

Accessible Design for Multitouch Tables, Large Displays, and Interactive Experiences



By Jim Spadaccini and Hugh E. McDonald

Accessible Design for Multitouch Tables, Large Displays, and Interactive Experiences

Over the ten-plus years Ideum has been designing [touch tables, multitouch displays](#), and the interactive software applications that run on them, we've consistently referred to industry accessibility standards to inform our design decisions.

The [Americans with Disabilities Act \(ADA\)](#) applies to all local, county, state, and federal government agencies, and also covers companies with 15 or more employees. That means that we must focus on the widest possible range of accessibility issues in nearly every product and interactive exhibit we create.

The [Accessibility Requirements for ICT \(Information Communications Technology\) Products and Services](#) drafted by the European Telecommunications Standards Institute (ETSI) and the ADA have been primary guides for making our products and interactive experiences as broadly accessible as possible. Like many companies that work with museums and public spaces, we also frequently look to the [Smithsonian Standards and Guidelines on Accessibility](#) for design and fabrication guidance.

We wrote this white paper to provide helpful information for two core elements of accessibility at multi-user digital exhibits: (1) the physical design of touch tables and displays, and (2) fundamental aspects of accessible user interface/user experience

(UI/UX) approaches to software development. This document focuses primarily on access for individuals in wheelchairs or those of short stature who may have reach, roll-up, or related mobility limitations.

Importantly, even the most current accessibility guidelines may not directly address all of the qualities and issues relevant to these relatively new interactive form factors. On the other hand, several accessibility issues are not covered in this paper. For example, readers specifically interested in audio accessibility may want to review Ideum's [Embracing Inclusive Design in Multitouch Exhibit Development](#).

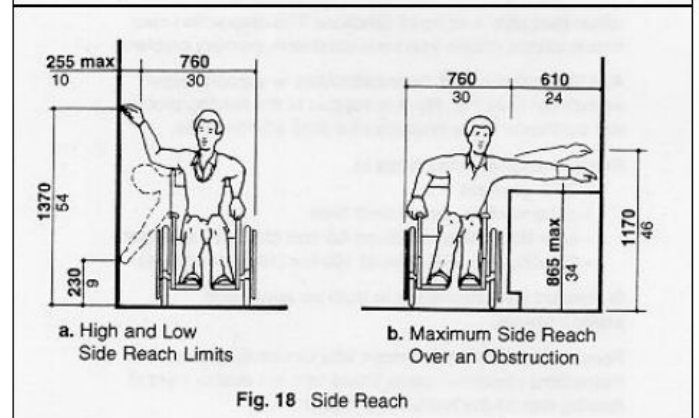
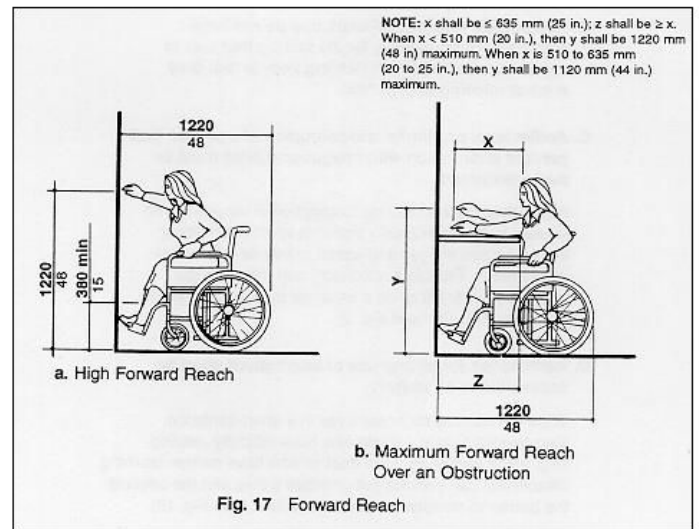
As we discuss in this paper, in the case of accessibility for multitouch tables, there are effectively two distinct interpretations when it comes to the specific issue of reach. In these pages, we will review these approaches for designing experiences for touch tables, which we are calling the "strict" and "broad" guidelines, along with the more unified approach to wall-mounted displays and kiosks.

Visitor Reach

All of Ideum's touch table models are under 34" (865 mm) in height, in full compliance with ADA. (Table heights vary between models, with heights ranging from 31" to 34".) The Smithsonian Standards state that "Interactives must be within reach range of people who are short or those who use wheelchairs as well as those who are standing.¹" This is further clarified with *Forward Reach* and *Side Reach* guidelines which do not require rolling a wheelchair beneath the table. (Based on the way that many or most visitors interact with our tables, we believe that a Forward Reach approach is generally more comfortable.)

As shown in Fig. 17b, the Forward Reach standard also stipulates that maximum reach is less than or equal to the usable roll-up space underneath the "obstruction" (the table itself). In most cases, this will be less than the 25" (635 mm) reach that is presented, as many touch tables use a central base to support the top surface. This final distance is dependent on the size of the screen.

Here, the "broad" interpretation would be that for either Forward or Side Reach, interactive elements need to be 24" (610 mm) or less from the closest edge of the table to accommodate individuals in wheelchairs or those of short stature. The "strict" interpretation is that the available UI area accommodating Forward Reach is the distance from the edge of the screen to the base under the table. We will explore this further later in the paper.



Figures 17 & 18, Smithsonian Standards and Guidelines on Accessibility.

¹ https://www.sifacilities.si.edu/ae_center/pdf/Accessible-Exhibition-Design.pdf, IV Audiovisuals and Interactives, Section E. p 29. Retrieved February 11, 2020.

Visitor Reach

Unfortunately, the European Telecommunications Standards do not provide clear tabletop height recommendations. (In fact, tabletops are presented as “obstructions” with the visitor reaching over them to touch items located on the wall.) While it is somewhat surprising that these standards don’t directly address surface or tabletop computing, one can extrapolate from their Forward Reach and Side Reach recommendations that the relevant distances would be similar to those outlined in the Smithsonian Guidelines. These present a maximum of 25” (635 mm) for Forward Reach and a maximum of 24” (610 mm) for Side Reach. (The minimum heights here are not relevant since we are assuming that visitors will be reaching controls found on the table surface itself, although they will be a factor when we look at drafting-style touch tables). Combining ADA and European guidelines, then, the clearest appropriate standard for both Forward and Side Reach would mandate locating all interactive elements no more than 24” (610 mm) from the edge of the table. (Again, this would be the “broad” approach; as we will discuss later, the “strict” approach for Forward Reach guidelines differs by screen size.)

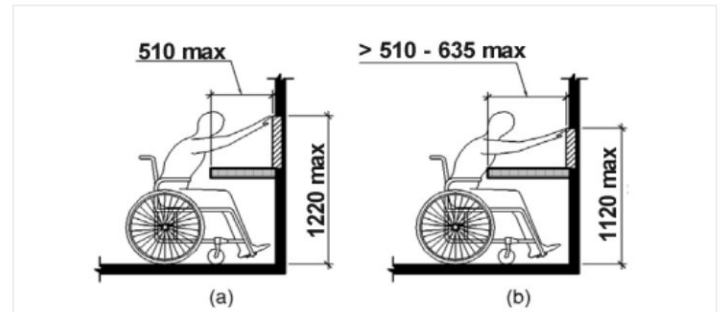


Figure 10: Obstructed high reach

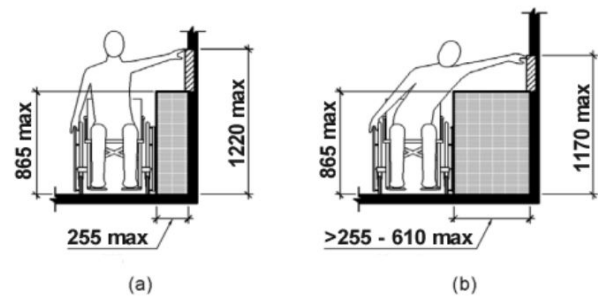


Figure 12: Obstructed high side reach

Figures 10 & 12, Accessibility Requirements for ICT (Information Communications Technology) Products and Services.

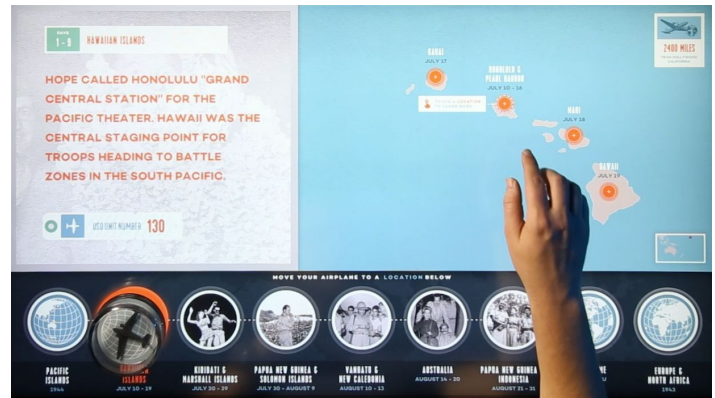
Visitor Reach

Under the “broad” interpretation, Ideum and other smaller screens are largely accessible. For example, Ideum has designed numerous fully accessible single-user applications for our 49” touch tables (which have a width of 27.3” / 693 mm) in which all interactive controls are at least 3.5” from the table’s far edge. If we are designing for a single user on a 55” touch table with a width of 29.6” (752 mm), we simply need to make sure interactive elements are at least 5” (127 mm) from the far edge. We have also incorporated alternative ways to navigate for more flexibility in the layout, allowing us to present intuitive interfaces that still remain accessible. (Including multiple ways to navigate is also an established technique for making Websites more accessible to individuals with cognitive disabilities.²)

Designing for “strict” standards can be more difficult, because as the display gets smaller, the accessible reach area shrinks as well. This may seem paradoxical, but it is again based on ability to roll a chair under the table. The figure below shows accessible reach distances based on approaching the touch table along the long sides:

Ideum Platform II Touch Table

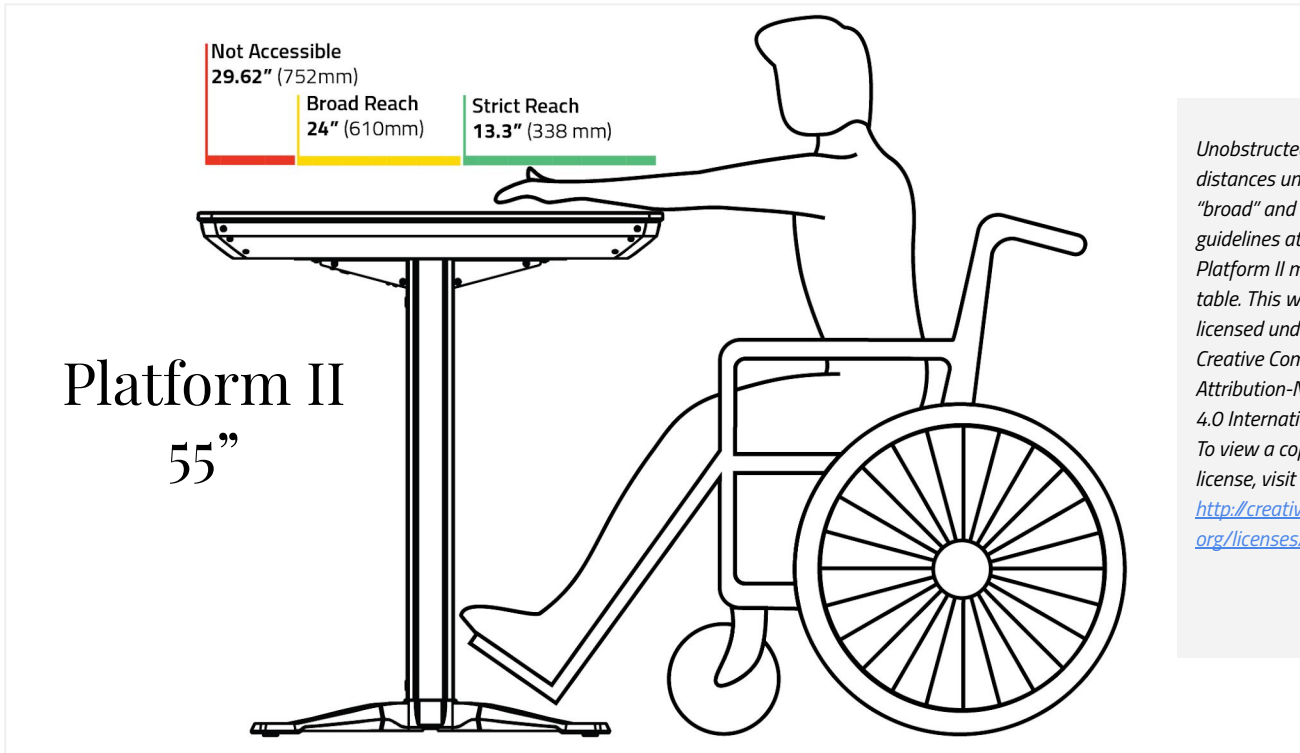
Size	Screen Width	Reach (“Strict”)
43”	23.6” (599 mm)	10.3” (262 mm)
49”	27.3” (693 mm)	12.2” (310 mm)
55”	29.6” (752 mm)	13.3” (338 mm)
65”	35.6” (904 mm)	16.3” (414 mm)



Two images of the [On the Road with Bob Hope interactive application](#) developed with the National World War II Museum. The first image shows points of interest that are close to the limit in terms of reach accessibility. This application was designed to run on a 49” touch table, so for the “broad” interpretation, the controls need to be about 3.5” (89 mm) from the far end of the display. The second image shows a way that visitors can access all points of interest from a single control much closer to the bottom edge of the table. These controls are around 12” from the bottom edge, allowing the exhibit to meet the “strict” ADA guidelines.

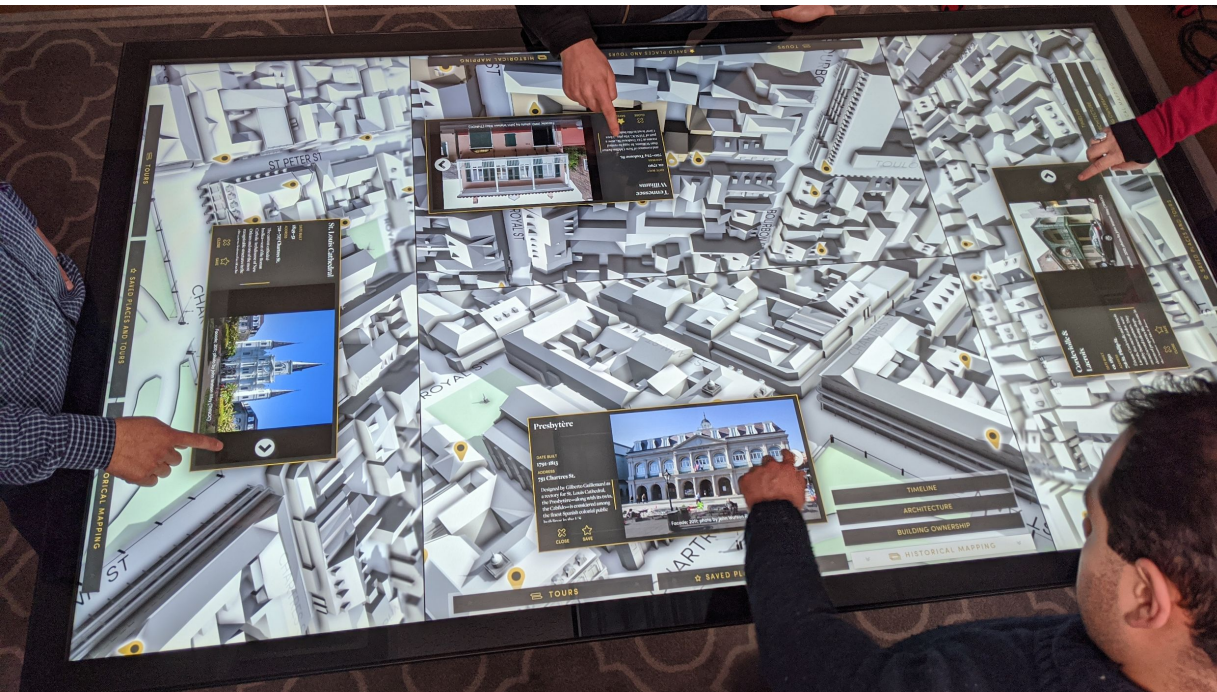
² <https://www.w3.org/TR/UNDERSTANDING-WCAG20/navigation-mechanisms-mult-loc.html>, Specific Benefits of Success Criterion 2.4.5. Retrieved February 11, 2020.

Visitor Reach



Ideum staff conducting hands-on tests with different touch table hardware. We recommend designers test applications using a wheelchair to better understand limitations associated with interaction while sitting.

Visitor Reach



The [French Quarter Tours touch table application](#) allows visitors to explore the history and architecture of the Vieux Carré. The exhibit supports four visitor stations that are all accessible. Controls are closest to the visitor, and the 3D scene itself can be dragged and zoomed to move all points of interest within accessibility guidelines.

Interactive applications designed for use on larger touch tables should have multiuser controls which do not exceed the 24" (610 mm) distance. Even on our largest 86" Colossus table, it is possible to create user stations that fall well within the guidelines. This table has a width of 49.5" (1257 mm), so if all interactive elements are accessible from the table's edges within 24" (610 mm), the complete exhibit would be in compliance with the "broad" guidelines. Based on the roll-under depth, the "strict" reach distance for this table would be 15.3" (389 mm).

For example, the [French Quarter Tours](#) exhibit Ideum created with The Historic New Orleans Collection has a full-screen mode for docent-led activities, but for unmediated use by visitors, the 86" display is divided into four interactive panels with all controls within specified reach guidelines.

In addition to ensuring that interactive elements are within reach of all users, designers must also ensure that controls are sized appropriately. Some users may find accurately touching elements such as buttons or sliders frustrating or even impossible. This is especially likely with elderly people or users with motor-control impairments. The Smithsonian Guidelines recommend that touch-sensitive areas be at least 3" (75mm) in diameter. For design elements where the visual target area is smaller than that, an invisible touch-sensitive zone should extend beyond the target so that "near misses" still activate the element. This means that careful thought should be given to distances between multiple active elements—and, more broadly, to the interactive's underlying conceptual design—to minimize the number of closely-spaced active elements where possible.

Roll-Up and Under

As noted earlier, the question of how visitors in wheelchairs roll up to an exhibit is fundamental. There is an important experience difference between interacting with a touch table in Side and Forward Reach scenarios. The Smithsonian Guidelines do not address modern touch tables in which content and controls are integrated on single surface: "Locate controls (e.g. levers, buttons, track balls) so that they are within reach range of a wheelchair user and unobstructed by shelves or furniture.³" These guidelines are based on the idea that visitors are simply pushing a button, moving a lever, or controlling a trackball, while the content or reaction may appear elsewhere. However, with most digital touch table exhibits, the table surface includes both the interface and the content in close proximity. In these instances, it is important that visitors are directly facing the actual content and can interact with it comfortably.

To make tables that allow accessible Forward Reach in every instance requires that touch tables have adequate space beneath the tabletop to allow visitors in wheelchairs to roll up and under. Occasionally, some of our custom fabricated touch tables only allow accessible Side Reach. In these cases, competing needs might affect the final design (but accessibility concerns of any kind are always a matter for discussion with our clients).

However, all of Ideum's standard touch tables are designed with clearance to allow visitors to roll up and under. Depending on the specific model, there are some space differences beneath the table contingent on whether visitors approach from the shorter ends or the longer sides, but all can be accessed from a wheelchair within accessibility guidelines. Again, the distinction in terms of reach is whether the application is designed to meet the "strict" or "broad" guidelines we've presented here.



Visitors can roll up and under a 65" Ideum touch table at the Smithsonian National Museum of African Art. At this exhibit, content is presented along all four sides. Under the "strict" interpretation, the reach here would be 16.3" (414 mm).

³ https://www.sifacilities.si.edu/ae_center/pdf/Accessible-Exhibition-Design.pdf, pp 29-30. Retrieved February 6, 2020.

Drafting vs. Flat Touch Tables

The angled drafting table format is not directly addressed in either the ADA or European Telecommunications standards. However, several related issues are addressed, and we can make some assumptions about accessibility of this format based on those guidelines. First, in terms of reach, items above the table have maximum reach guidelines that exceed the distances for items on the surface. From that, one could extrapolate that the accessible reach limits for an angled drafting-style table or kiosk would be no less than the established “broad” standard of 24” (610 mm) maximum (and could in fact be greater).

Using the flat surface reach standard for drafting tables as well may in fact be appropriate because a drafting table’s one-sided orientation makes it usable only from one direction, and thus primarily for single visitors or visitor pairs. Therefore, when designing interfaces for these tables, we make sure that all UI elements are within 24” (610 mm) from the edge of the screen closest to the visitor—the same as for a flat table. As we noted earlier, this is not a concern for most display sizes (43”, 49”, and 55”). However, for 65” drafting tables, which measure 35.6” (904 mm) from the display’s front edge to the top, interface elements need to be presented on the lower two-thirds of the screen. (This is good practice in general, because locating navigation elements at the top of the screen can mean that people’s arms could obstruct content. Additionally, long reaches can also cause fatigue, especially in older users.)

For this form factor, the “strict” interpretation would be the same as with flat tables: it would be dependent on the size of the display. The angle of a drafting-style table would seem to make the table’s surface more accessible in a front facing approach. However, with the “broad” interpretation already established based on ETSI and ADA side approach guidelines, a more liberal set of standards is already available.

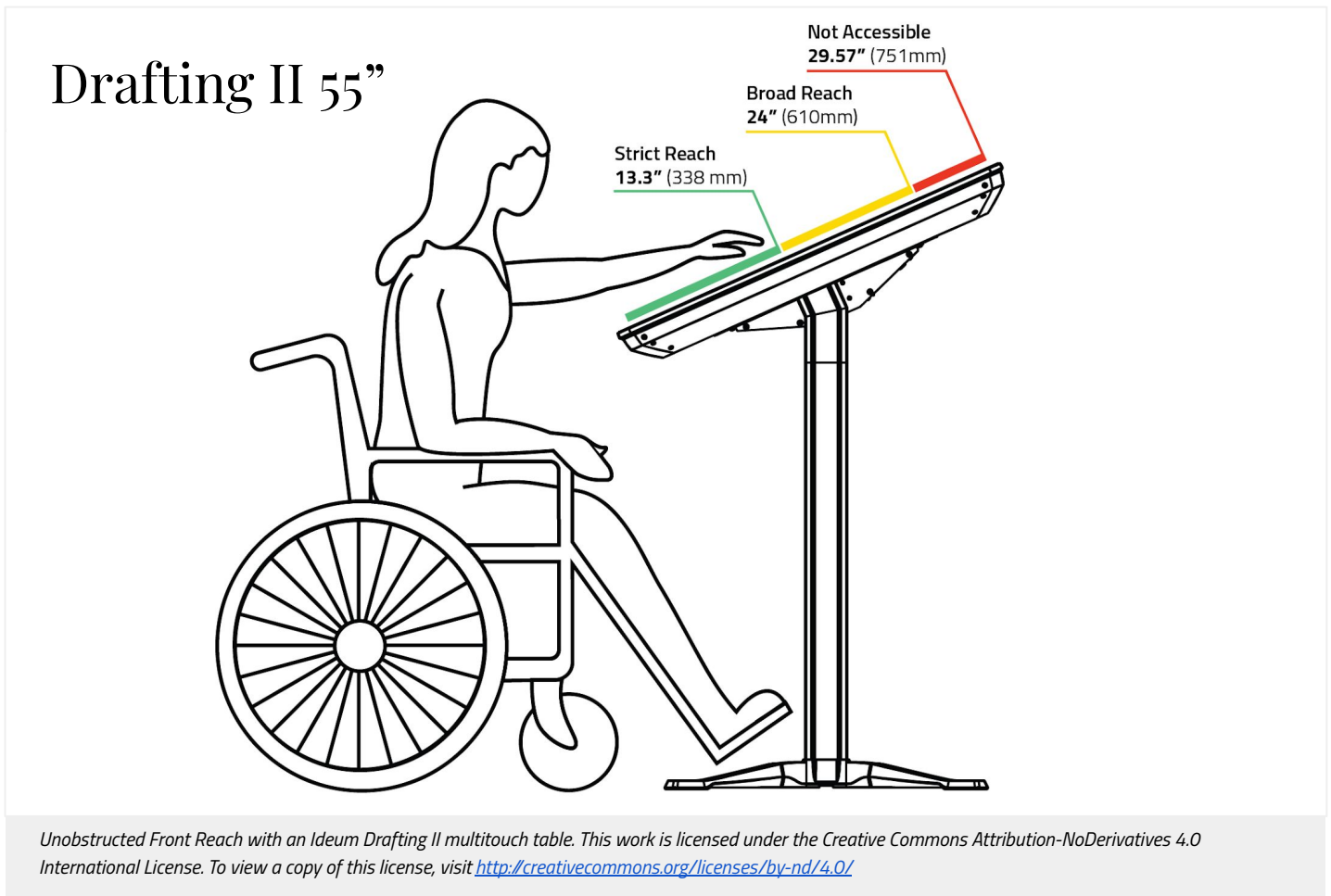


The Ideum Drafting II touch table.

Drafting vs. Flat Touch Tables

A related challenge with all touch tables, whether horizontal or angled, is presented by glare from ambient lighting. Glare is an important issue because these tables have glass surfaces and are often located in environments with specialized or directed lighting. The Smithsonian Guidelines address this issue in multiple sections. Importantly, because of their different viewing angles, visitors in wheelchairs or who are short in stature might see glare where others don't. This strongly suggests that testing includes viewing from lower-than-standard viewing angles so that the issue can be caught and corrected during design and installation.

In addition, viewing angle can sometimes be less than optimal depending on how the installation's larger context affects the position and point of view of visitors, making it difficult to perceive all content elements. This issue is not addressed in the guidelines we have consulted. With some installations, it may not be possible to completely eliminate this problem, but it can be mitigated by optimizing the quality of the monitor and touch sensor glass. (These are factors that Ideum takes into account as we design our touch tables and displays.)



Wall Mounted Displays and Portrait Kiosks

Our [Portrait vertical kiosks](#) and [Presenter](#) displays conform to ADA and European Telecommunications Standards Institute guidelines, but there are some considerations to keep in mind when designing experiences for these form factors. First, although guidelines for touch tables may require more active interpretation, clearer established standards for wall-mounted and vertical kiosks do exist. (This may be because wall-mounted graphic panels have been fundamental elements in museum settings for far longer than digital interactives.)

The Accessibility Requirements for ICT Products and Services from the European Telecommunications Standards Institute clearly show 15" (380 mm) minimum and 48" (1220 mm) maximum reach for Unobstructed Forward Reach—distances which align exactly with the Smithsonian Guidelines. However, for Unobstructed Side Reach, European and American standards differ. The European standards present minimum and maximum distances that are the same as Unobstructed Forward Reach, while the Smithsonian Guidelines present a slightly wider range, with a 9" (230 mm) minimum and a 54" (1370 mm) maximum.

For large mounted touch displays like Ideum's Presenter models, following the 15" (380 mm) minimum and 48" (1220 mm) maximum distances for Unobstructed Forward Reach provides a 33" (832 mm) range where interaction is accessible for all visitors. This means that our 43", 49" and 55" Presenter displays would be fully accessible if mounted according to these guidelines. Even our larger 65" display would be largely in compliance, with a 35.6" (904 mm) height when hung horizontally.

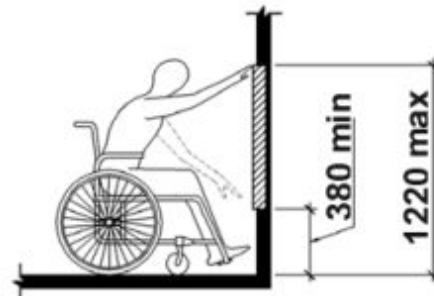


Figure 9: Unobstructed forward reach

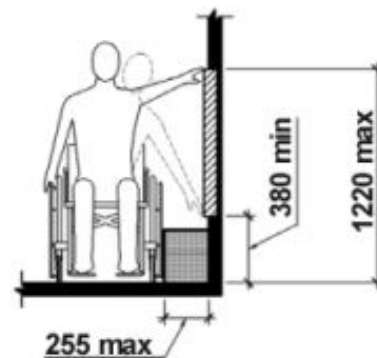


Figure 11: Unobstructed side reach

Figures 9 & 11, Accessibility Requirements for ICT (Information Communications Technology) Products and Services.

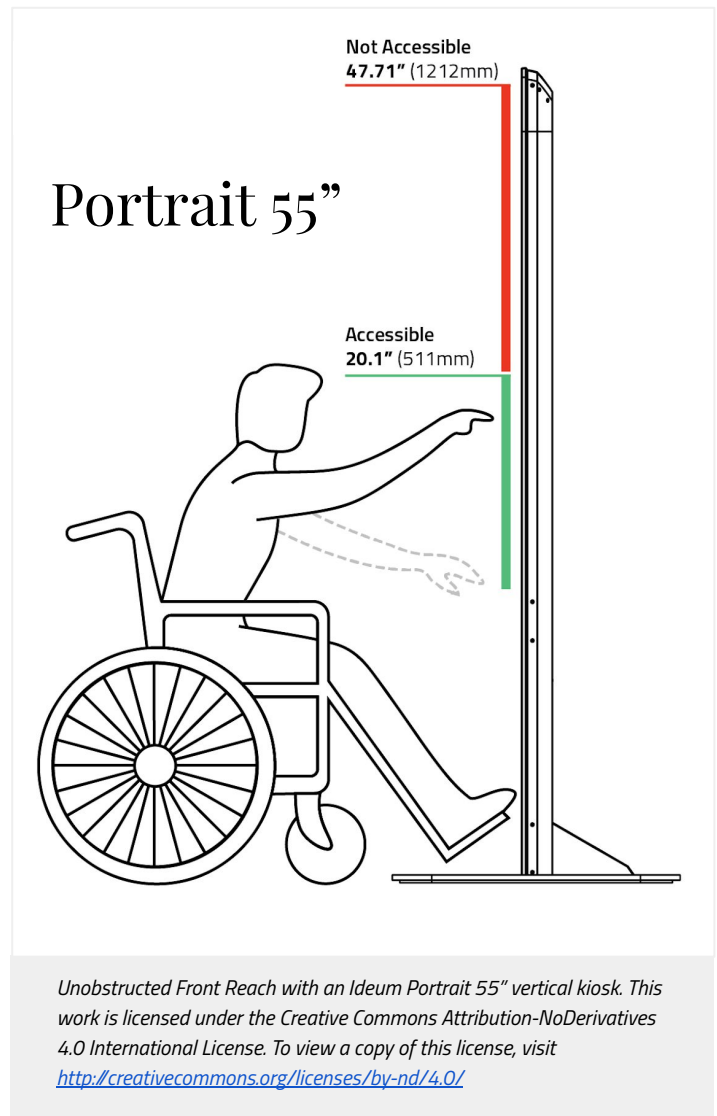
Wall Mounted Displays and Portrait Kiosks

However, it may be impractical to adhere strictly to these guidelines in all cases. For most standing adults, mounting a monitor 15" (380 mm) above the floor does not provide a comfortable height for viewing or interacting with content. Hanging monitors 24" - 36" (610-914 mm) from the floor may often be a better approach, though this does restrict the accessible "safe area" to 12" to 20" (305 - 508 mm) depending on which standard is consulted. (Note that this issue is one example of a larger challenge, mentioned elsewhere in this paper, of determining how to balance the goal of meeting or exceeding all accessibility guidelines with other design and installation goals.)

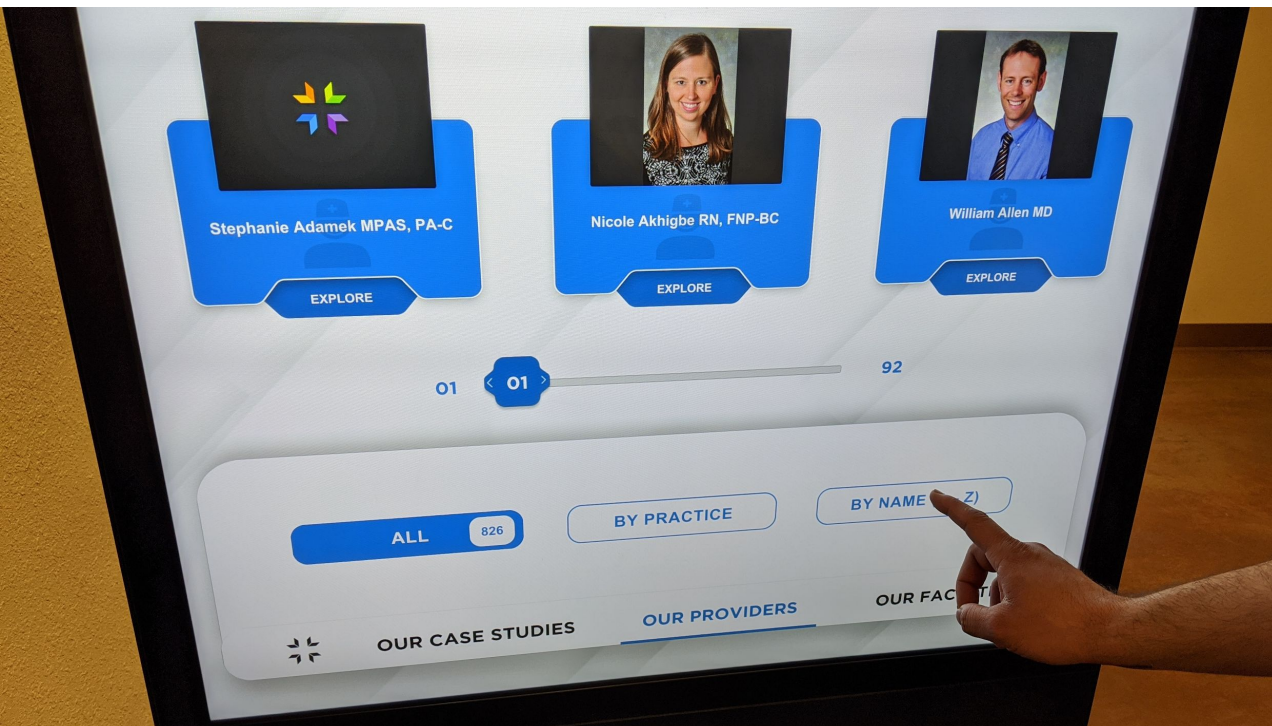
Ideum's Portrait kiosk has a vertically-aligned 55" display. In addition, it has a base plate which protrudes about 2" (255 mm) beyond the ITC Unobstructed Side Reach standard. For Unobstructed Forward Reach, we believe the base plate will normally be in compliance, because most wheelchairs can easily clear those few inches as the front wheels are usually a bit behind the chair's footrests. Still, in terms of Unobstructed Side Reach, it may be prudent to adhere to the ADA Obstructed High Reach standard rather than the ITC 48" (1219 mm) standard, as the ADA guideline is 2 inches lower at 46" (1170 mm).

The Portrait's vertical 55" display has a lower edge 27.9" (709 mm) above the base. This means that the lower 20.1" (511 mm) of the display is in compliance with both ADA and ITC Unobstructed Forward Reach standards. However, with a 47.7" (1212mm) tall visible area, more than half of the display cannot include UI elements to stay in compliance with all

accessibility guidelines. Additionally, the very bottom of the display, while technically accessible, is not *comfortably* accessible by most standing adults. As with Ideum's Presenter touch displays, we've found that placing interface elements starting approximately 36" above the floor is appropriate for most interactives. This leaves a fairly narrow area of 12" - 20" (305 - 508 mm) in the lower-to-middle third of the display for locating interface elements.



Wall Mounted Displays and Portrait Kiosks



Not unlike the alternative user interface we designed for the On the Road with Bob Hope exhibit for the National World II Museum, this exhibit, developed for a healthcare provider, has an alternative method for navigation. In this case, a single tap on a wheelchair icon moves all active UI elements to the bottom of the screen.

With such a small area that is both comfortable for most visitors and accessible to those in wheelchairs or short in stature, designers working with this form factor need to be more creative in building interfaces that work within the guidelines. In a few cases, we have developed alternative interfaces that allow access to all of the content available within an application. This approach of providing functionality in an additional interface allows us to build an experience that might use areas just outside of accessibility guidelines in one mode, but also provide an alternative mode that provides full access to all content in the exhibit.

Conclusion

As discussed above, while both the Americans with Disabilities Act (ADA) and the Accessibility Requirements for ICT Products and Services provide some guidance in terms of height and reach for touch tables and wall mounted displays, some limitations require interpretation. Neither of these guidelines factor in the idea that touch tables and displays are surface computers; instead, ADA currently views tables as a location for “exhibit controls” (such as physical buttons or trackballs), and ICT Products and Services characterizes them as “obstacles.” In either case, the table’s surface is not seen as a potential content delivery mechanism as well. Visitors certainly need to be able to reach and touch interface controls and view media elements—and touch tables and displays provide both interface and content.

With touch tables specifically, we can glean clear answers in terms of the appropriate height (under 34” / 865 mm) and reach (no more than 24” / 610 mm) for UI elements. Again, this is the “broad” interpretation; as we’ve seen, the “strict” interpretation differs based on the size of the display and the ability to roll under the table. With thoughtful UI/UX design, it is possible to adhere to the strict guidelines, although potentially with a secondary or alternative navigational scheme. It is important that at a minimum, designers adhere to “broad” standards, making their creations accessible to visitors in wheelchairs and those of short stature.

Design for wall-mounted displays and kiosks are more complicated due to the very low guidelines for the bottom of the display—15” (380 mm). As we’ve noted, this is not a comfortable height for most standing visitors. We therefore recommend hanging monitors 24” to 36” (610-914 mm) from the floor. This does limit the accessible area for interface elements to 12” to 20” (305 - 508 mm) toward the bottom of the display.

For exhibit developers, we strongly recommend interactive prototyping focusing specifically on display height. If a developer does not have access to the final display hardware, paper prototyping can still be used to determine the most comfortable location for interactive elements while using the guidelines to understand the boundaries of accessible interaction. In addition, it may be valuable to consider the *type* of museum the exhibit is being created for. For example, while staying within ADA guidelines, one might decide to hang a monitor lower for an exhibit that will be used primarily by children.

Touch tables and large displays are found in many museums around the country, as well as in an increasing number of public spaces of all kinds. Over the years, our company alone has sold touch tables and displays to thousands of museums, universities, nonprofits, and companies around the world. We hope that these considerations can play a helpful role in clarifying accessibility standards for these increasingly popular types of digital experiences.

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About Ideum



Founded in California, Ideum is a 20-year-old interactive design firm now based in New Mexico. We create meaningful experiences that use emerging technologies. We are committed to creating visitor-centric interactive experiences of substance delivered in immersive and exciting ways.

We work with museums, educational institutions, Fortune 500 companies, and other entities throughout North America and around the world. Our firm provides design services, custom software development, media systems design and installation, and custom fabrication. Our work spans the realms of informal and formal education, interactive technology, gaming, art, and entertainment. In over one hundred interactive projects, we've explored a wide range of topics in art, culture, history, science, and technology. Our 45+ employees have expertise in software and hardware design, human-computer interaction (HCI), user experience and interaction design, programming, computer vision, audio/visual systems, fabrication and installation, gaming, video and photography production, research and user evaluation, writing and editing, and museum planning.