensory rooms” also serve as waiting areas for families with children who have neurodevelopmental challenges, such as autism.
- Provide protected safe spaces for children who may feel overwhelmed by large crowds or other personal challenges that may arise during their travel experience.
- Consider mitigating noise in noisy waiting and boarding areas. An example of noisy areas are station platforms located in a highway median.

5.2 Audio systems

5.2.1 Hearing loops

Common background noises in a transit environment, such as wind and adjacent highway traffic, make hearing aids difficult to use. In a quiet environment, hearing aids work well in the 3 to 5 ft range. Hearing loops work by converting a communication message into the magnetic field and transmitting an audio signal directly into the hearing aid. These loops can be connected to local communications devices such as ticket agent booths or in large areas connected to station public address systems. Using the hearing loop system provides a better user experience and greater confidence while riding transit. The international symbol of accessibility for a hearing loop needs to be displayed for each loop to alert users that a hearing loop exists. The user can turn on the coil setting in his or her hearing aid to use the hearing loop system.

Hearing-assistive technology is a rapidly changing field. When replacing or upgrading systems, it is important to review options.⁵

5.2.2 Hearing assistance systems

Other hearing assistance systems include infrared (IR) and radio frequency (RF) systems

5.2.3 TTY/TDD telephone

TTY/TDD stands for teletype/telecommunications device for the deaf (text-based communications equipment). These devices have largely been supplanted with newer methods of communication such as mobile devices with messaging applications and email. The vast majority of transit systems have removed both TTY/TDD and pay phones from transit facilities because, once pay phones were removed, there was no longer a code requirement for TTY/TDD.

There are still reasons to provide TTY/TDD. TTY/TDD can act as the station courtesy phone to facilitate contact with the station agent by deaf and speech-impaired individuals. In addition, it can promote life safety for the deaf and speech-impaired because it can be operated after a disaster that takes down cell towers and eliminates use of cell phones.

Universal design best practice:

⁵ <https://www.hearingloss.org/hearing-help/technology/hat/>

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- Provide telecommunications devices for the deaf (TTY/TDDs) on each platform and in each concourse. Include means of communicating with station agent, agency's central control and police.

5.2.4 Station agent courtesy phones

Station agent courtesy phones allow users to communicate from various locations throughout the station. Typically, they are found at ticket vending areas, elevator lobbies and platforms. In some systems, a paging chime is transmitted throughout the station when the station agent is away from the agent booth to alert the agent that someone needs help. Transit agencies are now installing hands-free, push-button units in lieu of standard handset units. The latest technology includes equipment such as hands-free gate telephones (GTLEs), a universal push-button and push-plate system that allows for either hand or foot activation of the telephone/intercom.

Hands-free gate telephones have the following features:

- hands-free push-plate activation via a 30 to 36 in. tall kick plate
- two-way voice communication
- lights/sounds indicating the stage of the call—dialing, voice connection and call ending
- pictograms, visual, tactile and Braille signage to provide instruction
- accessibility-compliant push button for activation



Hands-free audio and visual intercom with kick panel activation

Los Angeles Metro, USA

5.3 Fare collection systems

Most transit systems collect fares. The means of collecting those fares can have many impacts on the accessibility of a system. Fare collection systems vary greatly among agencies and modes. However, all fare collection systems accomplish two fundamental tasks: They allow users to purchase tickets, and they allow agencies to ensure that users have purchased tickets.

There are several basic ways of accomplishing these tasks:

- The user pays the driver of the bus or train when boarding or deposits payment in an onboard machine under the observation of the driver, or presents a previously purchased ticket. The ticket may be validated by an onboard machine.
- The user pays a conductor onboard the bus or train, or presents a previously purchased ticket.
- The user purchases a ticket and then uses that ticket to enter the station through a turnstile or fare gate. Refer to Section 5.5.4 for guidelines on fare gates.
- The user purchases a ticket and then retains that ticket so it can be presented to a fare inspector if requested (“proof of payment”).

These systems also support preloaded passes or stored value cards, advance purchase of tickets on the internet or by mail, and payment by mobile app.

The choice of fare collection system shapes the user experience and affects different users with different levels of ability in different ways. For example:

- Turnstile-based systems can be hard to maneuver through for someone in a wheelchair, someone with luggage, or a family with small children.
- The proof-of-payment system, which eliminates fare gates, requires interaction between users and fare checkers, which can be problematic for some people with cognitive limitations.

Any agency that is implementing a new fare system, or making changes to an existing fare collection system, should consider the needs of all users in evaluating potential systems and involve members of the disabled community in those discussions.

The following sections discuss some common elements of fare collection systems and key aspects of the design of those elements, with examples or ways to make them more accessible.

5.3.1 Ticket vending machine (TVM)

A TVM can be difficult for any user, particularly new users and infrequent users. Users with cognitive disabilities, blind users, users who cannot read English, and users with mobility impairments may face particular challenges.

Universal design best practices for ticket dispensers:

- Design machines to be used intuitively with minimum instruction. If instruction is necessary, then use graphic illustrations if possible. If text is necessary, minimize the words, provide Braille and raised text, and translate the words into languages that are commonly used among users of the system and station.
- **Figure 2** shows a TVM screen providing language selection. Button D in the lower-left corner has all the available languages rotating for that button. Once the user presses the button, it leads him or her to the “Select Language” screen, where the actual language is selected. All the remaining displays are then in the selected language.

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Universal design best practices for ticket vending machines and similar devices:

- Locate on level or near-level surfaces so that transit customers using wheelchairs, walkers and other mobility aids can easily use the machines.
- Provide machines at accessible heights in accordance with ADA and code requirements. Refer to Section 5.10.5, “Reach range,” for additional considerations.

Universal design best practices for bill changers:

- Similar to ticket vending machines.

5.3.2 Mobile ticketing apps

Mobile apps should offer multiple languages and should be accessible to people with visual impairments through large-text and audio options.

Some ticketing systems only require users to show their phones to a conductor, driver or inspector. Others require the phones to be validated at a fare box or turnstile. For the latter, near-field communication (NFC) radio-based scanning may be easier for blind or mobility-impaired users scanning a bar code.

5.4 Handrails, leaning rails and seating

5.4.1 Handrails

While code-compliant handrails are required at stairs and on ramps, from a universal design standpoint they can provide needed assistance at long horizontal surfaces and corridors where those with walking or breathing impairments can steady themselves or pause for a short rest on their journey through a transit facility. Handrails may also incorporate concealed lighting that aids in wayfinding and safety.

Universal design best practices for handrails:

- Provide a railing shaped with a grip that facilitates grasping.
- Provide handrails along sloped walkways, whether classified as a ramp or not.
- Provide continuous handrail throughout multi-sectional ramps and stairs, to the extent possible.
- Provide handrail extensions parallel to the floor and return extensions to handrail supports or walls.
- Consider providing handrails at multiple heights to accommodate adults, children and those with physical impairments requiring alternative handrail locations.
- Design handrails to preclude use by skateboarders.
- Consider designing handrails with textures or other devices to signal location or other information to the visually impaired.



Handrails at varying heights to accommodate users
San Sebastian Central, Spain

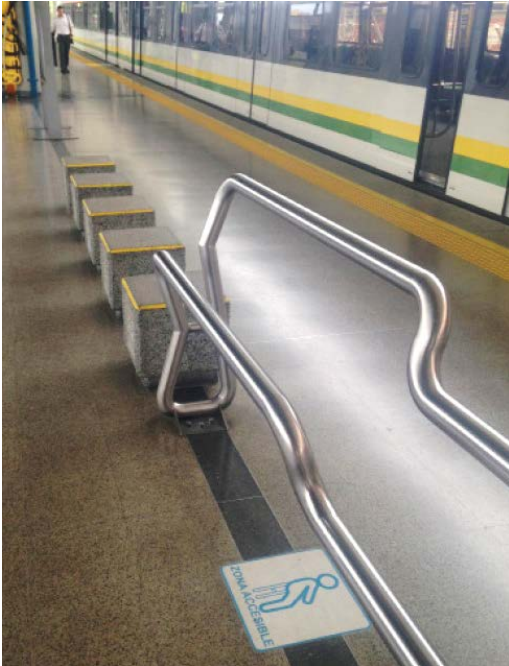
5.4.2 Leaning rails

Leaning rails are particularly useful at transit facilities with limited space and are primarily used by ambulatory standing users to offer a level of comfort to those needing to stand for an extended period. However, leaning rails should not completely replace seating.

Current practice typically uses leaning rails where transit stations are constrained and have limited space for seating. Bicyclists tend to use leaning rails more than other user groups.

Universal design best practices for leaning rails:

- Provide leaning rails at waiting areas that offer resting opportunities for all users.
- Provide leaning rails at multiple heights to accommodate a variety of height requirements, including adults, children and bicycles.



Leaning rails with multiple heights
Medellin Metro, Colombia

5.4.3 Seating

All transit users require access to seating at one time or another. Some users need seating just for rest or convenience, while for others it is a necessity while waiting for their next transit vehicle to arrive. Universal design dictates that when addressing the needs of individuals whose physical challenges necessitate sitting, the design should also accommodate all users. Therefore, users capable of standing for only short intervals of time or those temporarily disabled need seating that is conveniently located and adjacent to the loading area for the transit vehicle. The seating should not require any special operation, such as flipping down a seat or other adjustments.

Health and safety issues must also be considered. Seating surface materials should be nonabsorbent, inherently resistant to contamination and easily cleaned. The seating surfaces should also be smooth, but not slick, so that users can easily move on the surface. Surfaces should be designed so that they do not collect and hold liquids or moisture and are corrosion-resistant. Surfaces should be as vandal-proof as possible, and difficult to cut or scar. The material and color of the seating should not retain heat or burn skin and should be located with shade from the sun.

Universal design best practices for seating:

- If seating is provided at stations and stops as individual seats or benches with dividers, then provide some individual seats or bench spaces between dividers wide enough to accommodate individuals of above-average breadth.
- Seats should be sturdy enough to withstand vandalism and also to accommodate individuals who are heavier than average.
- Provide seating in intermittent areas along the circulation path to boarding areas.
- Provide seating within designated loading and waiting areas.
- Locate seating out of the main circulation area so as not to impede pedestrian flow, but locate it adjacent to accessible paths.

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- Provide clear floor spaces for wheeled mobility devices adjacent to seating areas. Distribute floor space for wheelchairs intermittently and next to seating so that friends and family groups can sit together.
- Provide a variety of seating options to accommodate all users. Include seating with greater seat heights and appurtenances (such as arm supports) that accommodate users who have difficulty lowering and lifting their bodies.
- At exterior locations, locate seating in sheltered areas that protect users from wind, sun, rain and snow, and provide thermal comfort in all seasons to the extent practical.
- Provide seating areas that are protected from splashing water, odors and the noise of traffic.
- Place seats facing the boarding area and, where possible, with a view of approaching trains or buses and visual message signs such as next bus or train signs.

5.5 Horizontal circulation

Horizontal circulation refers to the way individuals navigate throughout a single level of a building or outdoor area. It includes accessible routes through open areas, plazas, exterior walkways, sidewalks, interior walkways, corridors, concourses and platforms—in other words, all areas in which an individual can walk or use a mobility device.

5.5.1 Boarding areas

Universal design best practices for boarding areas:

- At transit hubs, minimize the walking distance between connecting public transport services.
- At transit hubs served by multiple modes, the maximum walking time between the farthest two stops or boarding areas should not exceed 5 minutes.
- Minimize the distance a pedestrian must walk to reach any transit boarding zone or stop from the outermost designated transit parking areas.
- Provide routes for users approaching a transit hub on foot or via mobility device, bicycle or another transit vehicle that do not necessitate walking through a parking area to reach the transit service they will be boarding.
- To maximize safety and convenience, streets leading to transit facilities should have continuous sidewalks on each side of the street and highly visible crosswalk markings.
- When bus platforms are in the middle or median of the street, provide accessible information to direct people, especially the blind and visually impaired, to the median platform.

5.5.2 Crosswalks

Universal design best practices for crosswalks:

- Provide crosswalks to delineate where pedestrian traffic intersects with vehicular traffic.
- Provide “continental” or “zebra” type crosswalks that use alternating dark and light strips painted on the road surface in a ladder-like method.
- Provide wide crosswalks up to 25 ft if space is available. Behavior observations have shown that when the crosswalk is wide, people will tend to stay in the center of the crosswalk.
- Provide wide curb ramps at each end of crosswalks to avoid “bottlenecks.” Align curb ramps at each end of crosswalks to minimize the need of users with wheelchairs or other wheeled equipment to weave through other users to reach a desired ramp.
- Use both contrasting-color striping and truncated domes as detectable warnings for pedestrians entering the crosswalk to indicate boundaries of safe crossing zones.
- Provide sufficient drainage to divert water away from pedestrian crossing zones and curb ramps.

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- Use changes in surface materials to clearly differentiate the crosswalk from the street. Provide both a visual and tactile indication of the crosswalk for all users.
- All crossing areas should be well-lighted to help ensure that pedestrians are visible to approaching vehicles and so they can avoid tripping.
- Where crosswalks cross rail tracks in streets or center medians, provide a walking surface at the same height as the top of the rail, and minimize the gap between the crossing surface and rail.
- Consider providing raised crosswalks, or crosswalks at the same elevation as the sidewalk. Provide warnings to vehicle users approaching these bumps.
- Provide pedestrian signals with the following attributes at all crosswalks:
 - Audible locator tones with ambient noise sensors to increase volume when intersections become noisier.
 - Locator tones that are present at both starting curb and ending curb to confirm to visually impaired users that they are going the correct direction from start to finish.
 - Vibration sensors to notify those with hearing and visual impairments of safe crossing.
 - Speech crossing information when button is held down (e.g., location, direction crossing).
 - Where red-light intersections are not present, other warning lights that align the pedestrian path to warn drivers that pedestrians are in the crosswalk.
 - Signal push buttons at conventional height and an additional foot-level kick panel for those without upper limb mobility and those using crutches.
 - Where bike paths are adjacent to a pedestrian crosswalk, a separate signal push button along the bike path at a level that individuals on bicycles can push without dismounting.
 - Longer time for the “walk” signal to ensure that individuals with mobility impairments have sufficient time to cross the street.
 - Where crosswalks cross rail lines (either in street or on its own guideway) consider a separate signal with crossing arms or gates that close at the pedestrian crossing and cannot be opened when a rail vehicle is approaching and crossing the pedestrian path.

5.5.3 Pedestrian, bicycle and auto separations

Universal design best practices for pedestrian, bicycle and auto separations:

- Provide clear delineation with barriers or buffers between paths dedicated to pedestrians and individuals with mobility devices, paths dedicated to bicycles, and paths dedicated to motorized vehicles.
- Minimize elevation change between paths to prevent tripping hazards.
- Use different colors or other visible contextual elements to differentiate between each designated path.



A dedicated and continuous pedestrian and bike path crossing a transit center
Amsterdam Central Station, Netherland

5.5.4 Fare gates

Universal design best practices for fare gates:

- Fare gates should be designed for bidirectional use to allow changes to accommodate the main commuter direction.
- Consistency of entry/exit/accessible gates should be maintained in each array to promote good user flow and use by users with accessibility needs. Clearly identify entry/exit with large graphics.
- Fare gates should be designed to deter fare evasion.
- The fare gate array should be designed to allow emergency egress.
- Place fare gates within common circulation paths to intuitively direct users in their sequential movement toward decision points and destinations.
- Implement a consistent design and pattern for fare gate location and operation (where to enter or exit, where to scan tickets and cards, etc.).
- Whenever possible, fare gates should be a minimum of 36 in. wide to accommodate all users, including mobility-impaired users and users with luggage, bicycles and strollers. When space doesn't allow for all gates to be 36 in. wide, provide a minimum of two gates at least 36 in. wide gates per array, to allow one gate to serve each direction. Systems with only one 36 in. gate in a group of gates make use of the gate a challenge when going against the commute direction.
- Accessible fare gates should have the following features:
 - smooth surfaces and rounded edges
 - sensors to keep the gate open until 20 seconds after the customer has safely cleared the gate paddles
 - the International Symbol of Accessibility (ISI) clearly visible on each gate
- Fare gates should have tones or spoken messages and text messages for fare card troubles. Suggested messages are wrong way, out of order, contact station agent, insufficient funds, and other pertinent information or directives.

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- For the fare gate audio tones, the following are the tone patterns as agreed upon with the Disability Rights Advocates group:⁶
 - Entry: one long beep (one tone, 200 ms [long])
 - Exit: two short beeps (two tones, 80 ms on, 80 ms off, 80 ms on [short-short])
 - Low balance: short beep followed by long beep (two tones, 50 ms on, 50 ms off, 360 ms on [short-long])
 - Invalid: three beeps (three tones, 100 ms on, 100 ms off, 100 ms on, 100 ms off, 100 ms on)
- Provide contact-free access to fare gates using internet and wireless technology. Fare gates that are configured for opening via long-range wireless card or an app downloaded on users' smartphones can be opened without the need to tap payment cards. This allows users who have difficulty with tapping a fare card to seamlessly enter and exit transit stations. Sensors installed near fare gates detect an authorized user within 6 to 10 ft of the gates and interact with fare gate infrastructure via software integration.



Well positioned backlit indicators showing faregate directions
East Japan Railway, Japan

5.5.5 Moving walkways

Universal design best practices for moving walkways:

- Moving walkways are typically provided in airports and in rail stations with remote platforms when distances are time-consuming and tiring and users typically have luggage.
- Provide moving walkways wide enough to accommodate wheeled mobility devices.
- Provide changes in surface textures as a warning before approaches to moving walkways.
- Typical approach of entrance and exit of walkways:
 - Use audible announcements to notify users when they are approaching entrances and exits of moving walkways and include the direction walkways are traveling. The announcements should be heard from within the ends of the conveyance system to best localize the target without sight. Note that notices from overhead or remote locations are counterproductive and not effective.

⁶ Disability Rights Advocates, with offices in New York and California, is a leading nonprofit disability rights legal organization.

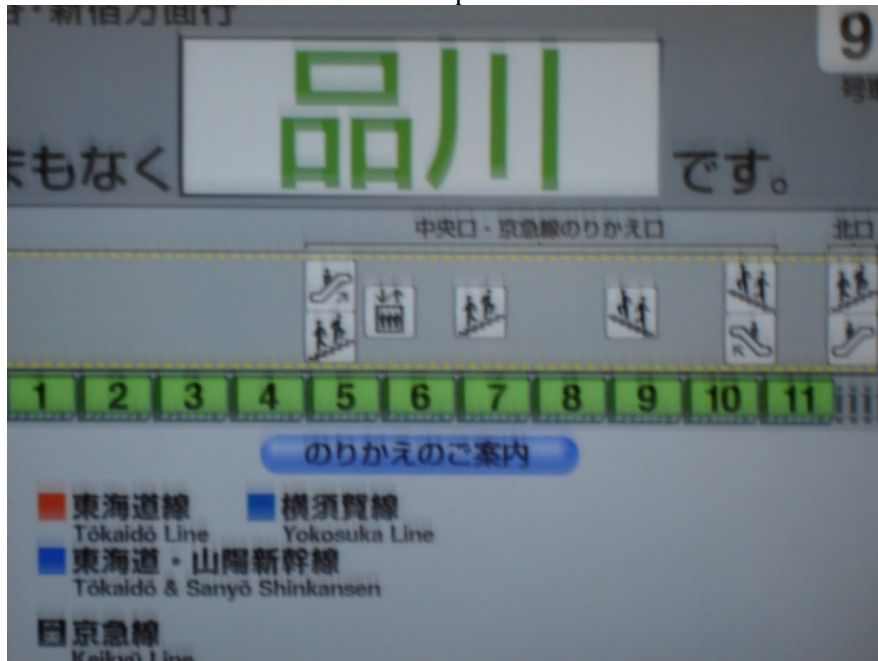
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- Use motion-sensor-activated audible devices to ensure that location is accurate with a minimum of excess noise.
- Accidental approach to exit portal of walkways:
 - Specify and engage audible alarms triggered by accidental approach into the exit portal of moving walkways. This is a critical feature for safe approach and used by people who are blind and visually impaired, as well as any person who may improperly approach an exit.
 - Use motion-sensor-activated audible devices that are able to activate in environments where noise levels fluctuate.

5.5.6 Interface between vehicle and station

Universal design best practices for vehicle-station interfaces:

- Minimize, to the greatest extent possible, the horizontal gap between the transit vehicles and the boarding platform, particularly rail vehicles, to increase ease of access for all users, especially wheelchair users, walking aid users, and those with luggage and strollers. Though some space must be left between the rail cars and platform for engineering purposes, some tools and materials are available that can be implemented to minimize that gap, such as the following:
 - Bridge plates that extend over gaps to overcome horizontal differences. These plates are designed to extend manually or automatically, although automatic installations are preferred.
 - Fixed thermoplastic “gap reducers” attached to vehicles to decrease the amount of space between rail cars and platforms.



A real time station display on the train depicting correlation of train position and platform circulation points Tokyo Metro Station, Japan

5.5.7 Tactile paths

A tactile path is intended to aid vision-impaired users in navigating between one location and another, mainly by means of a cane on surfaces such as textured, raised and audible (surface that has a sound that contrasts with adjacent surfaces). A tactile path is often enhanced for low-vision users with color contrast.

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Tactile paths are distinguished from detectable warning surfaces.

Depending on their location and height, guide strips used in tactile paths have been known to cause problems for some wheelchair users, some people who use walkers and other mobility devices, people with stability challenges, people wearing high-heeled shoes, and people traveling with wheeled luggage.

When an agency desires to install a tactile path system, the following should be considered:

- Tactile paths should be used sparingly and be continuous with no interruption of guidance, because such interruptions pose ambiguity and questions that cannot be easily and quickly resolved. If an interruption is inevitable and unavoidable, do not change direction within the discontinuous area unless the area is narrowly defined with inevitable points of reconnection that will be reliably found at either end. Never provide a change in direction within an intersection. Discontinuous tactile paths pose a significant problem for visually impaired users, because they can leave users with confusion about where to begin following the path again if the tactile path begins again in a different location. A problem could occur if a section becomes damaged and a discontinuity is created. One other challenge is how to communicate and direct users during a retrofit project where the construction removes a section of the pathway.
- Tactile paths should be limited in use to avoid confusion with detectable warning surfaces. In addition, make tactile paths distinct from detectable warning surfaces to preserve the communication of essential safety concerns.
- Conduct outreach and training on how to use the tactile path, including explanation of its purpose and destination (Steinfeld and Maisel).
- Consistency is key, including:
 - consistent material, width and color; and
 - consistent beginnings, endings and decision points along the path.
- If a tactile path is implemented, consider as a priority a path from bus and drop-offs into the station through the fare gate and to the platform or stair leading to the platform.

The following flooring and paving surface guidelines are relevant to tactile paths and flooring in general:

- Provide surface textures and patterns that are free of illusions that may disrupt visual perception of spatial order (e.g., a black tile may appear as a void).
- Provide glare-free surfaces and nonslip materials.
- Provide floor surfaces that do not impede the mobility of wheelchairs, strollers and other wheeled devices.
- Avoid the use of the following floor surfaces:
 - gravel, sand or stone
 - brick or concrete blocks that may produce an irregular surface
 - grates

Development of state or national standards for tactile paths is encouraged. Such development should be in conjunction with the disabled community and be thoroughly tested. Such standards would help establish consistency among agencies throughout regions and eventually across the nation. Once standards are developed, tested and adopted, a user visiting different cities should encounter consistent tactile paths to aid in navigation.

5.5.8 Navigation aids

Universal design best practices for navigation aids:

- Consider using multisensory placemaking features that offer perceptible information to all users.
- Use architectural nodes to provide an intuitive navigation option for all users.
- Distinctive colors and surface textures of greater width than tactile path guide strips can help all users differentiate high-traffic circulation paths and portals and easily navigate to their destinations.
- Changes in ceiling heights and other acoustical features can help users identify spaces by sound, while changes in floor material, floor textures and floor color contrast can assist in orientation as well. Refer to Section 5.1, “Acoustics.”
- Refer to Section 5.7, “Smartphone assist.”

5.6 Lighting

Lighting is critical for users’ comfort, safety and security. Lighting throughout transit facilities is essential for the effectiveness of wayfinding, as well as user and hardware interface. Universal design best practices for lighting:

- Lighting should provide extra illumination at major nodes and on wayfinding signage.
- Consider using flashing floor lighting at boarding platforms to notify users of incoming trains; these augment detectable warning surfaces.
- Use ample illumination to enhance overall perception, orientation and security. Design lighting to eliminate strong shadows that may cause confusion and make details of surroundings difficult to perceive.
- Consider smart-lighting systems that automatically adjust for time of day and activate when movement is detected. The smart activation of the lighting system can be coupled with activation of audible information for the hearing-impaired.

5.6.1 Lighting levels

Universal design best practices for lighting levels:

- The greatest number of visual tasks occur at the concourse level. A well-designed lighting system can dramatically enhance how users orient themselves within the space, locate wayfinding signage and identify key activity locations. Develop a hierarchy of lighting by illuminating key destinations distinctly brighter than the general circulation area. This helps new users understand the space.
- The platform level of the station should generally be illuminated to the same levels during the day and night. However, a nighttime reduction in light levels is recommended for energy conservation. Areas of the platform should have adequate lighting for reading print material.
- Bus stops and bus rapid transit stations similarly require a hierarchy of lighting so that key visual tasks such as reading schedules and maps and operating ticket vending machines have brighter illumination than general waiting areas.
- Stairs and escalators require uniform illuminance to provide a uniform visual experience of the steps. At locations where station connective elements link with the exterior environment, light levels that adjust for time of day are essential to promote users’ adaptation from an exterior to an interior environment and vice versa.

5.6.2 Lighting equipment

The success of station and bus stop lighting design in providing consistent lighting over time is dependent on a selection of equipment that is suitable for the application, easily maintained and long-lived. Lighting control systems also figure into providing effective and economical lighting.

Protection of the luminaire from physical damage, exposure to moisture (such as mist, rain, dripping water and condensation), and exposure to dust is required to ensure continued operation and effectiveness of equipment. Luminaires listed to comply with the UL standards for damp or wet locations are recommended. In addition, an ingress protection (IP) rating of 63 or greater is recommended to prevent damage from moisture. Equipment rated as vandal-resistant is also recommended in areas subject to tampering or potentially within reach of transit users and other members of the public. An unprotected luminaire that accumulates dust and debris over time will deliver reduced light output. This reduced light output requires oversizing the light output of the fixture at the time of installation by 30 to 50 percent. By using a protected luminaire, accumulation of dust and debris is reduced to as low as 10 to 20 percent, thus lessening the need to oversize the system.

5.6.3 Lighting controls

As part of designing facilities to best serve all users, use lighting controls designed to provide zoned control of fixtures for each specific application area. Lighting zones should be grouped and controlled together so that all areas of a particular application are controlled in a similar manner. The lighting control system provides a means of controlling the light levels of light fixtures in each zone. Manual override for individual zones is provided for maintenance purposes when the station is not open to the public.

The lighting control system includes an astronomical time clock, allowing for time-of-day lighting control that responds to available daylight. This allows light levels to be set for morning/evening hours, daytime hours and late-night (unoccupied) hours. Additionally, daylight sensors can be included in the lighting control system to allow for areas with access to daylight to be controlled accordingly.

5.7 Smartphone assist

New smartphone applications are being introduced frequently. The examples below illustrate some of the available technologies:

- **Aira app** (www.aira.io/how-it-works). While using the app, users can connect with an “Aira agent” and receive real-time assistance through their smartphone or Aira-provided glasses. This is a paid service with different packages to choose from.
- **Navilens app** (www.navilens.com). The app allows users, via the camera on their smartphone, to navigate and find objects that contain coded colored decals. Decals can be placed on any object, such as drinking fountains, curtesy phones, restrooms, fare gates, stairways to desired platforms, ticket machines, platforms and bus stops. These decals are tied to an internet link that can be tied to real-time information such as transit schedules. The real-time information is a benefit for sighted users as well. This is a free service to users with the cost paid by the transit agency.
- **Infsoft Indoor Navigation app** (www.infsoft.com). Via a smartphone app, users within a station can find their way around faster with interactive maps showing points of interest, such as ticket vending machines and concessions. The interactive maps can be integrated with the transit agency’s website. With this app, users can also access real-time schedules and receive messages regarding delays. Navigation can start on the journey to the station, including guidance to the right entrance.
- **Wayfindr app** (www.wayfindr.net/). Wayfindr is an indoor navigation app designed to assist blind and visually impaired users with independent travel through transit stations and hubs. This smartphone app provides voice or vibrational wayfinding instructions to assist with overall pedestrian navigation. Wayfindr, a tech nonprofit based in the United Kingdom, developed an internationally approved standard software prototype providing audio instructions and prompts—via smartphone—to blind and visually impaired users navigating transit facilities. The software relies upon signals from a network of Bluetooth low energy beacons (BLEBs) strategically placed inside the station. The

software determines the location of the customer based upon BLEB signals and provides appropriate audio instructions corresponding with key points along the pedestrian route of travel.

Los Angeles Metro conducted 50 successful trials of the navigation software application at the multimodal Los Angeles Union Station. As the participant makes his or her way along the route, the software is dynamically “learning” and adjusting to the subject’s gait and rate of travel. The majority of participants arrived within a few feet of the targeted finish. Participant reaction to the live trial was overwhelmingly positive. Post-trial survey results found 77 percent “much more likely” to use public transit if an indoor navigation mobile app similar to Wayfindr was available. Prior to the live trials, none of the participants had ever been able to successfully navigate Union Station independently. Rather than attempt the complexities of a fixed-route trip requiring transfer at LAUS, blind participants instead opted to rely on paratransit services or other means of non-fixed route transport.

Wayfinding beacons have the following features:

- open standard system composed of non-proprietary hardware and software
- compatible with all common types of smartphones
- inexpensive to install and maintain components
- available at no cost to the transit user
- available in multiple languages

5.8 Vertical circulation

Vertical circulation refers to the ways users navigate between different levels of multilevel or multistory facilities with stairs, ramps, elevators and escalators.

5.8.1 Elevators

Most elevator manufacturers comply with federal requirements for audible and visual communication regarding use of the elevators by people with disabilities. In addition to such regulatory requirements, consider the following provisions for elevators:

- Provide a minimum of two elevators (as large as physically possible to allow for future growth) connecting each destination floor. Having two elevators helps ensure continued service during repairs and scheduled maintenance. Elevator service is essential for some users, who may find themselves unable to access or exit the station without the use of an elevator. For others, use of elevators is a matter of safety and convenience. Whenever possible, at least one elevator should be located at a midpoint along the length of a platform. Locating a single elevator at a decentralized location should be avoided to minimize walking distances and to better integrate with the general circulation flow.
- Provide queuing areas outside regular circulation paths at elevator entries.
- Design for additional elevators to be added when growth requires additional elevator capacity.
- Elevators should not be located in isolated locations that require monitoring to prevent unsavory behavior.
- Elevator surfaces should enable easy cleaning, and provision for frequent cleaning should be incorporated into operating plans.
- Provide audible, visual and Braille information to serve those with visual and hearing impairments, including:
 - a visible and audible (verbal) signal at each entrance to indicate car arrival and the direction of travel of the car answering the call; and
 - an automatic verbal annunciator panel in elevator cars that announces the floor at which the car is about to stop.

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- Maintain required clear floor or ground space adjacent to elevator call buttons that are free of obstructions that would prevent wheelchair users and others from reaching the call buttons.
- Provide support rails, preferably on all inside walls of elevator cars that do not have doors, for people who are unsteady.
- Provide foot-activated call panels accessible to people in wheelchairs and people using crutches. Design call panels for minimal effort and limited range of motion.
- Where in-car signals indicating the direction of travel are provided, they should be visible from the floor area adjacent to the hall call buttons.
- If destination-oriented elevators⁷ are used, make sure the control system selected is equipped to serve blind and other visually impaired people in the transit environment.

5.8.2 Escalators

Universal design best practices for escalators:

- Locate escalators so they are easily found and accessed at station entrances and concourse levels.
- Provide queuing areas outside regular circulation paths at the top and bottom of escalators.
- Provide sufficient space and width so escalators can be used without overcrowding. Sufficient width of escalators shall permit two users standing comfortably side by side or permit one user to stand while other users pass.
- Provide audible warnings that signal the up or down direction of the escalator before entrance points of escalators.
- Provide cane-detectable warning surfaces and visual warnings prior to the top step and bottom step of escalators. In addition, provide a contrasting color band 3 in. from the fixed edge of the escalator apron that engages with the moving treads.
- Provide universal audible alarms triggered by accidental approach into the exit portal of escalators. This is a critical feature for safe approach and used by people who are blind and visually impaired, as well as any person who may improperly approach an exit portal.
 - Use motion sensor-activated audible devices that can act in environments where noise levels fluctuate.
- Use a contrasting color on the edge of escalator steps to differentiate between steps.
- To best facilitate efficient flow of people in and out of the transit facility, provide for changes in the direction of escalator movement based on peak commute times and volume of traffic.
- Locate stairs adjacent to and running parallel to escalators whenever possible.

⁷ Destination-oriented elevators use an optimization technique (destination dispatch) used for multi-elevator installations, which groups users with the same destination into the same elevators.



Real time escalator direction indicator
Athens Metro, Greece

5.8.3 Ramps

For vertical circulation, ramps easily accommodate the largest number of user groups and implement most of the principles of universal design. Ramps do not involve the use of any mechanical devices; demand no special knowledge to access or operate; may be nondirectional; and are intuitive, requiring no instructions or language skills. Ramps can be used to implement all vertical circulation without the need for elevators or escalators. Ramps do take longer to negotiate and may impede the rapid flow to and from transit loading platforms. However, ramps are less likely to experience accidents that typically occur on stairs and escalators, and they more easily accommodate heavy user traffic. Ramps require good wayfinding.

In most instances, provide elevators in addition to ramps, because users in wheelchairs may find long ramps difficult to negotiate. Also, people with limited stamina or who find walking on a sloping surface difficult may prefer stairs for short elevation changes and may need elevators for greater elevation changes. Individuals with no mobility impairments may prefer stairs because they can travel more quickly on stairs.

Ramps require the use of more building or site area than stairs or escalators and can be extremely long where vertical changes are significant. Intermediate landings required by codes and ADA also lengthen ramps. Transit stations located in constrained urban areas typically will not be able to use ramps for vertical circulation.

Universal design best practices for ramps:

- Place ramps within the main circulation path with the width to accommodate the expected traffic.
- Where possible, integrate ramps into the station area design so users cover distance from parking or from other areas along the ramp rather than travel the ramp only to change elevation.
- Locate ramps near or adjacent to stairs, if provided, and in the direction of the intended destination wherever possible.
- Design for all to use, rather than as a special accommodation for wheelchair users.

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- Provide tactile, visual and/or auditory cues that indicate changes of direction and the top and bottom of the run.
- Provide continuous railings along both sides of all ramps.
- Provide even illumination.
- Provide extra space on landings for resting, located where the resting areas will not disrupt traffic flow.
- To accommodate the widest range of users:
 - Provide ramps with running slopes lower than regulatory maximum.
 - Wherever possible, ramps should accompany stairs for use by those for whom distance presents a greater barrier than steps (e.g., people with heart disease or limited stamina). Stairs and ramps should be in immediate proximity to each other for simple and intuitive use and to provide best equity for all users.
 - Maintain a consistent width and running slope. Provide no or minimal cross-slope.
 - Provide edge protection on each side of ramp runs and at each side of ramp landings.



Sloped people mover is more universal than escalator
Milan Central Station, Italy

5.8.4 Stairs

Stairs are difficult to negotiate for many individuals with a physical or health-related disability; therefore, design stairs with the following provisions to help mitigate safety concerns:

- Provide stairs with riser heights and tread widths that permit ease of use.
- Provide stairways of consistent width.
- Transitions from level circulation paths to stairs often present a dangerous environment for visually impaired users if the user is not provided with clues before proceeding. Therefore, it is important that

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the following perceptible information be provided to help users most easily navigate their environments:

- Provide high-level visual and tactile contrast strips at stair nosings at least at the first and last nosing of each stair run, but preferably at each stair nosing.
- Consider providing photoluminescent stair nosings to assist in identifying stair nosings in unusual conditions such as low light level or smoke.
- Provide cane-detectable, visual and auditory cues to indicate change of direction, and top and bottom of stairs.
- Add tactile wayfinding to handrails to indicate to vision-impaired users the floor they are currently on.
- Provide handrail extensions.
- Detectable warning surfaces are not suitable for use at top and bottom of stairs for the following reasons:
 - Providing detectable warning surfaces at these locations deviates from their original purpose to indicate the transition between safe (pedestrian) areas and hazardous (vehicular) areas such as at platform edges and streets.
 - Detectable warning surfaces create unstable platforms from which to initiate and conclude the climbing of stairs.
- Provide continuous guardrails along both sides of stairs.
- Do not use winding or circular stairways.
- Locate stairways at the perimeter of escalators to allow through travel on the floor.
- Provide extra space on intermediate landings where slow or low-stamina users can safely step aside from the traffic flow. Avoid creating hiding places.
- Design underside of stairway in accordance with code:
 - Free of overhanging hazards to a minimum height of 80 in. above the floor.
 - Provide a cane-detectable object at underside of stairs to avoid overhead obstructions.
- Consider making stairways wide enough for intermediate railings to facilitate opposing traffic. Provide intermediate landings of sufficient length to permit both handrail extensions of the intermediate railing in accordance with code and a gap to permit movement from one side of the stairway to the other.
- Provide sufficient lighting to avoid dark locations along stairs.
- Design exterior stair treads and landings subject to wet conditions to prevent the accumulation of water. Design for safety during snowy and icy conditions.

5.9 Wayfinding

Wayfinding is defined as a system that allows people to establish their location, determine their destination, and then develop a plan that will help take them from their current location to their desired destination. This section details the elements that can help achieve successful wayfinding.

5.9.1 Station and site design

Thoughtful station and site design is the starting point for clear wayfinding. Universal design best practices for station and site design:

- Stations should have a recognizable image within the urban fabric.
- Entries should be prominent and easily identified and accessed.
- Routes should be arranged so that next destinations are visible whenever possible; for example, being able to see elevators and escalators from fare gates.
- Variations in the design of spaces can avoid confusing sameness; for example, one station or exit looking exactly like another.

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- Signage at station entry both identifies station by name and includes readily identified logos. Font size on signage at station entry shall be readily readable from a minimum of 60 ft.⁸
- Locate signage to complement different heights of users. Provide overhead signs with large type so all users regardless of height can anticipate direction from a distance. Overhead and eye-level signs at entrances to boarding platforms, also with large type, help assure users of all heights that they are boarding the correct transit vehicle. Floor signs or graphics also assist individuals with wayfinding, especially for those short in stature.
- Develop wayfinding as an integral part of the architecture and site design and not as an afterthought.

5.9.2 Clarity and consistency of graphic design

Universal design best practices for graphic design:

- Use consistent graphics and format for information displays throughout the transit system so that there is a recognizable identity that defines the regional system, including the following characteristics for sign types:
 - size, shape and color
 - content and format
 - hierarchy of information
 - method and location of installation
 - construction and materials
- Use both concise text conveying clear, simple and appropriate messages, and international graphic symbols and pictograms that can be comprehended by non-English speakers.
- Integrate code-mandated accessible route and tactile/Braille signs with wayfinding and identification signage. Consistency in message, contrasting color and placement is key for this accommodation.
- Provide Braille signage at top and bottom of stairs, top and bottom of escalators, station agent booths, elevators, and exits.
- Locate signage and information displays for readability, and ensure that transit wayfinding signage has priority over concessionaire signage, advertisements and similar signage. Avoid over-signing any area.
- Repeat key wayfinding signage along path of travel.
- Ensure that clear, concise information is given at “decision points” where it is necessary to choose a path of travel from more than one option.
- Supplement wayfinding signage with multilingual brochures, audio information and videos.

⁸ For guidance on fonts and signage size, refer to Transit Cooperative Research Program (TCRP) Report 12, “Guidelines for Transit Facility Signing and Graphics.”

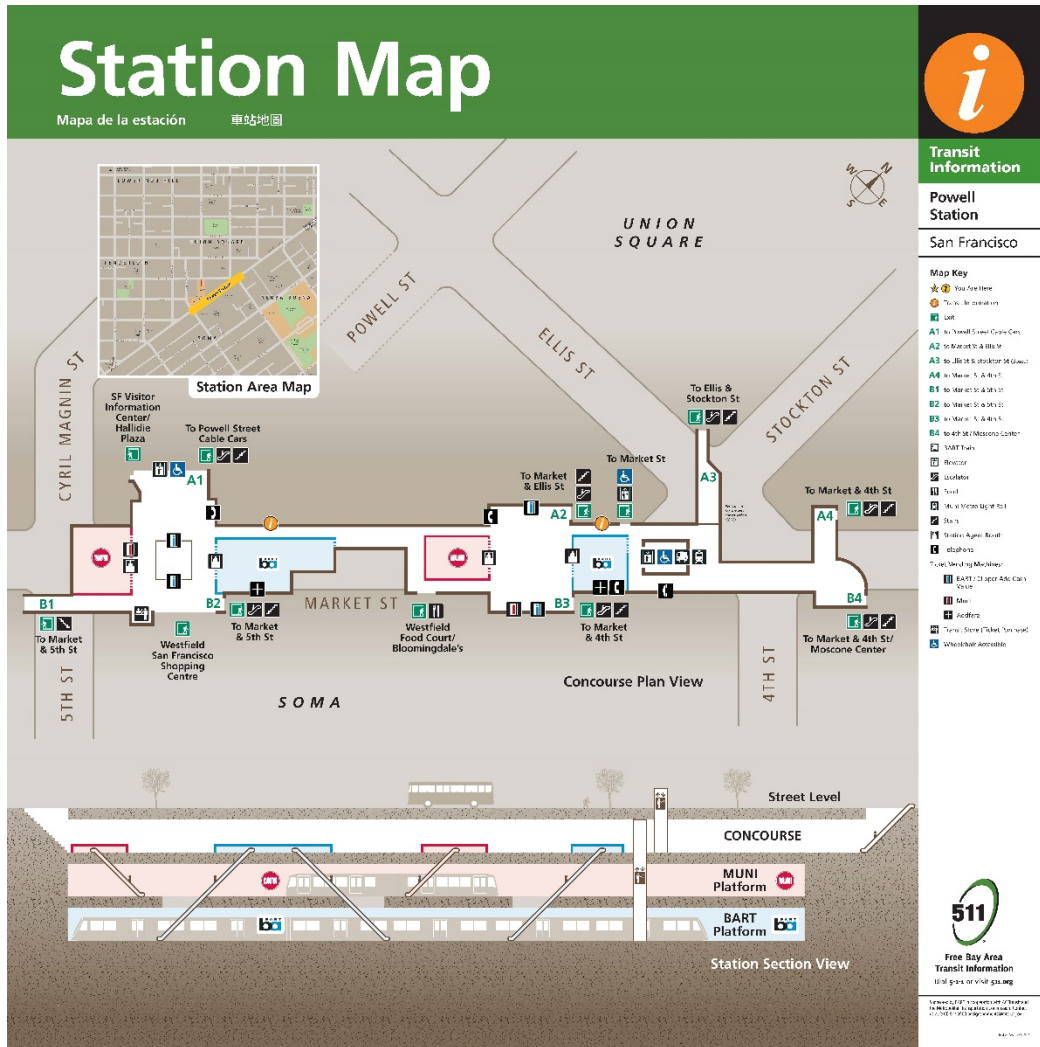


International pictogram for hearing loop system
Melbourne Metro, Australia

5.9.3 Transit maps and schedules

Universal design best practices for transit maps and schedules:

- For transit connectivity information at hubs, include both local- and regional-scale maps showing transit routes and popular destinations near transit services. Emphasize connectivity between transit systems.
- Detail the routes of each transit operator serving the hub on a map, with each operator shown in a distinct color.
- Clearly mark on the map boarding areas, key destinations and direction of travel.
- Identify streets, pedestrian routes and bicycle routes. Identify key destinations immediately adjacent to the station.
- Orient maps to the north, and include a north arrow and a “You are here” icon.
- Provide schedule and fare information that includes frequency of service during different periods of the day and week, and include an explanation of payment options.
- Make equivalent information available in accessible formats, including audio and tactile.



Station map to include special relationships and street connections
San Francisco Bay Area Rapid Transit District, USA

5.9.4 Real-time transit information

Real-time transit information that allows customers to know when to expect their next bus or train is an important component of regional transit connectivity and can provide an accurate means for the public to review transportation alternatives in the area. The displays should be easy to read, provide continuous updates of departures and other system information, and be paired with audible announcements. Real-time transit information should include information regarding escalator travel direction and which elevators are out of order. Place real-time information systems at several locations within the transit hub:

- directly outside the station paid area to enable decision-making prior to entering
- within the station to direct users to the correct platform or stop, particularly if loading locations change frequently
- at the platform or stop itself, where real-time information ensures that users board the correct vehicle

Additionally, provide “real-time” visual variable message systems and public address announcements at station entries that give notice of system delays or service interruptions. These assist transit users with timely information so additional information can be sought prior to passing through fare gates and arriving at the

boarding platform. With early information, users can avoid moving to an already-crowded platform and can consider transportation alternatives. The hearing-impaired benefit particularly, because they may miss public address announcements and may find it more difficult to catch information being passed by word of mouth.



Real time departure displays of transit services at an intermodal hub
San Francisco Bay Area Rapid Transit District, USA

5.9.5 Station maps

At complex stations, provide a station map at station entries to orient users. Identify station exits by a number/letter convention on the map (and reinforced in directional signs). For simple, surface-level hubs, designate exits with the name of adjacent street or another identifier/landmark.

5.10 User and hardware interface

5.10.1 Instructional signage

Instructional signage is typically associated with equipment such as ticket vending machines and fare gates. Effective signage helps users gain an intuitive understanding of how to use the machines. Design of instructional signage should involve testing signage effectiveness with users.



Pictogram instruction for boarding options for bus

Stockholm Metro, Sweden

5.10.2 Orientation videos

Orientation videos apply particularly to transit stations at airports. Orientation videos may also be provided on hotel television systems in areas where tourists and business visitors often use transit systems. Universal design best practices for orientation videos:

- Promote the concept of using a video to orient new users, particularly foreign visitors. The video would be similar to an airline safety video and would show how to buy a ticket and how to use the system. The video could be configured to allow the user to restart it. The video should be available with verbal instructions and subtitles in different languages.
- Include voiceover description of actions in the video for the visually impaired.
- Include accessible captioning for the hearing impaired.



A repeating video at platform provides safety instructions
Singapore MRT, Singapore

5.10.3 Audible sign systems

For people who are blind or visually impaired, large spaces can be disorienting, and audible wayfinding cues may be masked by ambient noise.

Consider the use of audible sign systems for the blind or visually impaired, as they may provide greater accessibility in the transit environment than traditional Braille and raised-letter signs.

One technology that is available uses small infrared transmitters and receivers. The transmitters are placed on or next to print signs and transmit information to an infrared receiver that is held by a person. By scanning an area, the person will hear the sign. This means signs can be placed well out of reach of Braille readers, even on parapet walls and on walls beyond barriers. Additionally, such signs can be used to provide wayfinding information that cannot be efficiently conveyed on Braille signs, especially in larger and more complex transit environments.

5.10.4 Public address systems

Universal design best practices for public address systems:

- The voices used in PA systems, whether digital or use of a live voice, should be clear and pleasing to the ear.
- Design PA systems to compensate for noisy environments. For example, more closely spaced speakers may be more effective than increased volume from fewer speakers.

5.10.5 Reach range

Operable parts including security controls, brochure racks and fare machines within transit facilities should be placed within comfortable reach range for a variety of user sizes. Design facilities to be inclusive regarding

reach range. In particular, when more than one of an item is provided in the transit environment, to the extent permitted by code, do not simply design everything for wheelchair accessibility.

Universal design best practices concerning reach range:

- At stations with fare gates:
 - All fare gates should be at least 36 in. wide (as described in Section 4.5.4).
 - Fare media identifiers must be at a level where they can be used by individuals using a mobility device.
- For equipment such as ticket vending machines, equipment heights for people in wheelchairs accommodate people of average height and shorter stature, as well as children. However, these heights may be awkward for individuals using crutches and those of tall stature. Provide equipment such as ticket vending machines at various heights, including at least two machines accessible to individuals using a wheelchair at each group of like machines.
- Security/safety features such as emergency phones for emergency exits need to be reachable by people of all height ranges.
- When multiple sinks are provided in restrooms, provide at least one sink at a lower height for people of shorter stature and children.

5.11 Station sequential experience

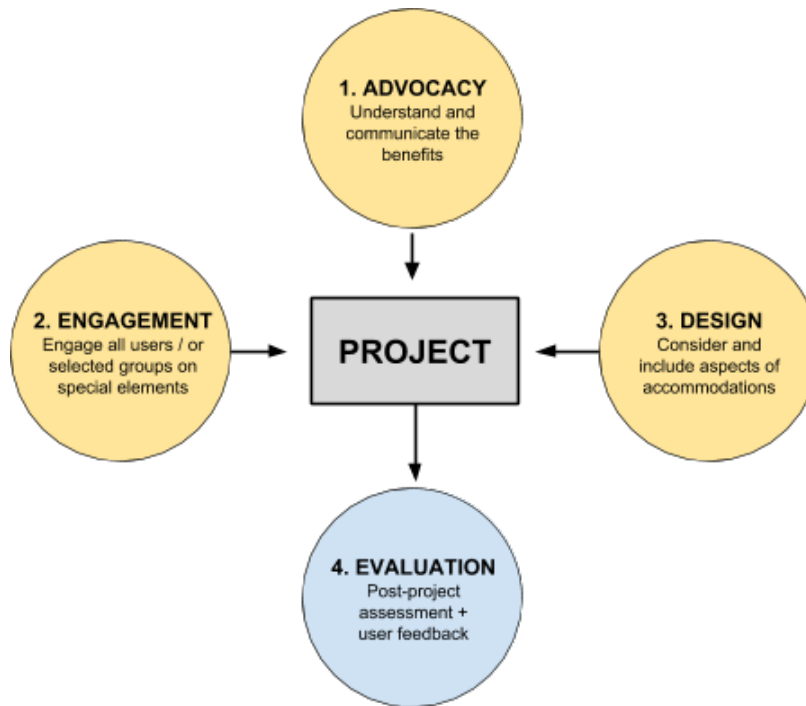
Travel is a sequential experience involving both time and motion. Within the transit environment, the user confronts a series of points where information is needed, and decisions based on that information are required to successfully use the transit system and to arrive at the desired destination. Understanding the segments that compose the circulation system serves as a framework for identifying decision points and, ultimately, for wayfinding signage at the site and facility.

6. Implementation

Through the process of implementing universal design guidelines for transit (see **Figure 3**), transit agencies begin to advocate for and empower accessibility for a diverse user population. Unlike building codes, which set a framework and specify minimum requirements to safeguard the health, safety and welfare of users, universal design for transit adds value through making accessibility decisions during a holistic design process and not after. The power of universal design for transit is that it introduces the opportunity for design freedom.

This section offers a process and approach for transit agencies to implementing universal design for transit through advocacy, engagement, and evaluating and finalizing design options. With this approach, transit agencies can attract new and retain existing ridership and come closer to providing implementable solutions that are inclusive and universal from the start.

FIGURE 1
Universal Design Process



6.1 Advocacy

Universal design principles greatly enhance the user experience when they are integrated seamlessly into the fabric of the transit facility. As such, the availability of such features may not always be transparent, even if all individuals benefit. To demonstrate consideration of accessibility for all users, and specifically for people with disabilities, state and local transit agencies should proactively offer resources and information to convey universal design principles. Clear messaging may be accomplished in the use of marketing materials and public interest campaigns that convey information about features in the facility. Promotional materials and information may be provided on site, in informational displays adjacent to universal design features, in promotional materials such as billboards and pamphlets, or through audiovisual resources on-site and on the internet.

Transit agencies should also consider implementing features that address unique user needs extending beyond transit-related services and enhance the user experience. For example, the addition of services such as adult changing facilities and family restrooms may not be required services to be provided by transit agencies, but they are necessary for full participation by all user groups, as is the availability of people to call for interpretation services to communicate with transit personnel.

Some benefits of universal design for transit:

1. **Making a positive impact that is more inclusive, increases satisfaction and reduces frustration.** Through inclusivity, universal design can make a positive impact by improving the quality of life and empowering the user population to achieve optimal human performance, health and wellness through equal access to all facilities and social participation, thereby increasing user satisfaction.
2. **A positive transit user experience that improves safety and sense of security.** Universal design is a means to maximize positive transit user experiences by implementing best practices in

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programming, designing and construction that create transit environments that are safe, enjoyable, understandable and easy to use.

3. **Smoother implementation and minimization of construction conflicts.** A well-informed universal design process will provide smoother implementation and minimize construction issues by identifying and addressing issues and conflicts early in the process, when design decisions can be assessed, tested and reevaluated.
4. **Reduce operational and capital costs, with fewer retrofits needed later.** A process that prioritizes inclusiveness from the start and takes into consideration a holistic “design for all” philosophy, where universal design is integrated seamlessly into the fabric of the transit facility, will lower operational costs in the long run and minimize or eliminate future retrofit costs.

6.2 Engagement

Universal design should be applied whenever and wherever possible, and this should be reflected in the engagement process. People are diverse, and some people in the engagement group might not be able to see/hear/move/speak/understand information well or at all. Some general best practices that can help in preparing for a presentation include presenting slowly and clearly, making text and important visuals big enough to be read even from the back of the room, translating the material for people speaking languages other than English, and having a facilitator. For a special element of the project, transit agencies may also consider additional engagement with the user group being addressed. If the audience and its special needs are known ahead of time, targeted presentation and material can be prepared to best facilitate the engagement process.

TABLE 1
 Effective Accommodation for Selected User Groups

User Group*	Effective Accommodation
Blind or low vision	<ul style="list-style-type: none"> • Be more descriptive in words • Offer handouts in alternative formats such as large print or Braille • Use three-dimensional models
Mobility impairments	<ul style="list-style-type: none"> • Provide a comfortable reach level • Keep enough aisle width for wheelchairs to pass through
Deaf or hard of hearing	<ul style="list-style-type: none"> • Provide captions and/or transcripts as appropriate for audio and video • Provide sign language interpreter • Face people with hearing impairments, and avoid covering your mouth, so they can see your lips
Families with kids	<ul style="list-style-type: none"> • Consider providing childcare services and/or material to keep kids engaged (e.g., coloring sheets with crayons) • Consider holding mini-meetings with kids

* Transit agencies may contact local Centers for Independent Living to ensure that engagement includes people with special needs. Centers for Independent Living are community-based, cross-disability, nonprofit organizations that are designed and operated by people with disabilities.

6.3 Design

Design plays a key role in creating implementable solutions that are inclusive, and a successful universal design outcome is dependent on the design process. When universal design benefits are understood and communicated among the agency stakeholders and all user groups are engaged, the transit agency should consider the aspects of accommodations listed in Section 5 and include the applicable tools into the project design. It is recommended that an iterative process be taken to ensure that budgets and schedules are aligned

with the chosen desired design elements. After the project is completed and constructed, an evaluation of the design solution needs to be executed and documented to better understand the lessons learned.

6.4 Assessment and evaluation

Assess and evaluate completed projects to gauge the successes and challenges of the universal design for transit process for a specific project. The process of verifying the user experience plays an important role in whether the goals were satisfied with respect to installation, construction and performance. A post-construction experience evaluation can help determine whether the universal design guidelines were successfully implemented.

The following is an assessment and evaluation process that can be completed by the agency:

1. **Post-construction experience evaluation.** Provide surveys and questionnaires to transit users, as well as transit staff
2. **Internal validation.** Observe the use of transit and determine whether universal design improves safety and increases satisfaction.
3. **Complete a report of the findings.** Document the universal design guidelines implemented, post-construction experience evaluation and internal validation for the internal record. Consider sharing the report with other agencies and organizations.



Engage stakeholders throughout all project stages
San Francisco Bay Area Rapid Transit District, USA

6.5 Example

Transit agencies may refer to the following step-by-step example to follow the universal design guidelines for transit implementation process.

Example: A transit agency needs to make improvements to its light rail station, which sits in the median of a busy street. The agency wants to follow the universal design guidelines for transit on this project.

1. Identify the issue. The improvement is mainly to improve the use of the system for transit users who encounter a difficult time crossing the street. The improvement likely involves providing or enhancing accommodations on horizontal circulation.

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2. Advocate the benefits of more inclusive design to reduce frustration and improve safety and sense of security. Gain support from funding agencies and stakeholders.
3. Have an engagement plan that is open to all but offer additional outreach to people who are blind or have low vision, as well as people with mobility impairments.
4. For the design process, refer to Section 5 of this document to identify applicable aspects of accommodations. In this case, “Crosswalks,” “Tactile paths” and “Turnstiles” under Section 5.5.
5. After implementation, evaluate the implementation by sending out surveys on whether the improvement increased users’ satisfaction with this transit stop. Make sure the outcome is universal to all users and not biased to or adverse to one user group or another.
6. Document the performance of the built project to measure the successes and challenges. Document any safety issues. The lessons learned may be applicable to future projects.

7. Resources for further information

The following organizations and federal agencies are resources for further information on universal design for transit. This list was taken from the Whole Building Design Guide, a program of the National Institute of Building Sciences:

- **American Association of Retired Persons (AARP):** A nonprofit membership organization dedicated to addressing the needs and interests of persons 50 and older. Through information and education, advocacy and service, AARP enhances the quality of life for all by promoting independence, dignity and purpose. Among other things, AARP seeks to promote independent living and aging-in-place.
- **Center for Assistive Technology and Environmental Access (CATEA):** CATEA is a multidisciplinary engineering and design research center dedicated to enhancing the health, activity and participation of people with functional limitations through the application of assistive and universally designed technologies in real world environments, products and devices.
- **Center for Inclusive Design and Environmental Access (IDeA Center):** The center—part of the School of Architecture and Planning, University at Buffalo, Buffalo, New York—is dedicated to improving the design of environments and products by making them more usable, safer and appealing to people with a wide range of abilities, throughout their life spans.
- **The Center for Universal Design, North Carolina State University, Raleigh:** A national information, technical assistance and research center dedicated to evaluating, developing and promoting accessible and universal design in housing, commercial and public facilities, outdoor environments, and products through design innovation, research, education and design assistance.
- **Design for All Foundation:** The Design for All Foundation is an international foundation that strives to research, develop knowledge, promote, apply and disseminate Design for All among companies, public, private and education organizations, designers (in the sense of any professional able to modify spaces, products or services) but also aim to reach individuals, as citizens or consumers, to achieve a more equitable and cohesive society.
- **Institute for Human Centered Design (IHCD):** The IHCD, founded in Boston in 1978 as Adaptive Environments, is an international nongovernmental organization (NGO) committed to advancing the role of design in expanding opportunity and enhancing experience for people of all ages and abilities through excellence in design. IHCD’s work balances expertise in legally required accessibility with promotion of best practices in human-centered or universal design.
- **National Endowment for the Arts:** An independent federal agency that funds and promotes artistic excellence, creativity, and innovation for the benefit of individuals and communities, the NEA funds and supports efforts that employ universal design concepts.
- **National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR):** A center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS), NIDILRR is a grants-making agency that sponsors grantees to generate new

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disability and rehabilitation knowledge and promote its use and adoption. NIDILRR funds the only national research center on universal design, the Rehabilitation Engineering Research Center on Universal Design and the Built Environment.

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- Universal Design: The HUMBLES Method for User-Centered Business* by Aragall, F., and Montana, J. England: Gower Publishing Ltd., 2012.

Applicable regulations

According to Federal Regulation 49 CFR Part 37 (§37.9 and Subpart C):

- (a) A public entity shall construct any new facility to be used in providing designated public transportation services so that the facility is readily accessible to and usable by individuals with disabilities, including individuals who use wheelchairs.

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Federal laws have established the compliance regulations and guidelines for accessible transit facilities. These laws are the following:

- Part 27: Nondiscrimination on the Basis of Disability in Programs or Activities Receiving Federal Financial Assistance
- Part 37: Transportation Services for Individuals with Disabilities
 - ADA Standards for Transportation Facilities
- Part 38: Accessibility Specifications for Transportation Vehicles
- Part 39: Transportation for Individuals with Disabilities: Passenger Vessels

In addition, the Federal Transit Administration has issued the following Final Rule on Reasonable Modification:

- Parts 27 and 37, Transportation for Individuals with Disabilities; Reasonable Modification of Policies and Practices (3/13/2015)
- Transit Facilities must also meet Title VI Requirements that address programs and activities regarding responsibilities to Limited English Proficient (LEP) Persons. The following webpage stipulates the FTA requirements:
 - Title VI Requirements and Guidelines for Federal Transit Administration Recipients
 - Copic, Aida, and Nicholas Seivers. Transit Design Standards Manual. Rep. River City: Transit Authority of River City, 2013. Print.
 - Steinfeld, Edward, and Jordana L. Maisel. “Public Transportation and Universal Design. “Universal Design: Creating Inclusive Environments. Hoboken: John Wiley & Sons, 2012. 339-364. Print.
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Definitions

Concourse: A concourse is a place where pathways meet. In a transit station, it is typically where tickets are purchased, information is gathered, and routes to specific platforms are selected. In grade separated systems, the concourse is on a separate level and vertical circulation such as stairs and elevators are accessed to reach the platform or platforms.

Mode: In regard to transit is a term used to distinguish substantially different ways or means of conveyance, such as air, water, and land transport. Mode further breaks down into various types of rail transit, various types of bus transit, ferries, and bicycles, as examples.

Node: A point at which lines or pathways intersect or branch; a central or connecting point.

Paratransit: Special transportation services for people with disabilities, often provided as a supplement to fixed-route bus and rail systems by public transit agencies.

Platform: A horizontal surface raised above the level of the adjacent area, such as a boarding and alighting area alongside rail tracks.

Abbreviations and acronyms

AARP	American Association of Retired Persons
ACL	Administration for Community Living
ADA	Americans with Disabilities Act
BATF	BART Accessibility Task Force
BLEB	Bluetooth low energy beacons
BRT	bus rapid transit
CATEA	Center for Assistive Technology and Environmental Access
GPS	Global Positioning System
GTEL	gate telephone

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HHS	Department of Health and Human Services
IDEA Center	Center for Inclusive Design and Environmental Access
IHCD	Institute for Human Centered Design
IP	ingress protection
IR	infrared
LRT	light rail transit
NATSA	North American Transportation Services Association
NFC	near-field communication
NIDILRR	National Institute on Disability, Independent Living, and Rehabilitation Research
NGO	nongovernmental organization
PA	public address
RF	radio frequency
ROW	right-of-way
TCRP	Transit Cooperative Research Program
TDD	telecommunications device for the deaf
TTY	teletype
TVM	ticket vending machine

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- None.

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