3.6 Doors

2 Credit: Implement 6 of 18 | 1 Credit: Implement 5 of 18

- *(Required)*: All doors are at least as wide as one clear floor space.
- *(Required):* All interior doors do not have raised thresholds.
- All doors encountered along primary routes open and close automatically based on presence sensor.
- All doors encountered along primary routes open and close automatically when activated by pressing a button.
- All doors encountered along primary routes and that open and close automatically are wide enough to allow an ambulatory person to pass a person using a wheeled mobility device.
- All doors that open and close automatically have sensors that hold open the door if the passageway is obstructed.
- All doors that open and close automatically and all doors that have an electronic locking mechanism have an emergency power supply.
- Doors are not required to access selected rooms and spaces (e.g., maze entry, air curtain, doors with magnetic hold-open device).
- All doors encountered along primary routes have an adjacent area to allow for pausing or waiting, located outside of the door swing and outside of the primary route.
- All doors to rooms and spaces are located where they can be used without disrupting ongoing activities in the room or space (e.g. using the door does not require crossing between an audience and presenter).
- All vestibules have the same overall passage width exiting the vestibule as entering the vestibule.
- All doors or door frames visually contrast with the surrounding walls.
- All doors that swing into a common path of travel are glazed or have a full-height view panel, except doors leading to spaces with a usable floor area less than 25 square feet (2.33 square meters).
- Selected spaces have doors in pairs designated for entering and exiting, labeled accordingly on both sides.
- All doors encountered along primary routes have hardware with design cues indicating the appropriate pushing or pulling action to open (e.g., plate or bar for pushing, U-shaped handle for pulling).
- Selected doors can be secured and unsecured using magnetic swipe cards, electronic key fobs, smart phones, numeric keypads, or other technology in lieu of keys.
- All doors with closers that do not open automatically have a shelf on each side of the door.
- Selected doors to access-controlled areas have an audio-video intercom system and/or two peepholes, one standing eye level and the other at sitting eye level.

1. Overview

Doors have both *aesthetic and safety* purposes. Doors control access to the interior or between spaces. The materials and locking devices allow for the user to control security and privacy, limiting access to people, animals, weather, and light. Door materials and hardware also depend

on the intended function of a space. Some types of doors include hinged doors, swing doors, storm doors, automatic doors, and self-bolting doors.

Doors are used to *mark a threshold*. They are a barrier which restricts who is able to access the space beyond. Some doors have glazing, which allows for visual access that would otherwise be restricted.

Commonly used materials to create doors are wood, fiber glass, and steel. Each material provides different aesthetics, fire ratings, and weight. Insulation and weatherproofing should also be considered for energy efficiency. Building users may chose to use locking devices such as dead bolts or electronic key fobs. Peepholes, windows, and audio-visual intercom systems allow users to monitor entry. Different spaces require different levels of security and privacy. There should be a conversation between the client and the designers about privacy and security requirements for each space.

2.   Issues to Consider

Fire Safety: A building, private or public, has different doors for different purposes. Exterior and interior doors are obvious examples. Some buildings have steel doors, sliding glass doors, or blind (shuttered) doors. Doors with extended fire safety ratings can be heavier than regular doors. This helps protect building users during a fire, but may make it more difficult to operate.

Larger rooms, like auditoriums, may have doors with higher safety ratings because the doors are meant to protect a larger space, and, therefore, more people. "Injuries such as bruising, trapped fingers and limbs, broken bones, and even amputation have resulted from everyday use of fire doors, with the main causes being their sheer weight and the force with which they close" (Fire Industrial Association, 2016). The designer should consider incorporating push buttons or sensors that operate doors automatically to reduce the rate of injury.

Figure 1: Image courtesy of *Fingersafe USA, Inc.,* *which sells products that protect fingers from being injured by closing door. These products are especially useful in daycares and elementary schools ("Door Safety," 2017).*

Door Related Injuries: All doors, not just fire safe doors, have the potential to cause an injury, especially to fingers. Children have a higher potential for injury, because they may not be fully aware of the harm a door closing on them can cause. This is an issue which can be addressed using minor design interventions.

The National Safety Council estimates that 300,000 injuries are caused by doors every year. Consumer Product Safety Commission statistics cite 44,676 injuries to fingers, hands, and wrists of children under the age of 14 in a single year (Redwoods: A Crum and Foster Company, 2014).
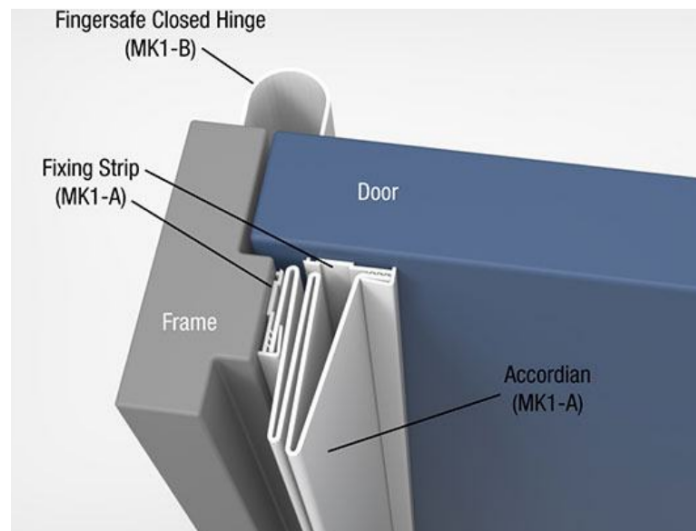
Companies, such as Fingersafe US, Inc., sell finger pinch protector guards. The pull side of the door has a "U" shaped blocking guard, while the pull side has an accordion style guard which push fingers out of the way (see figure 1). Daycares and schools are two types of facilities which may benefit the most from these physical interventions.

Weather Conditions: Designers should consider the climate when choosing door materials and features. It may take someone a longer time to cross the threshold of a door when snow or ice is on the ground. Automatic doors that are not appropriately timed can be dangerous in these conditions especially. One way to prevent the door from closing on someone is to install sensors that keep the door open when the threshold is blocked.

Smart Technology: Amazon has Amazon Key that includes an indoor security camera and compatible smart lock. Amazon Key allows members to give Amazon couriers the ability to place packages in the home. The courier unlocks the door, places the package in the home, and relocks the door (Popper, 2017). The in-home camera activates when the courier unlocks the door and records their actions. The home owner is alerted when the door is unlocked by someone else, and is able to access the camera feed in real time (Popper, 2017).

The benefits of smart technology go beyond convenience and security. It can also allow some people to live a fuller life. A homeowner with a physical impairment must unlock and open the door, which could take several minutes. The courier may have left by the time the homeowner opens the door. The courier may not even leave the package due to security concerns, inclement weather, or other policies.

Smart technology from a company like Latch also allows a homeowner to give access to a door via a virtual key on an application (Higgins, 2016). Such technology is especially helpful for people with temporary disabilities because it gives the homeowner full control over access to their home even if they're unable to physically answer the door. Designers should become familiar with these features and communicate their benefits and downfalls to their clients.

3. Referenced Standards

ICC A117.1 2017 Standards - 404 Doors: Section 404.2.8.1 states there should be a 5 second minimum for doors and gate closers to go from being open at a 90 degree angle to open at a 12 degree angle. However, it may be necessary to evaluate if an exterior door should stay opened for a longer duration. It may be difficult for some people to clear the door swing in 5 seconds, especially in poor weather conditions.

ADA 2010 Standards - 404 Doors: Section 404.2.9 states that the maximum force for opening a door be 5 pounds (22.2 N) maximum. Older adults, children, people with physical impairments, and people carrying items are able to more easily open a door with such force. This allows people to be more independent in the building. This requirement is meant to ensure that varying types of people are able to effectively use a door, allowing people to move about a building independently.

In addition, Advisory 404.2.7 restricts hardware from requiring simultaneous hand and finger movements (United States Access Board, 2010). When a door requires such dexterity to operate, there should be a shelf at the door on both sides. This allows users to free their hands before operating the door, so, if someone is carrying something, such as a cup of coffee or a stack of files, they do not have to place it on the floor, or risk dropping it to open the door.

ICC A117.1 and the ADA 2010 standards have some requirements which are similar to the *isUD Solutions*. The ADA 2010 standards specific some beneficial guidelines as advisories, which are not enforced. However, these advisories are important steps toward a universally design building. The *isUD Solutions* cover additional topics and provides a wider variety of solutions for more accessible, healthier, and safer environments.

Anthropometry of Wheeled Mobility Project completed by the IDeA Center, collected data on how different wheeled mobility devices were able to commit turns. The center set up temporary cardboard barriers, and asked participants to maneuver the space without touching the barriers. The wheeled mobility device users were video recorded while completing 90-degree and 180-degree rotations (with no restrictions on length of the maneuver), 180-degree rotation around a central barrier, and 360-degree rotation within a space with four walls. Use of multiple short turns were allowed in contrast to a single continuous turn (Steinfeld, et al., 2010). This study provided data for *isUD Solutions* included within this section and others.

Other *isUD Solutions* which are important to understand in relation to this section are *2.1 Clear Floor Space*, *2.2 Turning Space*, and *2.4 Reach Targets*. These basic building blocks allow designers to decide what level of access they give to different types of wheeled mobility users and ambulatory users.

4. **Measurement and Verification**

When choosing a door, designers should consider the expected circumstances and ability of future users. Hardware, materials, and technology impacts the effort required to open the door. Electronic components may require a specialist to install the door. If the door uses electronic parts to open and close, then the designer should incorporate another way for the door to operate in the event the area loses power or the parts malfunction. This will allow people to still get in and out of the building. Manufacturer instructions should provide the details for correct installation.

When choosing doorway widths, designers should reference the *isUD Solutions Chapter 2: Space Clearances*. Making the door smaller or heavier restricts some people from operating a door. The *isUD Solutions* on clear floor space and turning space help the client and designer chose what kind of access they would like to provide the users of the building. ICC A117.1 2017 has minimum maneuvering clearances from the front or the side of the door so that people in wheeled mobility devices are able to open and go through the door. Both ICC A117.1 2017 and the ADA 2010 standards have further requirements and illustrations to help people understand how to measure and verify that doors are accessible.

5.   Design Considerations

1.   *(Required): All doors are at least as wide as one clear floor space.* A 32-inch wide doorway accommodates greater than or equal to 95% of manual wheelchairs, between 90% and 95% of power wheelchairs, and between 75% and 95% of scooter users. A-34 inch doorway accommodates greater than or equal to 95% of manual wheelchairs, power wheelchairs, and scooters (Steinfeld, et al., 2010).
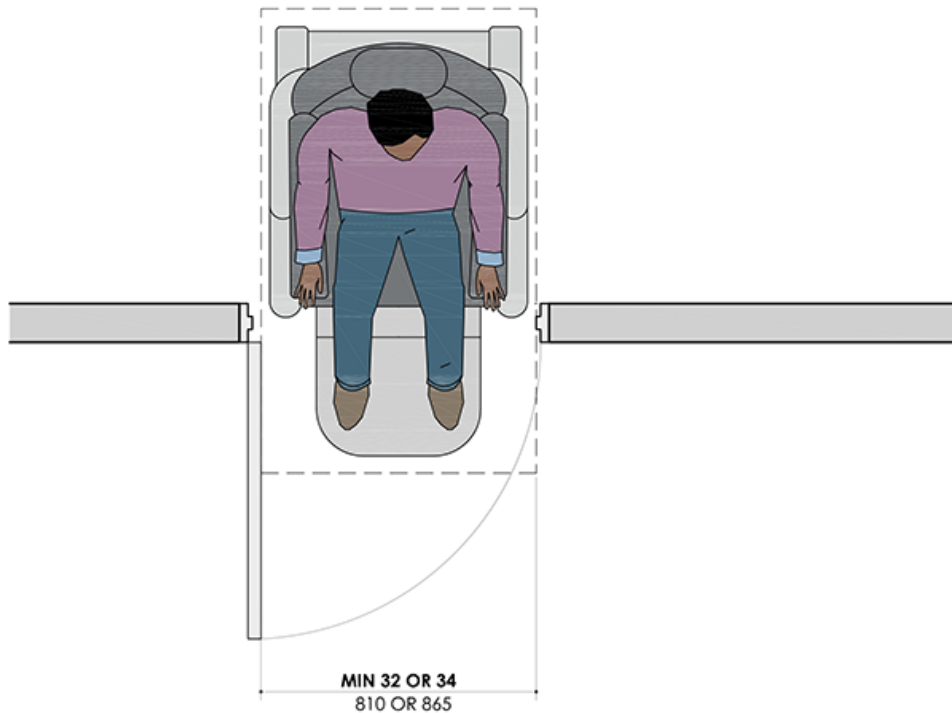

MIN 32 OR 34
810 OR 865

Figure 2: Door Width

2.   *(Required): All interior doors do not have raised thresholds.* Thresholds raised over ½ inch can greatly effect a wheeled mobility device user's ability to enter a room. If the user is not carefully lined up perpendicular to the raised threshold then the device could become unbalanced. Additionally, a wheeled mobility device user may not expect there to be a threshold at an interior doorway, and would not look for one. This increases the chance of a wheeled mobility device going into an unbalanced position, which may result in the device tipping.

3. *All doors encountered along primary routes open and close automatically based on presence sensor.* The ICC A117.1 2017 and the ADA 2010 standards have maximum requirements for force used to open a door. One way to remove the effort of opening a door entirely is to have the doors open automatically. A presence sensor allows someone with very low dexterity to easily pass through the doors. It may not be feasible to install sensors in every door of a project, but focusing on the primary routes allows for more people to navigate the building without assistance.
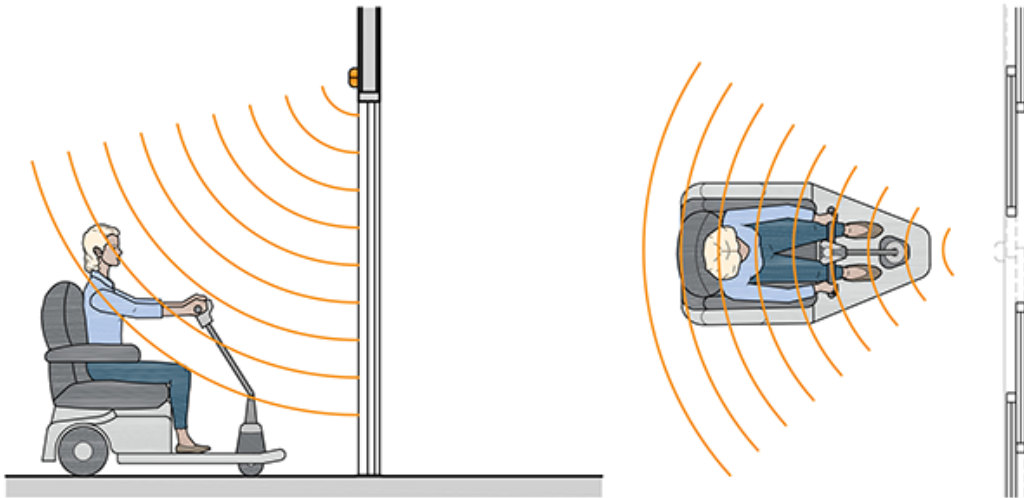
Figure 3: Automatic door with presence sensor

4. *All doors encountered along primary routes open and close automatically when activated by pressing a button*. The color of the button and wall should contrast, so people traveling by the button clearly notice it. The button should include a pictogram that indicates its function. The button should be large enough that someone could press it with their elbow if they do not have enough dexterity in their fingers to press it.
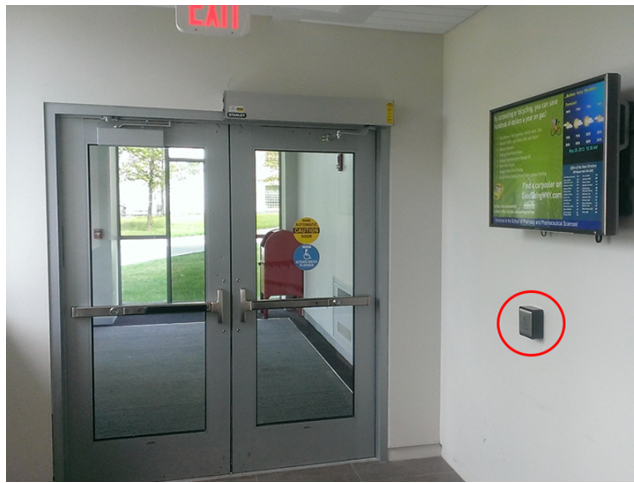
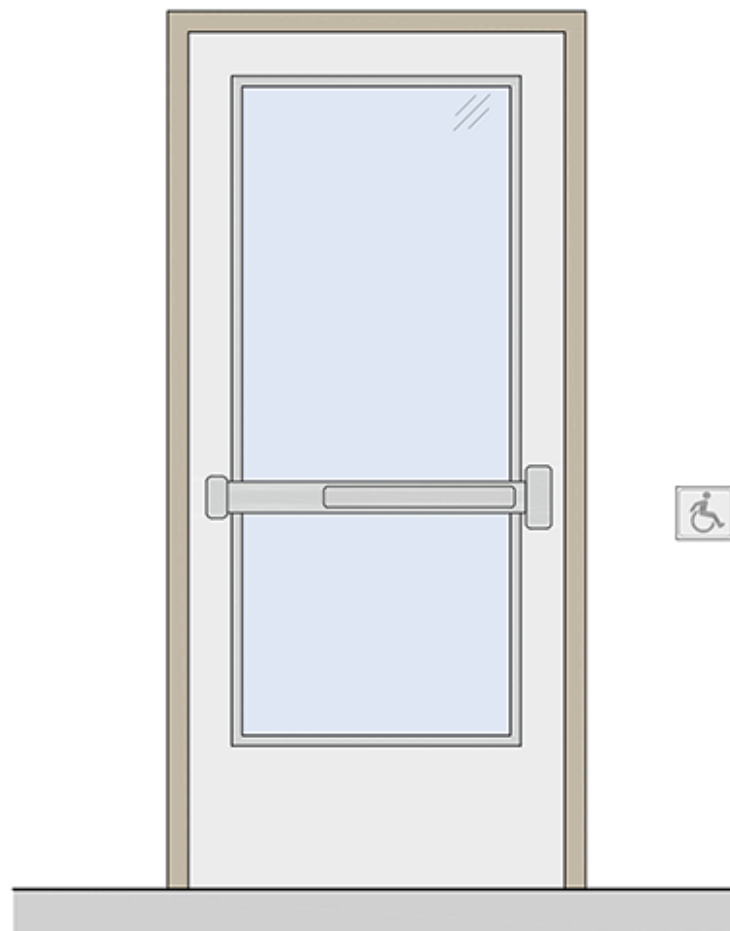*Figures 4 & 5: Door with switch activated automatic opener*

Figure 6: Door with switch activated automatic opener

5. *All doors encountered along primary routes and that open and close automatically are wide enough to allow an ambulatory person to pass a person using a wheeled mobility device.* If a person could not pass through a doorway while an ambulatory user was walking by, it would create congestion. This would draw extra attention to both users, which could make them uncomfortable.
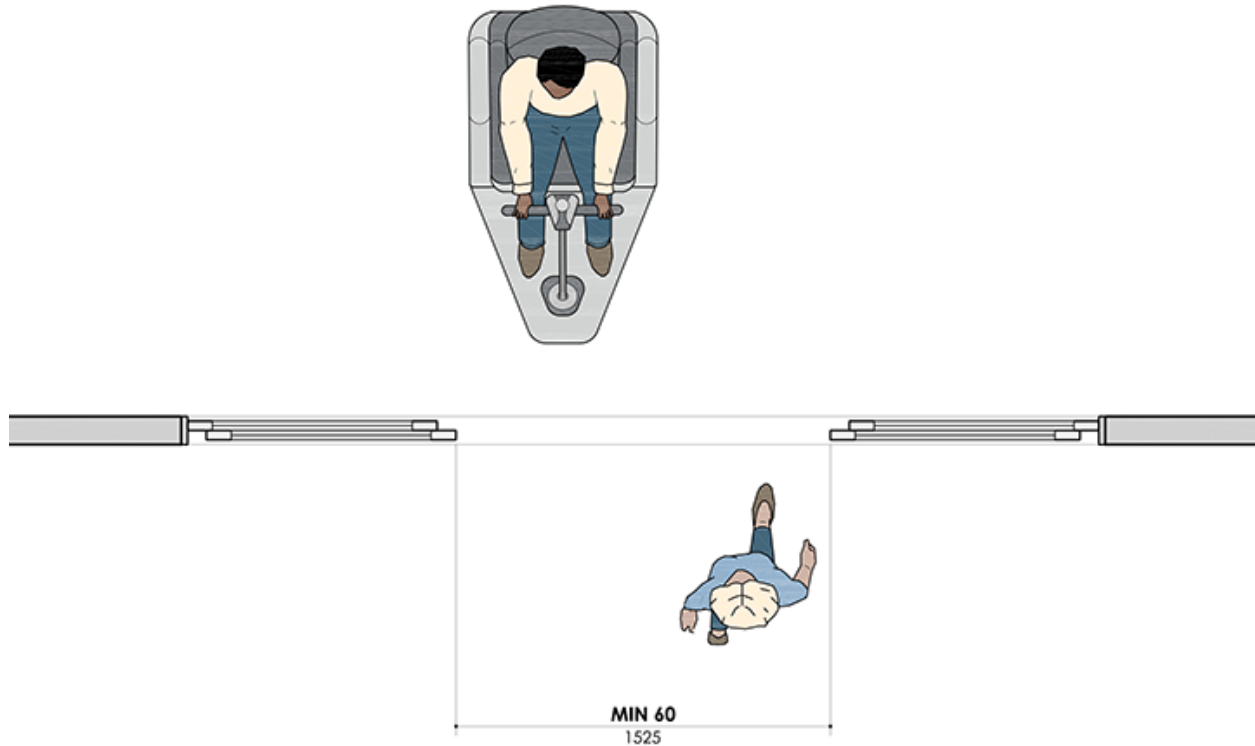

Figure 7: Automatic Door Width

6. *All doors that open and close automatically have sensors that hold open the door if the passageway is obstructed.* Certain populations may need a door to be opened for an extended amount of time. If a door shuts on a device, it could damage it, and if the door shut on a person, it could harm them. Families with small children or strollers, a wheeled mobility device user, and someone carrying a package are all examples of people who would benefit from this solution.

7. *All doors that open and close automatically and all doors that have an electronic locking mechanism have an emergency power supply.* People experience a higher level of stress during an emergency. People exiting in an emergency may not consider whether or not they are going to have to pass through automatic doors. In order to allow safe passage out of the building, the doors should have an emergency power supply for quick and effective evacuation.

8. *Doors are not required to access selected rooms and spaces (e.g., maze entries, air curtains, doors with a magnetic hold-open device).* For example, a restroom with a maze entry creates an entrance that can be easily used by people with luggage, people with strollers, people in wheeled mobility devices, etc. In addition, a maze entry provides visual privacy. There are a number of options for entryways which are easy to navigate and still provide privacy. Doors are not always necessary.
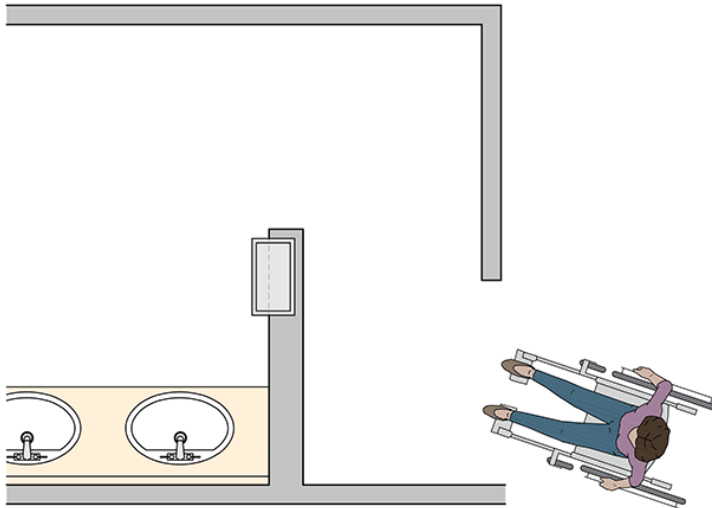

Figure 8: Maze Entry

Figure 9: Photograph of Maze Entry

9.   *All doors encountered along primary routes have an adjacent area to allow for pausing or waiting, located outside of the door swing and outside of the primary circulation path.* Busy hallways and crowded rooms can create congestion at doorways. Providing a space for refuge adjacent to a doorway creates a protected place to carry out side conversations without disrupting the flow of traffic. This solution decreases risk of injury by clearing distracted users from the path of travel.

10. *All doors to rooms and spaces are located where they can be used without disrupting ongoing activities in the room or space (e.g. using the door does not require crossing between an audience and presenter).* Doors to a space should not interfere with the program of the space. Placing multiple doors to access the room could help prevent traffic congestion. Placing the doors near the corners of the room may help prevent the door from being opened onto a person or equipment within the path of the door swing. Designers should communicate with the client to thoroughly understand how each space will be used before finalizing door placement.
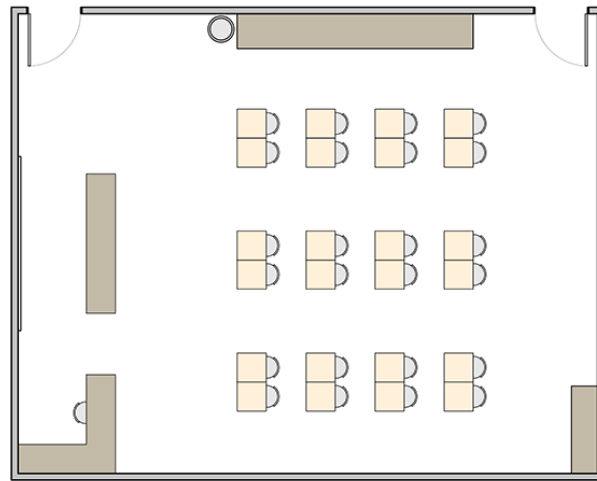

Figure 10: Doors in non-disruptive locations

11. *All vestibules have the same overall passage width exiting the vestibule as entering the vestibule.* In emergency situations, people evacuate a building more quickly than usual. If the vestibule exit is smaller than its entry, evacuation will take longer due to congestion. Additionally, if there are a different number of doors or if doors are differently distributed on either sides of the vestibule, then traffic in the vestibule will slow. It will take time for people to readjust their walking pattern. This would make it more likely for people to cross paths, which would result in longer times to exit the building and possibly in injuries.
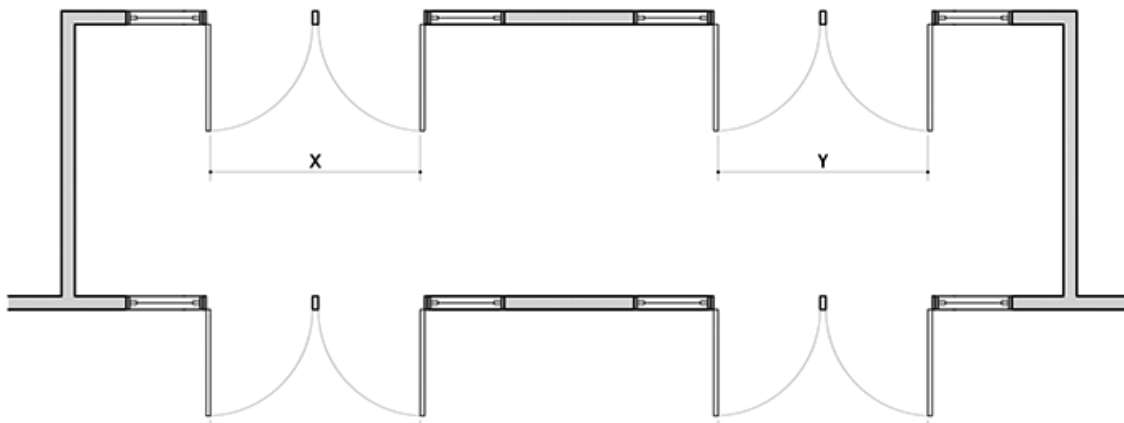

Figure 5: Vestibule passage width

12. *All doors or door frames visually contrast with the surrounding walls.* Someone visiting a building for the first time may have difficulty finding where they would like to go. Additionally, someone with low vision may have greater difficulty finding doors that blend in with the wall. Color discernment can be challenging for aging adults and people with vision impairments. First time visitors are more likely to miss visual ques and can easily become lost. Clearly differentiating doors and/or door frames from the surrounding walls makes using the building a more pleasant experience for a larger variety of people, by making it easier for people to navigate.

Figure 12: Vestibule doors that are glazed doors with side glazing.

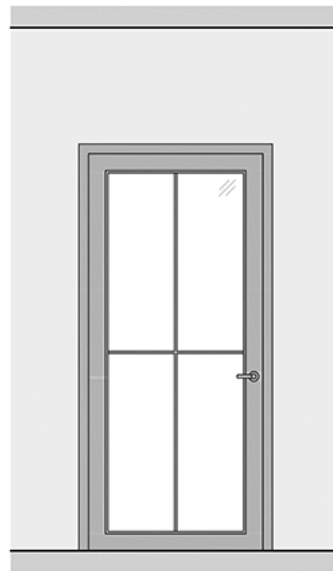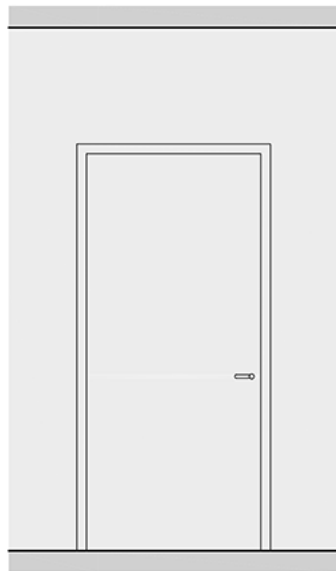*Figure 13: Doors with visual contrast from surrounding wall*

Figure 14: Door without visual contrast (left), and with visual contrast (right)
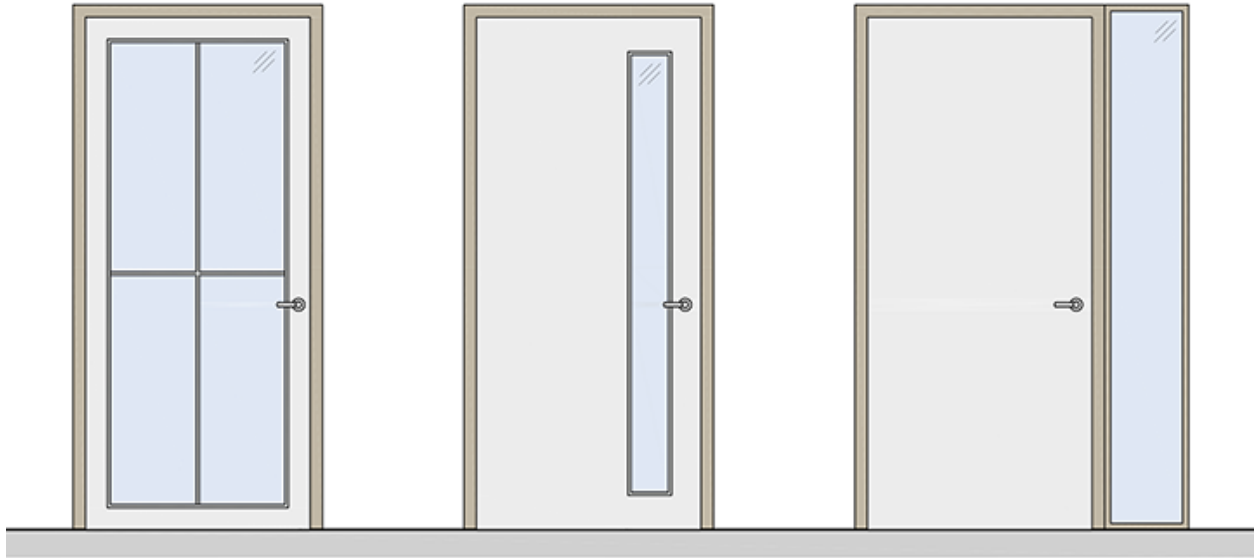
Figure 15: Doors with full-height view panels

13. *All doors that swing into a common path of travel are glazed or have a full-height view panel, except doors leading to spaces with a usable floor area less than 25 square feet (2.33 square meters).* The use of glazing provides visual access beyond a door. Glazing will help those behind the door to look into the circulation space. The resulting increased awareness makes it less likely for a person to open a door into another person's path of travel. See Figure 10 and Figure 13 above for examples.

14. *Selected spaces have doors in pairs designated for entering and exiting, labeled accordingly on both sides.* One door for entering and one door for exiting creates a circulation pattern in a space. This helps to limit the amount people must shuffle around to enter or exit the room. Spaces with high traffic volumes, such as a bathroom, this solution helps people move more efficiently.
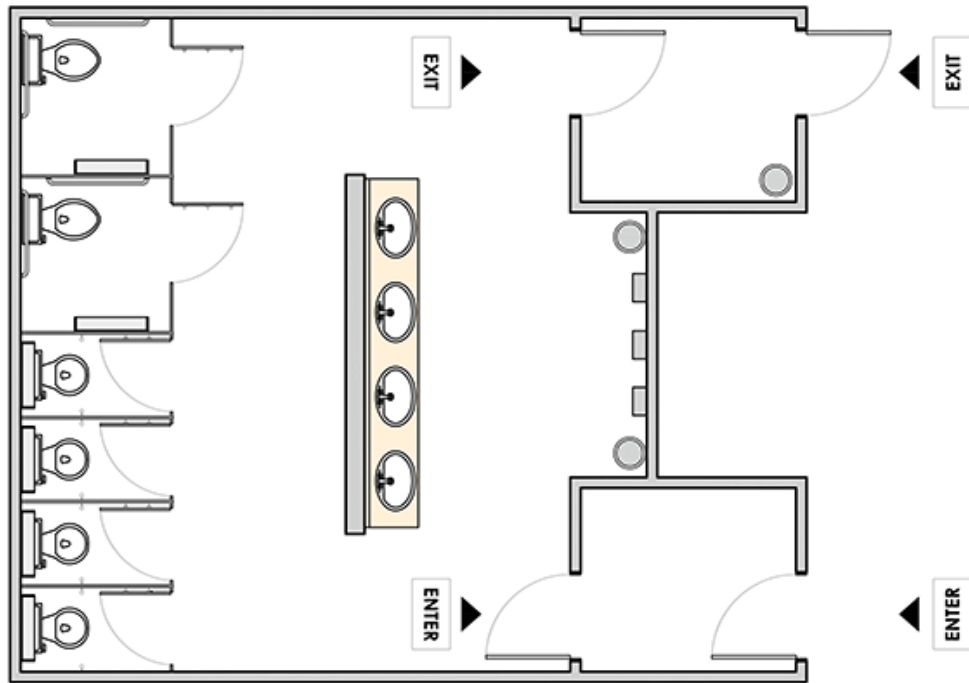

Figure 16: Doors in pairs labeled for exiting and entering

15. *All doors encountered along primary routes have hardware with design cues indicating the appropriate pushing or pulling action to open (e.g., plate or bar for pushing, U-shaped handle for pulling).* Visual acuity, or a person's ability to resolve fine details (Strong, 2010), can affect whether someone is able to detect if a door should be pushed or pulled. It may take greater effort for someone who is aging, physically impaired, or holding a large item to open a door. If the person judges incorrectly that a door should be pulled yet they push, then they may collide with the door, causing injury. Furthermore, this door may become a hazard in an emergency situation, when people need to use it to evacuate the building. The door may take longer for users to operate, as they must try different methods for opening it. The extra time it takes to understand how to operate a door could be eliminated by providing clear visual indicators of how to use the door.
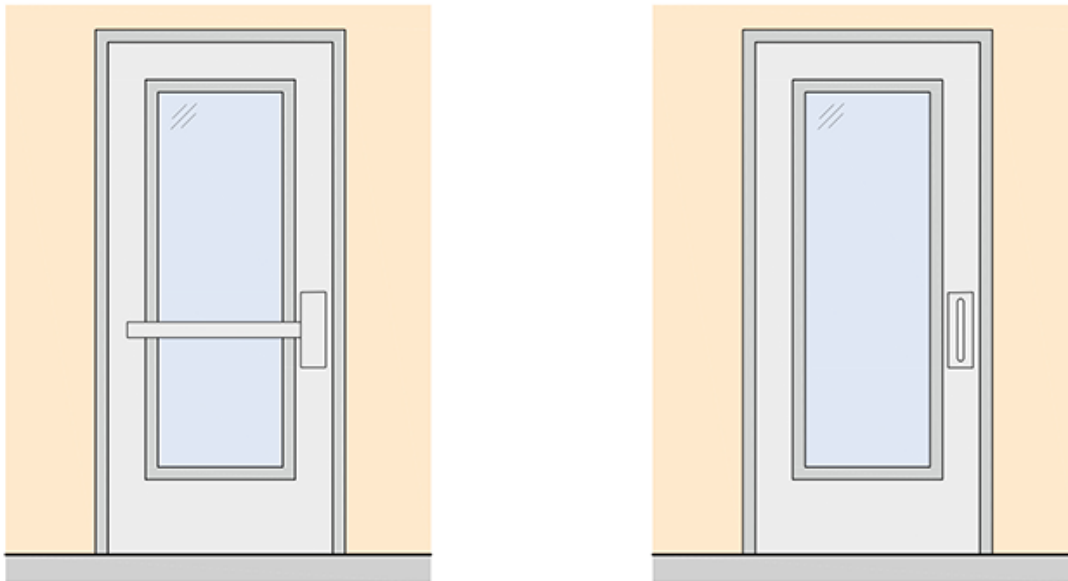

Figure 17: Door hardware indicating push (left), and pull (right)

16. *Selected doors can be secured and unsecured using magnetic swipe cards, electronic key fobs, smart phones, numeric keypads, or other technology in lieu of keys.* Using a key to operate a door requires fine hand and finger dexterity along with visual coordination. Allowing the use of technology could make it simpler for more diverse populations to operate the door. Incorporating the use of a magnetic swipe card, smart phone, or other technology allows users to operate the door in a more expedient way, than if they were using a key.

17. *All doors with closers that do not open automatically have a shelf on each side of the door.* Coffee mugs, a stack of files, and umbrellas are items that may be difficult for a user to hold while opening a door. Carrying multiple items makes opening a door more difficult. Some people have different levels of ability in each hand or arm. Someone with carpal tunnel, arthritis, or another dexterity impairment may only be able to use one hand. Lifting something off the ground can put stress on the back which could result in an injury. Awkward postures can cause someone to acquire a musculoskeletal disorders (OSHA, 2000). Placing a shelf near the door would lessen the chances that the item the

person was carrying is damaged, and prevent someone from going into an awkward posture, risking injury.

18. *Selected doors to access-controlled areas have an audio-video intercom system and/or two peepholes, one standing eye level and the other at sitting eye level.* Some rooms or buildings may need to have audio-visual intercom systems in order to determine if someone should be let inside. For example, someone who is not a parent may try to enter a school. This person may be trying to contact or intimidate a student in the school. This audio-visual system increases the level of safety for the teachers and students in the school.

Two peep holes, one at standing eye level and the other at sitting eye level, can be useful in accommodating people of varying heights, ambulatory users, and wheeled mobility device users. For example, hotel rooms have a high turnover rate, and a diverse user group. Most hotel guests will only be using the space for a few days, and multiple peepholes may grant them the feeling of security in this temporary housing space.

6.   Definitions

The following definitions are adapted from Anthropometry of Wheeled Mobility Project and the Design Resource 13 – Vision Aspects of Universal Design.

Anthropometry	Measurement of the physical characteristics and abilities of people.
Clear Floor Length	Measurement of the horizontal distance between the forward-most point and the rear-most point on the wheeled mobility device or occupant, whichever is larger. This includes accessories attached to the device.
Clear Floor Width	Measurement of the horizontal distance between the side-most points of the wheelchair or participant on the right and left sides.
Color Discrimination	A person's ability to distinguish between objects or lights having different wavelength compositions (colors). Color vision is commonly tested using plates consisting of an organized pattern of dots against a neutral background of another color. The pattern becomes indistinguishable when a color vision deficit is present. The respective colors are selected to differentiate between different types of color vision defects and quantify the level of the color vision deficit from mild to profound [8].
Musculoskeletal Disorders	Injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system.
Visual Acuity	A person's ability to resolve fine details; common visual acuity testing utilizes paper or projected charts composed of systematic rows of letters that become smaller and more difficult to see; a person`s visual acuity identifies the smallest letter size that can be seen by the individual being tested [8].

Wheeled Mobility Device	This includes devices such as manual wheelchair, power chair and scooters.

7.   References

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