isUD
innovative solutions for Universal Design

2.4

DESIGN RESOURCE

Space Clearances

2.4 Reach Targets

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1. Overview

There are many objects that building users must reach. These include controls like light switches and thermostats, hardware like window and door locks and objects that are stored on shelves, racks or hanging rods. In anthropometry, the object to be reached is called a “target”. An individual might grasp an entire object, e.g., a piece of fruit or a small container, or only a part of an object, e.g., a switch on a piece of equipment. In the first case, the entire object is the target while in the latter only the switch would be the target. There are also situations where judgement is needed to ascertain the true target. For example, an article of clothing hanging in a closet can be reached by grasping the clothes at the bottom of the hanger, not necessarily at the top where the clothes hanging rod might be located. The ability to reach an object is tied to an individual’s range of reach but the ability to lift an object is related to the amount of force required to lift it (it’s weight) and its position vis a vis the body. If a large force is required to lift an object, then positioning closer to the body and shoulder height will make it easier. Generally, this also holds true for devices that need to be manipulated but the shape of object, frictional resistance and other factors will also come into play for manipulation.

Reach limits in accessibility codes are based on anthropometric data on range of reach and do not reflect the amount of force required to use objects. Further, they often do not address the true target location, using a landmark in the environment as a proxy for the target rather than the target itself. Storage shelf heights are good examples. Since there are so many objects that can be stored on shelves, standards developers treat everything the same. But, in practice, designers should consider the weight of the target for tasks involving lifting and the force required to operate controls in deciding the best location to support use.

Two other important factors influencing reaching ability are the approach clearances and the presence of obstructions within the range of reach. Everyone needs enough space near the target to position their body within reach. Wheeled mobility device users, of course, need more space than ambulant individuals. If reach targets like electrical outlets and switches are mounted on walls behind counters, access to the target is obstructed, reducing reaching ability. Lowering the target somewhat can make it easier to reach such objects if they cannot be placed somewhere where the depth of reach is not as great.

As an example, supermarkets are places that require the user to reach a variety of things. How the aisles are arranged and how the items on the shelves are located can constrain or support an effective and comfortable reach. Aisles need to be wide enough to allow users to position themselves effectively. Accessibility codes ensure that such space will be provided but they provide no guidance for where objects might be placed on the shelves. Goods are often packed in tightly. In many cases, the shelves even tower above the heads of the shoppers. Placing heavier, bulky objects within the middle of the reach range, however, can make it easier for users to grasp what they need unassisted. For example, if heavier items, such as large jars of pickles, are placed on lower shelves, shoppers must bend over to reach the jar, lift it, and then transfer the jar into the cart. It would be more accommodating for different body sizes if the heavy jars were in the middle of the reach range and lighter items were on the high and low ends of the reach range. But, if the smaller jars are the more popular items, it is also desirable to have some of them in the middle range as well. Rather than putting all the heavy objects at a low height, distributing them vertically makes it easier for people with limited strength to shop independently. Clearly, it is never desirable to put heavy objects up high.

Structural columns or walls often cause obstructions in retail locations. This is particularly true in older buildings that were not designed for such uses. Store managers can plan product placements so that, where clearances are tight, there are some of the same products located where the clearances are more generous. In many retail locations, movable product displays obstruct access to shelves behind. These displays can be located strategically to ensure that some of each product is available on either side. Thus, careful management of a space over time is critical for insuring access to reach targets.

2. Issues to Consider

Objects Obstructing Reach Range: In a workspace, many of the electrical outlets are placed on the floor or underneath a desk. These outlets can be difficult for an ambulatory user to reach, and nearly impossible for most wheeled mobility device (WMD) users to reach. A solution in existing buildings is to provide a power strip on top of the desk. In new structures, some electrical outlets can be located within the comfortable reach range. New products, on the market can be used to integrate outlets and controls in work surfaces.

Facilities Management: Although the built environment may initially provide building users with sufficient support to reach everything they need, there may be features and equipment added later. It is important that personnel responsible for facilities understand how to maintain an environment that is easy to use and to avoid introducing barriers to reach. This could include staff who order the furniture, maintenance workers, and office workers who might modify a team workspace by bringing in equipment like space heaters or store items like boxes of files in places that block access to operable controls like light switches or stored items.

Direction of Access: When considering where to place something that needs to be reached and moved, it is preferential that a clear floor space is provided for a side reach. Research demonstrates that side reach is generally easier for this group compared to forward reach over the toes (Edward Steinfeld, Victor Paquet, Clive D'Souza, Caroline Joseph, & Jordana Maisel, 2010) (D'Souza, Steinfeld, & Paquet, 2009). Forward reach can be more convenient if eye-hand coordination is important for completing a task. Since wheeled mobility users cannot reach as well in the forward direction, knee clearance is needed to bring objects over an obstruction within their reach range.

Comfort Zone: Requiring users to reach, lift or manipulate critical objects outside the comfort zone of 24 to 48 in. (610 to 1220 mm) above floor level should be avoided, if possible. If it is impossible to locate all reach targets within the comfort zone, consider options like adjustable height devices and storage units that allow the user to position objects that are critical for them where they want them.

Accommodating Children: Most spaces are designed to prioritize use by adults. In schools, daycare centers, playgrounds, and locating objects that are safe and desirable for children to manipulate should be an equal priority. This could include lockers, sinks, light switches, coat hooks, storage shelves, etc. Heights in the lower range of the comfort zone would be adequate. Where adults are the major users but children often are present, providing steps for children to reach objects at adult level like lavatory faucets and spigots are another option.

3. Related Standards

2017 ICC/ANSI A117.1 Standard - Section 308 Reach Ranges provides requirements for accessible reach ranges. The standard also has adjustments for children's facilities. Following the minimum requirements of the standard does not ensure full access to all users. For

example, the standard allows top loading washing machines but many wheelchair users and people with dwarfism will not be able to reach to the bottom of the drum in these machines. Front loading machines would be preferable. The current standards also assume that the best location for reach targets is centered on the wheeled mobility device. But, in fact, the easiest reach is directly out from the shoulder. Reaching across the body is more difficult. And, the standard allows an unobstructed forward reach range to start at as low as 15 in. (380 mm) above the ground. Edward Steinfeld et al. (2010) found that many wheeled mobility device users are at risk of losing balance when reaching below the comfort zone.

2010 ADA Standards for Accessible Design - Section 308 Reach Ranges has similar requirements as the 2017 ICC/ANSI A117.1 standard.

The dimensions in the *isUD™ Solutions* are based on data that was collected from IDEA Center anthropometry studies. One of the goals of *isUD™* is to create a safe and inclusive environment. Utilizing more effective reach ranges than required by standards and codes is a key to accomplishing this goal.

4. Measurement and Verification

The recommendations below are derived from Edward Steinfeld et al. (2010) There were 495 participants throughout the project. Not all participants, however, had functional reaching ability. The recommendations are based on the ability of a wheeled mobility device user to complete a forward reach without exerting force. Lower/higher positions should be provided when force is required to lift objects or manipulate devices with force. Ideally, objects should be positioned within the reach comfort zone, as noted above, if possible.

5. Design Considerations

i. *Reach targets are not under or behind built elements or furniture.* The designer needs to consider the type of furniture which may be placed in different parts of the space. Some areas will have different levels of accessibility when there are different arrangements. The design process is iterative and requires input from many people. The space may have to be reevaluated at different points in time. *See Appendix A, Figure 1*

ii. *Reach targets have a clear floor space positioned for side approach wherever knee or toe clearance is not provided*. Most wheeled mobility users have a larger reach range to their side. If space for a side reach is not possible, knee clearance will be necessary (*See isUD ™ Design Resource Knee and Toe Clearance*). *See Appendix A, Figure 2*

iii. *Where only a forward approach to a reach target is available, the reach target overlaps the clear floor space by at least 4 inches (100 mm) (i.e., knee and/or toe clearance brings reach target closer to the user)*. This brings the target closer to the user's body and within reach of a wider percentage of the WMD population. *See Appendix A, Figure 3*

iv. *Reach targets are at least 12 inches (305 mm) from any corner*. Corners would make it difficult for the user to become situated close enough to reach the target. The clear floor spaces necessary for a wheeled mobility device could prevent a centered approach to the reach target or prevent the user from utilizing their more dominate hand to reach. *See Appendix A, Figure 4*

v. *Selected reach targets have overlapping clear floor spaces allowing right and left shoulder alignment for side and/or forward reach*. People usually use their dominant hand to reach and manipulate objects but can be either right-handed or left-handed. People with disabilities, especially wheeled mobility device users, often have limitations on one side of their body. While only about 10% of the general population is left-handed, our research showed that 25% of wheeled mobility users preferred to use their left hand for reaching tasks. The easiest reach will be directly out from the shoulder so providing enough space for left-handed and right-handed use will give the user a more individually appropriate option. *See Appendix A, Figure 5*

vi. *Selected reach targets that have a clear floor space for side approach positioned less than 10 inches (255 mm) from the reach target are 24-48 inches (710-1120 mm) above the finished floor*. The lower limit of reach in the current ICC/ANSI and ADA Standards (15 in.) is too low for the majority of users to be able to perform a reaching task safely. Raising the lower reach range to 24 in. will accommodate the 90% of manual wheelchair users and the 75-95% of power wheelchair users. Sixty percent of scooter users will be able to reach as low as 24 inches. Raising the low point of the range to 28 inches will accommodate 80-95% of scooter users (E Steinfeld, V Paquet, C D'Souza, C Joseph, & J Maisel, 2010). *See Appendix A, Figure 6*

vii. *Selected reach targets that have a clear floor space for side approach positioned 10 inches (255 mm) or more from the reach target are 28-44 inches (710-1120 mm) above the finished floor*. When reaching over an obstacle 10 inches or more deep reduces the reach range. This reach range will accommodate 75-95% of manual wheelchair and scooters users. From 50-85% of power wheelchair users will be able to reach within this range as far away as 16 inches. Only around 20-45% of power wheelchair users will be accommodated if they must reach a target farther than 16 inches (E Steinfeld et al., 2010). *See Appendix A, Figure 6*

viii. *Selected reach targets have a clear floor space for side approach positioned 20 inches (510 mm) or less from the reach target.* When an obstacle in front of a target is 20 in. deep or more, significantly fewer people can reach it. Limiting the depth of an obstruction to 20 inches or less will allow approximately 75% or more of the manual wheelchair users, 50% of power wheelchair, and 40% of scooter users to complete the reach within this range (E Steinfeld et al., 2010).

6. References

D'Souza, C., Steinfeld, E., & Paquet, V. (2009). *Functional reach abilities of wheeled mobility device users: toward inclusive design.* Paper presented at the Proceedings of the 2009 International Conference on Inclusive Design.

Steinfeld, E., Paquet, V., D'Souza, C., Joseph, C., & Maisel, J. (2010). Anthropometry of wheeled mobility project-Final report. *Buffalo, New York: Center for Inclusive Design and Environmental Accesss (IDeA Center)*. Retrieved from http://idea.ap.buffalo.edu/wp-content/uploads/sites/110/2020/01/AnthropometryofWheeledMobilityProject_FinalReport.pdf

Steinfeld, E., Paquet, V., D'Souza, C., Joseph, C., & Maisel, J. (2010). *Anthropometry of Wheeled Mobility Project: Final Report*. Retrieved from Buffalo, NY:

7. Appendix A

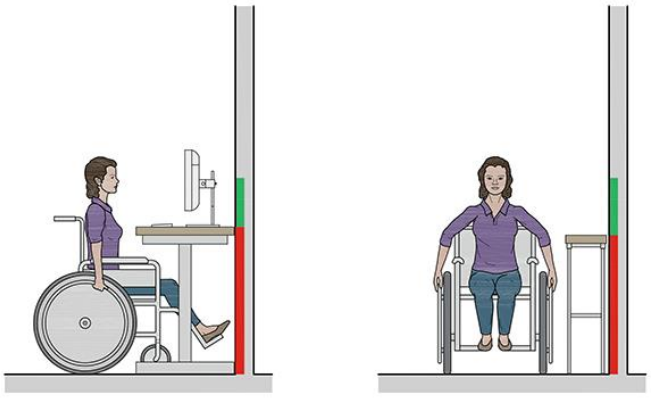

Figure 1: *Reach target barriers. The red line indicates the area that is unacceptable to require reaching. The green line indicates the area that is acceptable to place a reach target.*

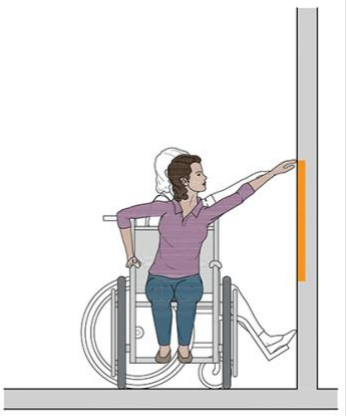

Figure 2: *Side approach to reach target*

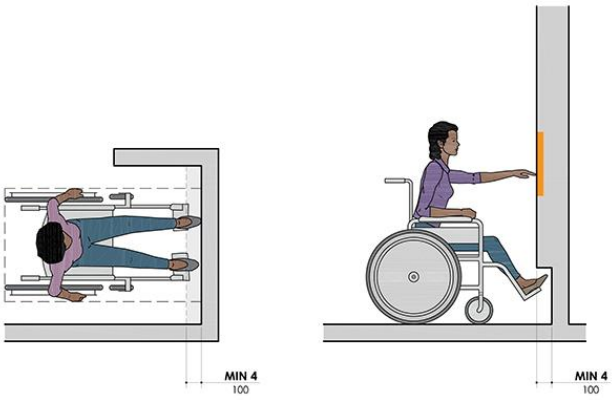

Figure 3: *Forward reach projection*

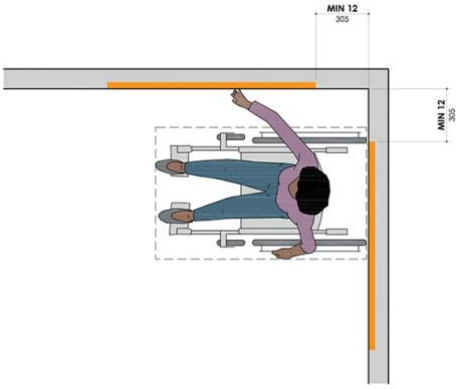

Figure 4: *Reach target in corners*

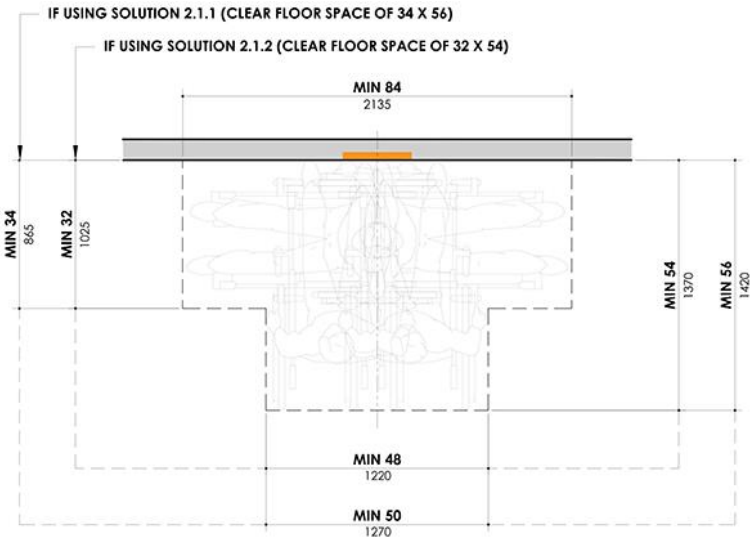

Figure 5: *Clear floor space for side and forward reach for both right- and left-handed people*

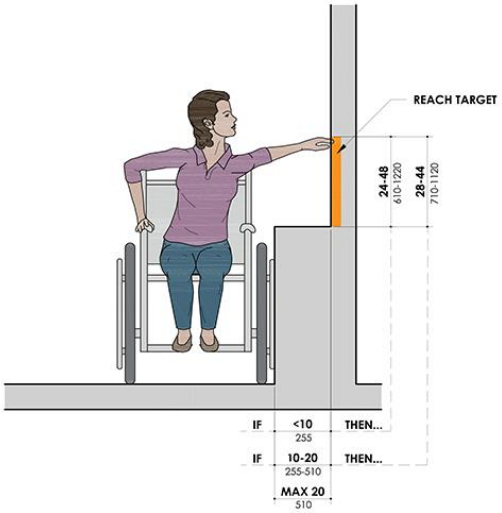

Figure 6: *Side approach reach target height range*