isUD
innovative solutions for Universal Design

DESIGN RESOURCE

2.3

Space Clearances

2.3 Knee and Toe Clearance

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1. Overview

All public accommodations in the U.S. must comply with accessibility standards that are referenced in building regulations and disability rights laws. These standards require knee and toe clearances wherever wheeled mobility device (WMD) users must get close to devices to use them easily. Knee and toe clearances are often used together, but they can be used independently, for example, a toe space under a toilet partition. Knee and two clearances are "building block" elements because they are applied throughout accessibility standards. Thus, they have dimensions have significant implications throughout a building.

Currently, the standards for knee and toe space clearances incorporated in standards are based on data collected during the 1970's. Since that time, wheelchair design and the population of people with disabilities have changed substantially. In the last 20 years, research in the U.S. demonstrated that the current standards for knee and toe clearances are inadequate for accommodating many WMD users, especially those using power wheelchairs and scooters (Steinfeld, Paquet, D'Souza, Joseph, & Maisel, 2010).

Both knee and toe clearances are necessary for individuals who use wheeled mobility devices to complete tasks in a forward position. While some tasks can be accomplished easily from the side, for example, opening a door lock or adjusting a switch, other tasks require more effort and sustained activity like writing, washing one's face, food preparation, dining, and drinking from a fountain. Without knee and toe clearances, these tasks can be difficult if not impossible to complete independently.

Floor mounted cabinets have "toe kick" spaces that allow ambulatory individuals to get closer to countertops and upper storage areas. Without these spaces, they would have to stand back a few inches and extend their reach or bend further to accomplish many tasks. Expanded toe kicks can both benefit ambulatory users and provide additional maneuvering room for wheeled mobility users. If toe clearances are high enough, they can reduce the clearance needed between cabinet faces to allow wheeled mobility users to turn around in small spaces. Toe clearances can also be used under partitions in restrooms and changing rooms to reduce the space necessary within compartments by "borrowing" space from adjoining compartments, although there are privacy concerns that need to be addressed in such spaces as well.

In seated workstations, dining areas, and counter or desk areas used for business transactions, knee space is needed by both ambulatory and non-ambulatory people to sit comfortably. Providing enough space for WMD users will accommodate everyone else. Toe clearances used in combination with knee clearances provide additional space where supporting structure or equipment is provided below counter heights, e.g., lavatories, kitchen sinks, ATM machines and water fountains.

Another important use of knee and toe space is to bring devices that need to be used by hand within functional reach. Although standards specify the maximum height of operable devices for front reach, in reality, a large percentage of WMD users cannot reach an object located beyond their footrests or toes (see *isUD™ Design Resource 2.4. Reach Targets*). Providing knee and toe space will effectively bring the target object within their functional reach.

Knee and toe clearances in existing accessibility codes and standards do not reflect the results of recent research (D'Souza, White, Steinfeld, Paquet, & Center, 2011; Steinfeld et al., 2010). From this research, we know that many wheeled mobility users of today require much larger knee and toe clearances than the minimum clearances that are currently required by standards.

Further, knee and toe clearances are much more complex than the way they are described in codes and standards. The clearances needed depend on what activity will be performed and the shape and size of any obstacles under a counter or work surface.

Thus, in universal design, it is important to consider how to plan the best knee and toe clearance for a particular location. For simplicity's sake, however, clearances can be defined that work in most situations. The dimensions in the *isUD™ Solutions* above will provide a good solution for most applications.

2. Issues to Consider

Purpose of the task: Consider the type of activities that will occur in a space. Dimensions may need to differ from those specified in *Appendix A Figure 1* in order to accommodate what the user is expected to accomplish. For example, if a WMD user has to approach close to a countertop or table to eat, the location of the abdomen is the reference point for the depth of the clearance. If the surface is shallow, a knee and toe clearance beyond the opposite side might be needed. If equipment underneath necessarily restricts access and the surface cannot be increased in depth (e.g., sink drain in residential kitchen), the front of the knee is the reference point. The forward-most point of the wheeled mobility device or individual's toes will govern if one is trying to determine how much a piece of equipment or operable device should project off a wall to ensure functional reach. And, if a wheeled mobility device will be positioned back against a wall, the rearmost point of their device, including any objects hanging off it, is the reference point. The knee and toe clearances required in each of these conditions are different.

Scooters are a special case. The steering stock on some scooters can be folded out of the way for a front approach. Many scooters have rotating and height adjustable seats however, so their users can park their device in a parallel position if there is enough room and still access a knee clearance. But this position requires a wider clear floor space (see section 2.1. Clear Floor Space of the Design Resources). To use a scooter safely, one should be able to stand and transfer, so scooter users should be able to transfer to chairs where they are available, e.g., dining areas. Transferring to chairs would be inconvenient, however, for brief tasks like drinking from a fountain. Where transfer is likely, a place to park a scooter out of the way is required to maintain circulation clearances for everyone else using the space.

Types of Devices Expected: The popularity of different device types may change from building to building and community to community. For example, in a hilly location like San Francisco or Pittsburgh, people who use public transportation and need to get around outdoors on their own are likely to have more powerful and thus larger power chairs. In facilities serving large numbers of older people, there are likely to be more people using scooters. It is important to contemplate the potential populations who will use the building. There is a trend toward the use of larger devices like power chairs and scooters (D'Souza et al., 2011; Steinfeld et al., 2010). Accommodating the larger people and devices will be beneficial in the long run because it will allow more users to use a space. As a rule of thumb, however, devices design specifically for exterior use do not have to be accommodated indoors. Facilities where such devices are expected, e.g. dining areas or displays at visitor centers in major outdoor recreation sites like local, state or national parks, could have indoor manual wheelchairs available for guests who use larger powered equipment.

Accommodation models: *Steinfeld et al. (2010)* measured five anthropometric dimensions of WMD and their devices. These are defined, in anthropometric terms as follows:

1. Foot clearance height (FCH): the vertical height from the floor to the dorsal foot point (i.e., near the crease of the foot and the lower leg).

2. Foot clearance depth (FCD): the horizontal distance from the anterior-most (rear) point on the person or wheelchair, to the dorsal foot point on the right foot.
3. Knee clearance height (KCH): the vertical distance from the floor to the superior aspect of the right knee.
4. Knee clearance depth (KCD): the horizontal distance from the forward-most point on the person or wheelchair, to the forward-most aspect of the right knee.
5. Abdomen extension depth (AED): the horizontal distance from the forward-most point on the person or wheelchair, to the forward-most aspect of the abdomen.

Using these five dimensions, the IDEA Center developed a new graphic representation method for knee and toe clearances in which the dimensions of the space are related directly to landmarks on the body and device. Four different accommodation models (D'Souza et al., 2011; Steinfeld et al., 2010) were developed depicting knee and foot clearance spaces for manual wheelchair users for different positions of the individual in relationship to the built element:

1. The forward-most point of the body or equipment touching a facing wall
2. The crease of the foot and lower leg in contact with the built element
3. The forward-most point of the knee in contact with the element
4. The forward-most point of the abdomen in contact with the element

These graphic representations provide information on the minimum knee and foot clearance height and depth needed in order to accommodate a specific proportion of the sample (e.g., 95%, 90%, 75%, etc.). Designers can use these models to estimate the percentage of WMD users who are accommodated by different dimensions. Click on this link to find a dynamic form of the knee and toe clearance model: Design Guidelines for Wheeled Mobility Accessibility. Using these versions of the model, a designer can select which model they want to use. Then they can either select dimensions and learn what percentage of the population will be accommodated or select the percentage of the population they seek to accommodate and find the clearances needed to accommodate that part of the population. They can also select the type or types of WMD they want to accommodate. This provides the ability to do "what if" analyses and settle on the best solution for a particular application.

Each model applies to a different design scenario. The designer should select the model that is most appropriate for the task or activity to be conducted at a location and physical constraints in the environment. For example, a safe under an ATM may restrict the depth of the toe clearance, thus the first model would be used. But, in designing a desk for filling out a job application, there is no technical reason for restricting the depth of toe clearance, but the leading edge of the desk should be as close to the abdomen as possible. Thus, the fourth model is more appropriate.

3. Referenced Standards

2017 ICC/ANSI A117.1 Standard - Section 306 Knee and Toe Clearance specifies that if a space below an element is to be considered as part of the clear floor space, then it must provide a knee and toe clearance. The knee clearance height must be 27 in. (685 mm) at a minimum. The *isUD™ Solutions* increase the space so a person with higher arm rests or seat heights can comfortably use the element in the space. The 2017 ICC/ANSI A117.1 Standard requires a 6 in. (150 mm) maximum depth for toe clearance. Many WMD users would not benefit from toe space this deep. By reducing the depth of the toe space and adding it to the knee clearance depth, more space can be provided for the knee depth portion of the combined knee and toe clearance. This provides more room for people who need deeper knee space. The height of the

toe space in the 2017 ICC/ANSI A117.1 Standard is 9 in. (230mm) minimum. A significant proportion of WMD users requires higher clearance. By raising the clearance, *isUD™* accommodates a larger number of WMD users and allows more people to pull up closer to the leading edge of counters and fixtures.

2010 ADA Standards for Accessible Design - Section 306 Knee and Toe Clearance The 2010 ADA Standards for Accessible Design requirements for knee and toe clearance are identical to the 2017 ICC/ANSI A117.1 Standard. The illustrations in the 2010 ADA Standard, however, are confusing because they separate the clearances in plan and section and do not graphically describe how the two clearances are related.

In following the recommendations below, it is important to check standards and codes to make sure that dimensions remain within the bounds of the code limitations, despite their inadequacies. There are at least two potential conflicts between these recommendations and the code requirements. First, the knee clearance height plus the thickness of a counter or work surface could exceed the code maximum of 34 in. (865 mm) for some applications, e.g., accessible lavatory height, accessible kitchen counters, etc. Second, accessibility standards include provisions to protect people with visual impairments from protruding hazards in the path of travel. See sections 307 in both the 2017 ICC/ANSI A 117.1 Standard and the 2010 ADA Standards for Accessible Design. One of the rules in the standards is a 27 in. (685 mm) maximum overhang. The intention of this rule is to keep overhangs within the detectable range of a mobility cane. But it should only be applied when an object protrudes into a path of travel from the side, e.g., a water fountain hanging off a wall of a corridor, where such overhangs are unexpected. Some code officials interpret this rule to apply to front approaches to lavatories, furniture, and other equipment, even when an approach from the side is impossible or protected by walls or partitions. Proper cane technique in a restroom or room with furniture and equipment would detect overhangs in front of a person.

4. Measurement and Verification

Dimensions in construction drawings and field measurements can be used to determine if an element meets the *isUD™* recommendations. In applying the solutions, the designer should consider the tasks that will take place at the location, how much time someone is expected to spend in the space, how far they are expected to reach from the workstation, and the need to maneuver to nearby spaces. More space provides more convenience in most cases. But increasing the height of the knee clearance can make tasks above a counter or fixture uncomfortable and increasing the depth of the combined clearances can put reach targets out of range for a forward reach. Note that reach targets can be brought closer to the person without compromising the knee and toe clearance (see section 2.4. Reach Targets of the Design Resources).

5. Design Considerations

i. *Knee clearance height is at least 29 inches (740 mm), at selected features and elements (e.g., work stations, tables, drinking fountains, lavatories, etc.).* Knee clearance is necessary for a user to come close to an element in order to use it properly. When someone in a wheelchair uses a sink, they need to get close, lean over, and reach the faucet to use the feature. The minimum recommended 29 in. (740 mm) knee clearance height will accommodate approximately 95% of manual wheelchair users and 90% of power wheelchair users to position themselves fully underneath the element.

ii. *Knee clearance depth is at least 11 inches (280 mm), as measured at the top of the knee clearance.* A depth of 11 in. (280 mm) for knee clearance will accommodate approximately the 75th - 90th percentile of manual wheelchair users. This depth would accommodate around the 50th percentile of power wheelchair users. The depth will affect how much overhang there is to an element in the workspace, and how far in a wheeled mobility user can under a fixture or piece of equipment.

iii. *Knee clearance depth is at least 13 inches (330 mm), as measured at the top of the toe clearance.* A depth of 13 in. (330 mm) for knee clearance will accommodate up to 95$^{\%}$ of manual wheelchair users and 75$^{\%}$ percent of power wheelchair users. More knee space will allow the user to get closer to what is on top of the feature. This may include being closer to a desk space so the user can write or reach a keyboard, reaching a switch on a lamp or a telephone.

iv. *Toe clearance height is at least 13 inches (330 mm).* A depth of 13 in. (330 mm) for toe clearance will accommodate up to the 95% of manual wheelchair users. It accommodates the 70-90% of power wheelchair users. To reduce the risk of pressure sores caused by sitting in one position for a long time, WMD users need to adjust positions frequently. The higher toe clearance height will give users a greater range of adjustments for reclining seats and adjusting footrest height.

v. *Toe clearance height is at least 11 inches (280 mm).* A height of 11 in. (280 mm) for toe clearance will provide enough space to accommodate 75-90% of manual wheelchair users and 50-75% of power wheelchairs. Wheeled mobility device users' feet may be higher off the ground based on how their chair is set up. Toe clearance height helps shorter WMD users position themselves better for using equipment and conversing with others, e.g. while dining.

vi. *The maximum toe clearance depth counted as part of a clear floor space is 4 inches (100 mm) beyond the knee clearance depth, as measured at the top of the toe clearance.* Toe space should only be considered as clear floor space for up to 4 in. (100 mm) because the knee space determines how close a WMD user would be able to get to feature. Getting close to a table or computer display are critical for completing tasks with dignity and efficiency.

6. References

D'Souza, C., White, J., Steinfeld, E., Paquet, V., & Center, I. (2011). DR# 17: Knee and Toe Clearances for Wheeled Mobility Users. *IDeA Center, Buffalo, NY. Retrieved from http://www. udeworld. com/dissemination/designresources. html*.

Steinfeld, E., & Paquet, V. (2004). *Space Requirements for Wheeled Mobility: and internation al workshop*. Retrieved from

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

7. Appendix A

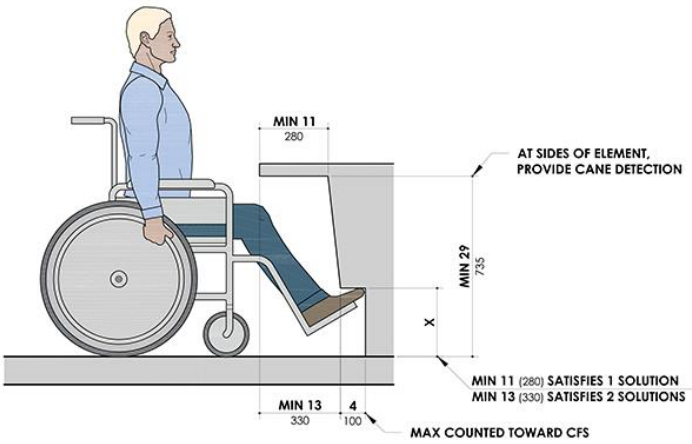

Figure 1: *Figure 1: Illustrated solutions for basic knee and toe clearance.*