Chapter 2

Characteristics of Pedestrians

Public sidewalks and trails are more effective when designed to accommodate the needs of all potential users. To develop effective transportation networks, people responsible for designing public sidewalks and trails must understand the needs of the full range of route users. The concept of the “standard pedestrian” is a myth; in reality, the travel speeds, endurance limits, physical strength, stature, and judgmental abilities of pedestrians vary tremendously. Sidewalk and trail users include children, older adults, families, and people with and without disabilities.

Pedestrians are defined in this report as people who travel on foot or who use assistive devices, such as wheelchairs, for mobility. Many people have conditions that limit their ability to negotiate public sidewalks and trails. According to the 1990 U.S. Census, an estimated 49 million noninstitutionalized Americans (about one in five) have a disability (U.S. Department of Commerce, Bureau of the Census, 1994). Many of these individuals have needs characteristic of more than one type of limitation. For example, a wheelchair user might also have a hearing impairment.

Different individuals are capable of varying degrees of mobility. Some people are able to climb mountains, whereas others cannot cross a room independently, even with the aid of an assistive device such as crutches or a wheelchair. In general, the ability to reach a destination depends on a person’s speed, coordination, endurance, and the types of obstacles, grades, and cross-slopes he or she encounters along the way. Accessibility guidelines, such as ADAAG or UFAS, provide minimum specifications for accessibility that meet the needs of most people. However, exceeding the minimum standards whenever possible will increase a facility’s overall ease of use and will make environments accessible to more people. For example, routing a trail to minimize grades, rather than installing an 8.3 percent ramp, would enable more people who cannot negotiate steep grades to use that trail.

The physical fitness of pedestrians spans a wide range and affects mobility in a number of ways. Strength and flexibility, for example, are required to open doors, press control switches, and travel up curbs and stairs. Stamina, or the ability to repeat a movement, is required to travel for extended distances.

More than 50 percent of American adults are considered overweight or obese. Excess body weight increases strain on the body during physical activity and intensifies the risk of joint injury, temperature regulation problems, and heart disease (American College of Sports Medicine, 1997). Cardiac conditions such as atherosclerosis and angina, pulmonary diseases such as emphysema, circulatory problems such as hypertension and peripheral vascular disease, and degenerative joint diseases such as arthritis are other examples of long-term medical conditions that may limit the individual’s capacity for walking. Cardiac conditions also might limit an individual’s ability to perform sudden movements such as moving out of the path of an oncoming car.

Carrying packages or luggage, pushing children in strollers, pulling delivery dollies, or otherwise transporting items can also limit the physical capabilities of pedestrians. Pedestrians who are transporting additional items cannot react as quickly to potential hazards as other pedestrians because they are more physically taxed and distracted. They might walk more slowly, tire more easily, and require larger spaces to turn or maneuver than other pedestrians.

Facilities that are accessible to people with disabilities are generally safer and more user-friendly for all pedestrians. Most people will become temporarily disabled by injury at some point in their lives. People with temporary disabilities, such as a broken arm or sprained ankle, will be able to continue their daily functions with less inconvenience if accessible features, such as curb ramps, are available in their communities.

Some design approaches might benefit one group but inhibit access for another. For example, installing ramps to accommodate wheelchair users might make walking more difficult for many cane and crutch users who may have an easier time negotiating short steps. To accommodate both user groups, steps and a ramp should be provided whenever possible. The needs and capabilities of all potential users should be considered and balanced when designing pedestrian facilities.

2.1 Older Adults

Improvements in quality of life, nutrition, and health care have lengthened the average American lifespan and increased the ranks of older adults. By the year 2020, it is estimated that 17 percent or more of the U.S. population (nearly one in five) will be older than 65 (Staplin, Lococo, and Byington, 1998). Although aging itself is not a disability, according to the U.S. Census, in 1990 “most persons aged 75 or older had a disability” (U.S. Department of Commerce, Bureau of the Census, 1994). Many of the characteristics commonly associated with aging might limit mobility. Because the attenuated reflexes and physical limitations of older adults might prohibit them from driving automobiles, they are more likely to rely on public transit or walking than other adults (FHWA and NHTSA, 1996). Although not all older adults have disabilities, those who do benefit from accessible designs.

The aging process frequently causes a general deterioration of physical, cognitive, and sensory abilities. These changes intensify over time and are most pronounced for individuals over 75 years of age (ibid.). Characteristics of many older adults may include the following (FHWA and NHTSA, 1996; University of North Carolina Highway Safety Research Center, 1996; Knoblauch, Nitzburg, Dewar, Templer, and Pietrucha, 1995; and Staplin, Lococo, and Byington, 1998):

- Vision problems, such as degraded acuity, poor central vision, and reduced ability to scan the environment
- Reduced range of joint motion
- Reduced ability to detect, localize, and differentiate sounds
- Limited attention span, memory, and cognitive abilities
- Reduced endurance
- Reduced tolerance for extreme temperature and environments
- Decreased agility, balance, and stability
- Inability to quickly avoid dangerous situations
- Excessive trust that fellow drivers will obey traffic rules
- Slower reflexes
- Impaired judgment, confidence, and decision-making abilities

2.1.1 Safety

Older adults are more likely to suffer serious consequences or fatalities from falling or traffic crashes than other pedestrians (Burden and Wallwork, 1996). Older people generally need frequent resting places and prefer more sheltered environments. Surveys of older pedestrians indicate that many have an increased fear for personal safety. Their fears are confirmed by statistics indicating that older pedestrians appear to be at increased risk for crime and crashes at places with no sidewalks, sidewalks on only one side, and places with no street lighting.

Older people would thus benefit from accessible paths that are well lit and policed (Knoblauch, Nitxburg, Dewar, Templer, and Pietrucha, 1995).

2.1.2 Ambulation

Because older people tend to move more slowly than other pedestrians, they require more time to cross streets than other sidewalk users. One survey revealed that the most common complaint among older pedestrians was not having sufficient time to cross intersections before signal changes (ibid.). The *Manual on Uniform Traffic Control Devices* (MUTCD) assumes that the average pedestrian walking rate is 1.2 m/s (4 ft/s) (US DOT, 1988). However, adjusting signal timing based on an assumed walking speed of 0.85 m/s (2.8 ft/s) might better accommodate older pedestrians (Staplin, Lococo, and Byington, 1998).

The ambulation of older adults is also affected by their reduced strength. Traveling over changes in level, such as high curbs, can be difficult or impossible for older adults (Knoblauch, Nitxburg, Dewar, Templer, and Pietrucha, 1995). However, some older people may prefer the direct path of short stair steps to the gradual grades of lengthy ramps.

2.1.3 Object Manipulation

The reduced manual dexterity, grip force, and coordination experienced by many older people can affect their ability to operate common mechanisms such as doors and door handles, phones, drinking fountains, pedestrian-actuated traffic signals, and parking meters.

2.1.4 Visual and Cognitive Processing

Older people are likely to experience a reduction in visual ability. The reduced visual acuity of older people can make it difficult for them to read signs or to detect curbs. Visual changes that occur with age make older people more dependent on high contrast between sign backgrounds and lettering. Older people are also more susceptible to glare. Reduction in pupil size with age also makes night travel more difficult for older people. Contrast-resolution losses in older people can cause them to have difficulty seeing small changes in level, causing trips and falls on irregular surfaces (Staplin, Lococo, and Byington, 1998).

A reduced capacity for sensory processing or problem solving can cause older adults increased difficulties when negotiating unfamiliar environments. Older adults tend to require more time to make decisions and often start moving later than other pedestrians when crosswalk signals indicate a walk phase. These limitations, plus reductions in peripheral vision capabilities, the tendency to underestimate traffic speeds, and a diminishing ability to process multiple sources of information, make it difficult for older adults to use wide, complex intersections (Staplin, Lococo, and Byington, 1998). Several studies indicate that the majority of older people do not correctly understand many traffic signals. This confusion was attributed to inconsistent meaning and insufficient clarity of the signals (Knoblauch, Nitxburg, Dewar, Templer, and Pietrucha, 1995).

2.2 Children

Children have fewer capabilities than adults because of their developmental immaturity and lack of experience. Compared to adults, children tend to exhibit the following characteristics (FHWA and NHTSA, 1996):

- One-third less peripheral vision
- Less accuracy in judging speed and distance
- Difficulty localizing the direction of sounds
- Overconfidence
- Inability to read or comprehend warning signs and traffic signals

- Unpredictable or impulsive actions
- Lack of familiarity with traffic patterns and expectations
- Trust that others will protect them
- Inability to understand complex situations

Like older adults, children rely on public transit and walking more than other people because they cannot drive. Routes frequently traveled by children, including areas near schools or playgrounds, should have traffic flow patterns that are simple and easy to understand.

Children are involved in more than 30 percent of traffic crashes involving pedestrians. In 1991, entering the street midblock was by far the leading cause of traffic accident fatalities for children (54 percent for ages 5 to 9 years, 26 percent for ages 10 to 14 years). These large proportions may indicate a need to add more midblock crossings in areas frequented by children (Burden and Wallwork, 1996).

Children benefit from facilities such as lower drinking fountains, lower sign placement, and doors that are easier to open because they lack the physical stature and strength of adults. In addition, because many children have not yet learned to read, symbol-based pedestrian signals might be easier for them to understand than signals that contain words.

2.3 People with Disabilities

According to the 1990 U.S. Census, one in every five Americans has a disability (U.S. Department of Commerce, Bureau of the Census, 1994). Anyone can experience a temporary or permanent disability at any time due to age, illness, or injury. In fact, 85 percent of Americans living to their full life expectancy will suffer a permanent disability (University of North Carolina Highway Safety Research Center, 1996).

People with disabilities are also more likely to be pedestrians than other adults because some physical limitations can make driving difficult and because they experience financial hardship at a higher rate than other adults (Golden, Kilb, and Mayerson, 1993).

For the purposes of this report, disabilities have been divided into the following three categories:

- Mobility
- Sensory
- Cognitive

2.3.1 People with Mobility Impairments

People with mobility impairments include those who use wheelchairs, crutches, canes, walkers, orthotics, and prosthetic limbs. However, there are many people with mobility impairments who do not use assistive devices. Characteristics common to people with mobility limitations include substantially altered space requirements to accommodate assistive device use, difficulty negotiating soft surfaces, and difficulty negotiating surfaces that are not level.

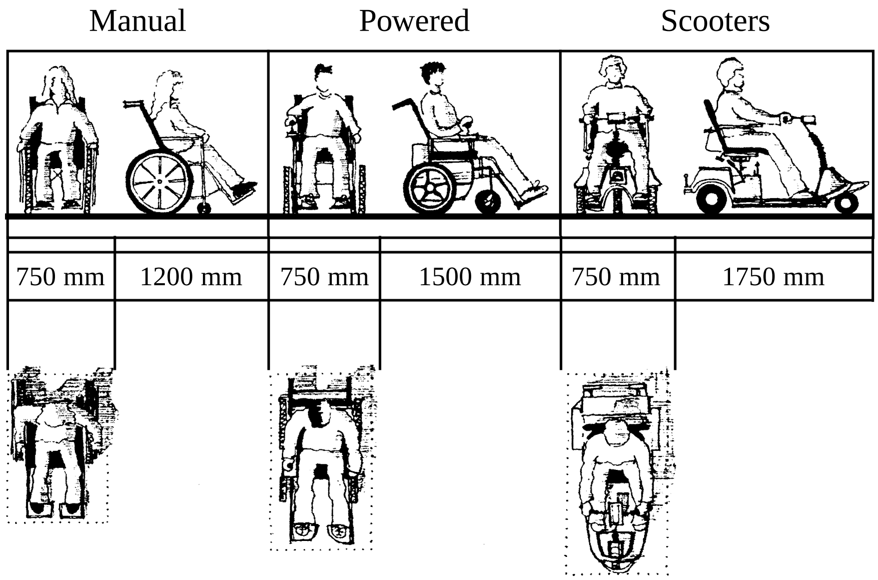
2.3.1.1 Wheelchair and scooter users

In 1990, 1.9 million Americans identified themselves as wheelchair users for the U.S. Census (U.S. Department of Commerce, Bureau of the Census, 1994).

Wheelchair and scooter users often travel much faster than walking pedestrians, especially on level surfaces or downgrades, but they can be much slower when traveling uphill. In addition, their stability and control can be affected by surfaces with cross-slopes, grades, or rough terrain. Wheelchair and scooter users require a wider path of travel than ambulatory pedestrians. Therefore, sufficient passing space should be provided to allow wheelchair users to pass one another and to turn around.

Figure 2-1:

Wheelchair and scooter dimensions (in mm) ***(based on Architecture and Engineering for Parks Canada and Public Works and Government Services Canada, 1994).***



Wheelchair and scooter users require more space to turn around than other pedestrians. Furthermore, people who are unable to pull backward on their wheelchair wheels require a larger maneuvering space than those who can move one wheel forward and the other backward while turning. The turning diameter of a wheelchair or scooter is dependent upon the length of its wheelbase. Powered wheelchairs and scooters are generally longer than manual wheelchairs (Figure 2-1). Research at the Georgia Institute of Technology by John Templer (1980c) found that the turning radii of manual wheelchairs ranged from 0.635 to 1.270 m (25 to 50 in). Powered wheelchairs tended to have larger turning radii than manual wheelchairs because of the longer wheelbase (Templer, 1980c). The Templer research did not address scooters because they were relatively new in 1980.

ADAAG Section 4.2.3 specifies a 1.525 m x 1.525 m (60 in x 60 in) area for a wheelchair user to make a 180-degree turn (Figure 2-2). According to ADAAG, a T-intersection of two walkways is also an acceptable turning space (ADAAG, U.S. Access Board, 1991). The ADAAG specifications for turning space are consistent with the findings from the Templer research.

The U.S. Department of Housing and Urban Development (HUD) sponsored a study comparing the reach and physical capabilities of a number of wheelchair users and walking pedestrians. Many of

Figure 2-2:

Circle diameter of a standard manual wheelchair ***[ADAAG, Figure 4.3(a), U.S. Access Board, 1991].***

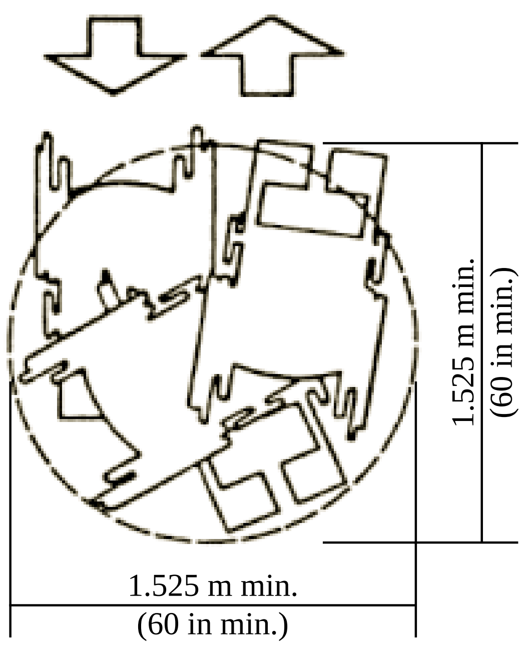
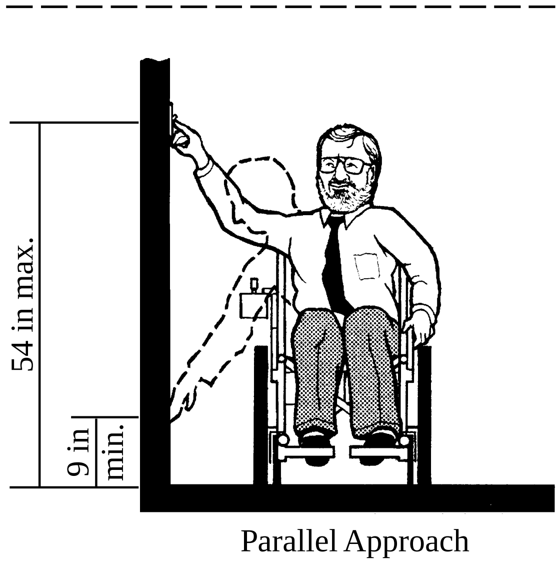


Figure 2-3:

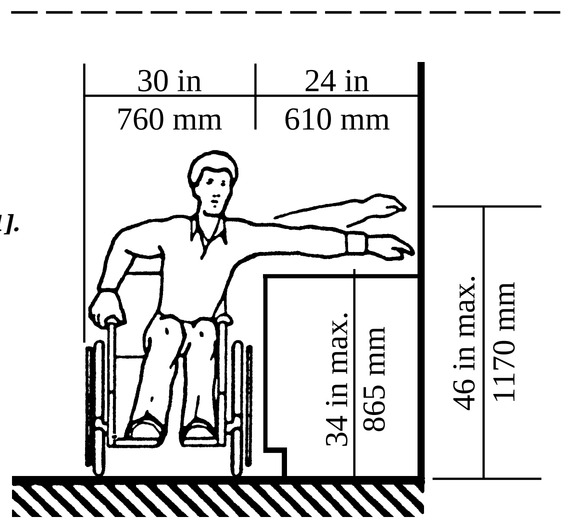
High and low side-reach limits
(Barrier Free Environments, Inc., 1996).



the specifications in ADAAG and UFAS are based on the anthropometric data obtained in the HUD study. Of the wheelchair users who participated, 87 percent had a maximum high side-reach of at least 1.370 m (54 in), when the clear floor space allowed a parallel approach to an object (Table 2-1) (Steinfeld, Schroeder, and Bishop, 1979). ADAAG specifies a maximum high side-reach of 1.370 m (54 in) and a minimum low side-reach of 0.230 m (9 in) when a parallel approach is possible (ADAAG, U.S. Access Board, 1991). Figure 2-3 illustrates maximum high side-reach and maximum low side-reach. If the side-reach is over an obstruction, such as a pedestrian-actuated signal positioned next to a trash receptacle, the reach and clearances should be consistent with Figure 2-4.

Figure 2-4:

Maximum side-reach over an obstruction
[ADAAG, Figure 4.6(c), U.S. Access Board, 1991].



ADAAG Section 4.2.5 specifies a maximum high forward-reach of 1.220 m (48 in) and a minimum low forward-reach of 0.380 m (15 in) if an object can be approached only from the front (ADAAG, U.S. Access Board, 1991). Figure 2-5 illustrates maximum high forward-reach and maximum low forward-reach. If the

Figure 2-5:

High and low forward-reach limits
(Barrier Free Environments, Inc., 1996).

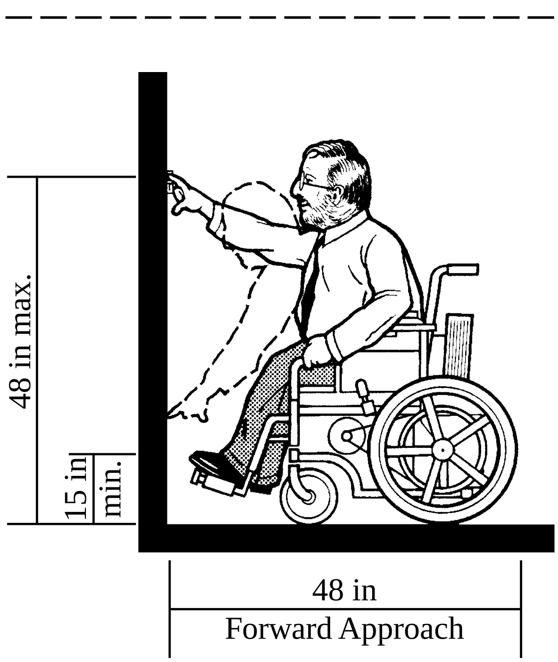


Table 2-1:

Highest Reach for Wheelchair Users
(based on Steinfeld, Schroeder, and Bishop, 1979)

Maximum High Side-Reach (m)	Number of Subjects	Percent of Subjects
<0.915	1	2
0.915–1.065	0	0
1.065–1.220	1	2
1.220–1.370	4	7
1.370–1.525	19	31
1.525–1.675	30	51
1.675–1.830	3	5
Missing data	1	2
Total	59	100

forward-reach is over an obstruction, the reach and clearances should be consistent with Figure 2-6.

The seated position of wheelchair users also impacts the height of their line of sight, which is important when looking for traffic and reading street signs. Based on the results in Table 2-2, the HUD study recommended that the eye level for wheelchair users be considered as a range from 0.890 to 1.320 m (35 to 52 in) (Steinfeld, Schroeder, and Bishop, 1979).

Table 2-2:

***Eye-Level Measurements for Wheelchair Users** (based on Steinfeld, Schroeder, and Bishop, 1979)*

Eye-Level Height (m)	Number of Subjects	Percent of Subjects
<0.915	0	0
0.915–1.015	1	2
1.015–1.120	12	20
1.120–1.220	37	62
1.220–1.320	8	14
>1.320	0	0
Missing data	1	2
Total	59	100

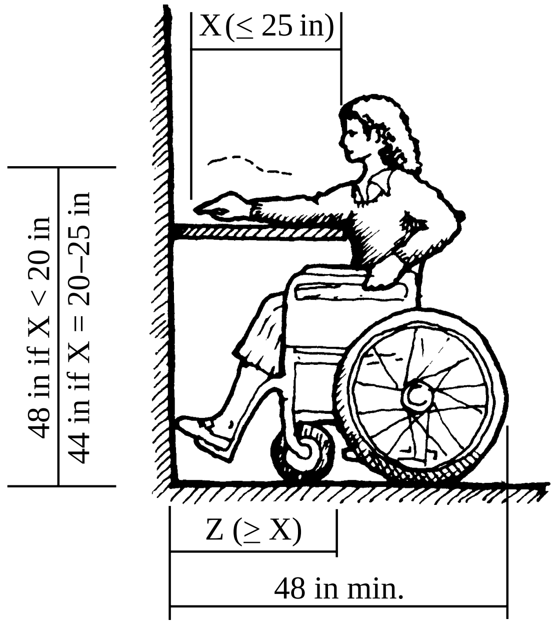
Because wheels are difficult to propel over uneven or soft surfaces, wheelchair and scooter users need firm, stable surfaces and structures such as ramps or beveled edges to negotiate changes in level. Curb ramps allow wheelchair users to negotiate curbs more easily.

Because cross-slopes tend to cause wheelchairs and scooters to veer downhill, manual wheelchair users must perform additional work to continue traveling in a straight line over areas such as driveway crossings. Severe cross-slopes can cause wheelchairs to tip over sideways, especially during a turn (FHWA and NHTSA, 1996).

Cross-slopes that change very rapidly cause additional problems for wheelchair users. The rate of change of cross-slope is most problematic when it occurs over a distance of less than 0.610 m (2 ft), the approximate distance covered by a wheelchair wheelbase. As the wheelchair moves over the surface of a severely warped driveway flare, it will first balance on the two rear wheels and one front caster. As the wheelchair moves forward, it then tips onto both front casters and one rear wheel. This transition may cause the wheelchair user to lose control and possibly tip over. A rapid change in cross-slope can also cause people with walkers to stumble. For more information on rate of change of cross-slope, refer to Section 4.3.2.

Figure 2-6:

***Maximum forward-reach over an obstruction** (PLAE, Inc., 1993).*



2.3.1.2 Walking-aid users

People who employ walking aids include those who use canes, crutches, or walkers to ease their ambulation. According to the 1990 U.S. Census, 4 million adult Americans reported having used a cane for longer than 6 months (U.S. Department of Commerce, Bureau of the Census, 1994). The limitations of walking-aid users might include the following (Bhambhani and Clarkson, 1989):

- Difficulty negotiating steep grades
- Difficulty negotiating steep cross-slopes
- Decreased stability
- Slower walking speed
- Reduced endurance
- Inability to react quickly to dangerous situations
- Reduced floor reach

People who use walking aids are often able to negotiate small steps and might even prefer steps to a longer ramp. In these situations, railings can be extremely helpful. Tall steps are generally quite difficult for cane, crutch, and walker users to negotiate. People who use walkers and crutches also benefit from stairs deep enough to accommodate all four legs of the walker or crutches positioned in front of the feet.

Surface quality significantly affects ease of travel for walking-aid users. Grates and cracks wide enough to catch the tip of a cane can be potentially dangerous for walking-aid users. Icy or uneven surfaces can also be hazardous because they further reduce the already precarious stability of walking-aid users.

People who use walking aids tend to travel more slowly than other pedestrians. As a result, they benefit from longer pedestrian signal cycles at intersections and the presence of passing spaces to allow others to travel around them. According to ADAAG Section A4.2.1(2), people who use crutches or walkers can maneuver through clear width openings that are 0.815 m (32 in); however, at least 0.915 m (36 in) is necessary if the passageway is restricted for more than 0.610 m (24 in) (ADAAG, U.S. Access Board, 1991).

Walking-aid users also require significantly more energy for ambulation than pedestrians who do not use walking aids (Fisher and Patterson, 1981; Fisher and Gullickson, 1978). As a result, they benefit from sidewalks and trails that have frequent rest areas.

2.3.1.3 Prosthesis users

People lacking one or more limbs, hands, and/or feet often use prostheses such as metal hooks or molded plastic limbs to help them walk or grip items. Prosthesis users with amputations due to diabetes, cardiovascular problems, or other diseases might have a more limited capacity for exercise than prosthesis users whose missing limbs resulted from developmental difficulty or traumatic injury (Shephard, 1990).

Although people using leg prostheses can achieve levels of fitness similar to their peers', their most comfortable walking speeds are typically slower than those of individuals without disabilities (Ward and Meyers, 1995). People who use above-knee prostheses move more slowly and expend more energy in ambulation than individuals with below-knee prostheses (ibid.). In general, prosthesis users benefit from extended signal timing at wide intersections. Some people with lower limb prostheses might have greater difficulty than other pedestrians maintaining balance on grades or cross-slopes.

Some electric devices, such as computerized information kiosks, use screens sensitive to the body's electric potential to interact with the user. Although these heat-sensitive devices can be helpful for people with little manual dexterity, people who use metal hooks or plastic hands cannot trigger these sensors with their prostheses.

2.3.2 People with Sensory Impairments

Although sensory disabilities are commonly thought of as total blindness or deafness, partial hearing or vision loss is much more common. Other types of sensory disabilities can affect touch, balance, or the ability to detect the position of one's own body in space. Color blindness is also considered a sensory deficit (University of North Carolina Highway Safety Research Center, 1996).

2.3.2.1 People with visual impairments

In 1990 the U.S. Census reported that 1.8 million noninstitutionalized Americans over the age of 15 had a visual disability that prevented them from seeing words or letters in ordinary newsprint. (U.S. Department of Commerce, Bureau of the Census, 1994). Visual disabilities can cause the following impediments to mobility (Clark–Carter, Heyes, and Howarth, 1987):

- Limited perception of the path ahead (preview)
- Navigation with limited information about surroundings, providing less protection against obstacles and other dangers
- Reliance on memory and unchanging conditions in familiar terrain
- The need to assimilate information obtained through nonvisual sources such as texture and sound.

Because many people with visual disabilities have diminished peripheral vision, they may have difficulty perceiving or reacting quickly to approaching dangers, obstacles, and changing conditions (Clark–Carter, Heyes, and Howarth, 1987).

2.3.2.1.1 Cane users

Many people who are blind use long canes to navigate. There are two principal cane techniques: touch and diagonal. In the touch technique, the cane arcs from side to side and touches points outside both shoulders. In the diagonal technique, the cane is held out stationary across the body or just above the ground at a point outside one shoulder. The cane handle or grip then extends to a point outside the other shoulder. The touch technique is generally used in uncontrolled areas such as on a sidewalk, while the diagonal technique is used primarily in controlled and familiar environments. Cane users are often trained in both techniques (Park, 1989a; Jacobson, 1993).

The touch and diagonal techniques are typically used in conjunction with the constant-contact technique. When the cane user wants to explore an area more completely, he or she will drag the cane tip across the surface. The constant contact between the cane and the ground provides very detailed information about the area explored (ibid.).

2.3.2.1.2 Dog-guide users

Some people who are blind use dog guides to navigate. "Dogs guide in response to a specific set of commands given by voice and hand signals" (Whitstock, Franck, and Haneline, 1997, in Blasch et al.). A common misconception about dog guides is that they are capable of making decisions for their owners. Dog guides are trained to avoid obstacles, including those overhead that would not be detected by a long cane. Dog guides are also taught to pause at stairs, curbs, and other significant changes in elevations. When traveling along a sidewalk, dog guides tend to follow the left border of a sidewalk or trail. Because dog guides crossing an intersection generally aim for the opposite curb, they may guide their owners outside the marked crosswalk path, missing medians and pedestrian refuge islands, to take the shortest path to the opposite curb. (*The Seeing Eye*, 1996). Intersections are easiest to negotiate for dog-guide users when the line of travel from the edge of the sidewalk to the opposite curb is straight rather than skewed, as it is at some irregularly shaped intersections.

2.3.2.1.3 Information for people with visual impairments

People with visual impairments benefit from two distinct types of information along sidewalks and trails: detectable warnings, which are intended to identify potentially hazardous situations, such as the transition from the sidewalk to the street; and wayfinding information, which allows users to orient themselves within their environment.

Detectable warnings are surfaces that can be detected underfoot and by a person using a cane through texture, color, and resilience. Detectable warnings should convey a “stop” message to people with visual impairments. Once the user has stopped and identified the hazard, he or she can determine if it is safe to proceed. Detectable warnings are not required on sidewalks. However, if they are installed, they should be consistent with the specifications in ADAAG Section 4.29. Use of a consistent formula to indicate detectable warnings will prevent people with visual impairments from misinterpreting warning messages as orientation information.

Wayfinding information does not convey a warning, but rather provides orientation information to the user. People with visual impairments use a variety of cues to orient themselves within their environment. However, many of the cues, such as the sound of traffic, are not consistently available. To provide people with visual impairments with accessible wayfinding information, environmental modifications should be provided. Visual cues, tactile surfaces, and audible pedestrian signals can make information about traffic flow and street crossings accessible to people with visual impairments. Examples of accessible wayfinding information include audible pedestrian signals and tactile guidestrips at crosswalks. Visual information, such as painted crosswalks, are beneficial to the 80 percent of the people who are legally blind but have some residual vision. If a detectable surface is used to provide wayfinding information, it should be distinct from the surface used to convey a warning message. For more information on detectable warnings and wayfinding information, refer to Section 4.4.2.

2.3.2.1.4 Crossing intersections

Where pedestrian signals are not accessible, people with visual impairments might start to cross an intersection later than other pedestrians because they might wait for the sound of parallel traffic and/or other crossing pedestrians to identify the crossing interval. In addition, people with visual impairments might have difficulty identifying and maintaining the correct path across the intersection. In combination, these factors increase the amount of time that people with visual impairments might need to complete street crossings.

People with severe visual impairments take the following steps to cross an intersection:

1. Detect arrival at an intersection by using a combination of cues such as a raised curb, the slope of a curb ramp, the absence of a building shoreline, detectable indicators, remembered landmarks, traffic sounds, and any other available wayfinding cues.
2. Determine whether a pedestrian signal must be actuated to get the walk signal and actuate it if necessary.
3. Determine when it is safe to walk by using traffic or pedestrian surge noise cues or audible traffic signal cues.
4. Orient themselves toward the crosswalk by using cues such as traffic noise, audible or otherwise detectable beacons (see Chapter 4), and physical features of the environment, such as the boundary between a sidewalk and an adjacent planting strip, that are known to be parallel to the crosswalk, or curb lines that are known to be perpendicular to the crosswalk.

5. Navigate to the opposite curb through any medians, islands, crosswalk angles, or other obstacles.

2.3.2.2 People with hearing impairments

Although as many as 40 percent of older adults have hearing impairments, hearing loss is not generally believed to be a significant barrier to sidewalk and trail use. However, hearing loss can limit a person's ability to use cues such as the increasing noise of an approaching vehicle to detect impending dangers. Hearing loss thus forces users to rely heavily on visual indicators or vibrations caused by passing traffic. Areas with long sight distances relatively free of visual obstructions, such as landscaping, may be useful to people with hearing impairments (FHWA and NHTSA, 1996).

2.3.3 People with Cognitive Impairments

Cognition is the ability to perceive, recognize, understand, interpret, and respond to information. It relies on complex processes such as thinking, knowing, memory, learning, and recognition. Cognitive disabilities can hinder the ability to think, learn, respond, and perform coordinated motor skills.

The movement skills of people with cognitive disabilities vary tremendously. However, the motor skills and fitness potential of people with cognitive disorders are often hampered by a lack of opportunity to learn and practice appropriate physical activity movements. As a result, walking speed has been shown to decrease with the presence of cognitive or depressive disabilities (Woo, Ho, Lau, Chan, and Yuen, 1995). People with cognitive disabilities also might have difficulty navigating through complex environments such as city streets and might become lost more easily than other people.

Design approaches for people with cognitive impairments also might benefit children and the more than 20 percent of American adults who do not read English (National Library of Education, Office of Educational Research and Improvement, personal communication, 1998). Signs that use pictures, universal symbols, and colors convey meaning to a broad range of people. For example, pedestrian crossing signals that display a picture of a person walking may be more universally understood than signs reading WALK. Always placing the DON'T WALK signal above the WALK signal also increases the clarity of pedestrian signals for users because people who cannot read can derive meaning from the order of the signals. Traffic signals for automobiles are also placed in a consistent order to benefit people who are color blind and cannot distinguish between red and green. Additional research is needed to determine if the contrasting colors of the WALK and DON'T WALK lights play a significant role in people's understanding of pedestrian signals. However, people who are color blind do not benefit from pedestrian signals that use distinct colors.

2.4 Conclusion

A good understanding of how all pedestrians, including people with disabilities, older people, and children, perform in sidewalk and trail environments can help designers determine how best to implement accessibility improvements to outdoor facilities. Sidewalk and trail designers who have a solid background in the capabilities and travel habits of their design audience can make more informed decisions to create pathways that serve the entire community.