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# Universal Design Plan

Exhibit Design  
& Development

# Universal Design Plan

## Exhibit Design & Development

In order to reach the widest possible audience, the exhibit teams at the Museum of Science and their associated contractors and collaborators will employ a universal design approach to content development and design. Universal design is defined by the Center for Universal Design as

***The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.***

A commitment to a universal design approach means that the exhibit teams will work to create experiences that are accessible and educational for a broad range of visitors along the spectrum of able to disabled. Universal design also acknowledges that the design of environments and exhibits can determine whether visitors are “able” to engage in an activity and learn from it. It also reflects a desire to create environments that promote inclusion—not “separate but equal” experiences for people with disabilities.

Exhibit teams will work to promote inclusion in the following three key areas, ensuring that a wide range of visitors can:

### **Physically interact with/perceive the space**

Is the environment inclusive so that a diversity of individuals can physically interact with/relate to the space? In other words, is the space set up so that a diversity of individuals can move around the space comfortably and safely? Is the information in the space conveyed in a variety of formats so that a diversity of individuals can perceive it? Can a diversity of individuals manipulate or cause things to happen within in the space?

### **Cognitively engage with the materials**

Is the environment inclusive so that a diversity of individuals can cognitively engage with the materials? In other words, is the information conveyed using a range of media to allow a diversity of individuals with a range of learning styles to engage with the materials? Do the materials take into account a diversity of individuals with a range of learning and cognitive skills? Do the materials take into account a diversity of individuals with range of experiences and sets of background knowledge?

### **Socially interact with one another**

Is the environment inclusive so that all individuals can socially interact with/relate to one another? In other words, is the environment generally safe and welcoming for a diversity of individuals? Is the space set up to comfortably and safely foster and facilitate encounters and engagement among a diversity of individuals? Are the materials designed to provide meaningful reasons to foster and facilitate encounters and engagement among a diversity of individuals? To ensure the physical accessibility of the exhibition and the Museum’s adherence to its legal requirements, the 2010 ADA Standards for Accessible Design will be followed.

# Process *(Project Manager)*

To ensure that the final exhibit adheres to the guidelines laid out in this document as well as to known best practices within the field, universal design checks have been integrated into the project's approval process. This section defines where in the exhibit development process the Universal Design to-dos, deliverables, and checkpoints will take place.

## Idea Development phase

No specific UD to-dos, checkpoints or deliverables

## Concept Development

- The exhibit team will brainstorm multi-sensory concepts and interactive ideas
- Develop project-specific draft of Universal Design Plan
- Eliminate unrealistic concepts (based on space, time, budget, safety, maintenance, and accessibility)
- **Deliverable:** Universal Design Plan for project
- **Approvals:** Universal Design for Exhibits Committee (UDEC) reviews and approves UD Plan

## Design & Prototyping Phase: Story Testing

- Conduct visitor evaluations of Stage 1 prototypes for visitor learning and engagement and for usability of component
- Exhibit design team will develop potential logos, typefaces, and graphic treatments, which will have a UD review
- Eliminate unrealistic concepts (based on space, time, budget, safety, maintenance, and accessibility)

## Design & Prototyping Phase: Beta Testing

- Conduct visitor evaluations of Stage 2 prototypes for visitor learning and engagement and for usability of component
- Conduct evaluations with people with disabilities
- Review complete exhibit experience for Universal Design
- **Deliverable:** Construction Drawings / dimensional concepts signed off
- **Approvals:** Expanded team (including UDEC) review each component in complete drawing packet

## Build & Install Phase

- Check in with UDEC on any changes to components or layout

## Post-Opening Phase

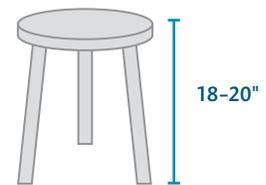
- Append the Universal Design Plan with any changes, findings, and future recommendations

# Overall Exhibition *(Exhibit Designer)*

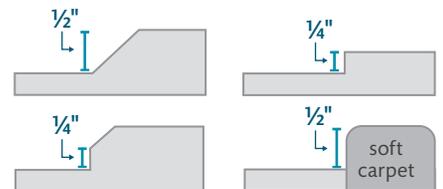
Does the exhibition provide a space that is comfortable and welcoming, both physically and mentally, for a broad range of visitors?

- **Create effective lighting** of exhibition that sufficiently lights objects and paths. Suggested lighting levels:
  - Ambient lighting: 50-300 lx; 5-30 fc
  - Text panels: 100-300 lx; 10-30 fc (avoid shadows on labels)
  - Controls: 100 lx; 10 fc
  - Directional signage: 200-300 lx; 20-30 fc
  - Specimens, objects: 100-300 lx; 10-30 fc
  - Ramps, stairs: 100-300 lx; 10-30 fc
  - Visitor pathways: 100-300 lx; 10-30 fc
- Control the effect of **ambient noise** from inside and outside the exhibition.
- **Eliminate** unnecessary flashing lights and other **visual distractions**.
- Provide stools (18"-20" high) for experiences requiring interactions longer than 30 seconds. *Fig. 1*
- Provide **comfortable seating** throughout the exhibit (in addition to seating at exhibit components.)
- Provide **quieter spaces** for visitors to rest and isolate themselves from crowds, if possible.
- Design for **easy wayfinding**. Tools include advanced organizers, demarcation of exhibit sections, and guidance for visitors who are blind.
- **Flooring transitions** should be less than 1/2", 1/4"-1/2"; ramps required at 12:1. *Fig. 2*
- Leave room for **wheelchair navigation**. Provide turning space of 60" diameter or a T-shaped space. *Fig. 3*
- Provide **wheelchair clearance** in straight and turning hallways as shown in *Fig. 3*
- Provide **door clearance** as shown depending on direction of approach and which way the door opens. *Fig. 4*
- Audio handset should be located on the left of the interactive, with a 1" square button.
- Include open captioning in all audio and video, and provide printed labels for all audio content.

*Fig. 1*  
Stool height



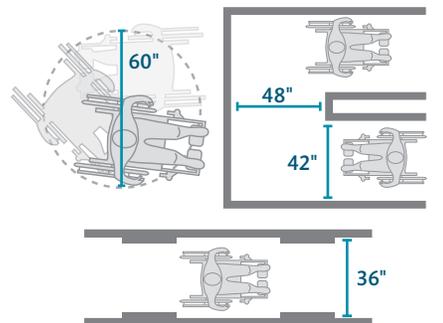
*Fig. 2*  
Flooring transitions – options  
maximum measurements



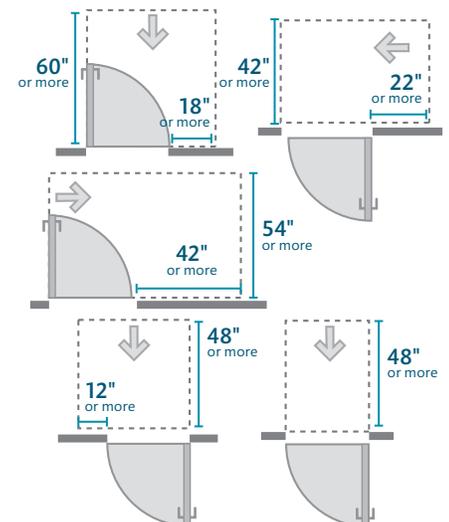
Ramps



*Fig. 3*  
Wheelchair clearance  
minimum measurements



*Fig. 4*  
Door clearance – options



- Allow **circulation space between exhibits**. Whenever possible, leave 60" between exhibit elements. In situations where this is not possible, a minimum width of 60" is required (for clusters of components). *Fig. 5*
- Remove **overhanging objects**. Any objects between 27" and 80" above the floor must protrude less than 4", or be designed to be cane detectable (e.g., by using table legs on the corners of a component or by placing an object permanently on the floor below the protruding object). *Fig. 6*
- Freestanding signs should be designed according to *Fig. 7*.
- If head clearance is less than 80" in any given location, a cane-detectable object (27" or shorter) should be incorporated at that location. *Fig. 8*

## Content Development *(Exhibit Developer)*

Can a broad range of users receive the informational and instructional content that the interactive delivers? Can they participate in meaningful activities that support the educational goals of the exhibition?

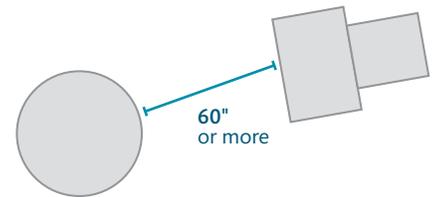
- Communicate main messages using **multiple modes**: audio, text, images, artifacts, tactile graphics or models, and interactives. Examples include soundscapes and lightscapes, *Weighing Your Risk for Heard Disease* (from *Secrets of Aging*), and *Science in the Park* seesaws.
- Ensure the different modes support each other. For example, initial language for audio and text is the same; graphics repeat ideas and directly relate to the written text.
- Use a range of multisensory activities to engage visitors of varying sensory abilities/disabilities in the exhibit's main ideas.
- Include a main title, introductory paragraph, or question(s) to introduce the primary message(s) of an activity or area.
- Communicate the main ideas using the simplest possible language. Avoid jargon and unnecessarily complex sentences. Use an appropriate language level for the intended audience.

## Incorporating Audio

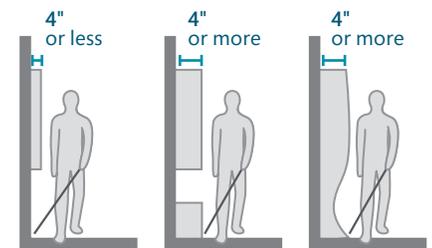
*(Exhibit Designer, Tech Designer)*

- Use audio labels to read aloud all text that communicates content and/or instruction and to describe videos, images, and other visual media. *See Appendix A for more details about audio labels.*
- Incorporate audio, tactile and visual feedback elements into the interactive wherever possible.

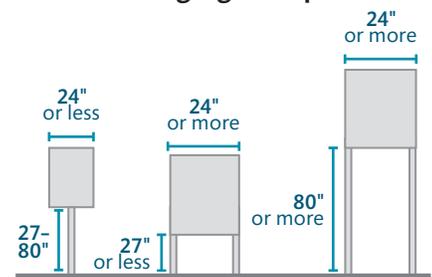
*Fig. 5*  
**Circulation between free-standing components**  
*Recommendation*



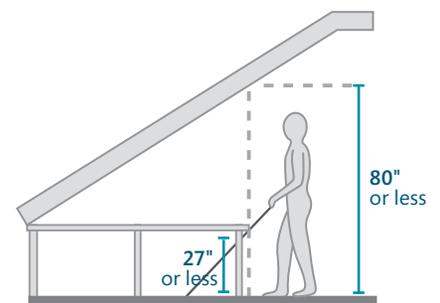
*Fig. 6*  
**Protruding objects – options**



*Fig. 7*  
**Free-standing signs – options**



*Fig. 8*  
**Head clearance**



# Mechanical Interactives

(Exhibit Designer, Technical Designer)

- Make table tops 27" high (from floor to the bottom of the table). This is high enough to allow wheelchairs to pull underneath, but low enough to be detected by a cane and for children to access. *Fig. 9*
- Build table tops a minimum of 17" deep. This is deep enough for a wheelchair to pull underneath. *Fig. 10*
- Wheelchair pull in should be a minimum of 36" wide. *Fig. 11*
- Place interactive elements, such as buttons, switches, handles, and flip labels within easy reach. Depth for obstructed reach, such as on a table-top interactive: no more than 11" from the edge of the table. However, elements should be placed as close as possible to the front edge of the table. *Fig. 12*
- Height for unobstructed side reach, such as on a wall: between 36" and 48", so that the component can be reached by individuals of a range of heights, such as children, tall adults, and wheelchair users.
- Provide room for visitors to rest their hands near the edge of the table surface.
- For physical controls, provide elements that allow for easy grip and release.
- Mechanical actions and movements should not require excessive force to move and stop.
- Incorporate powered systems to assist with mechanical actions that may be challenging.
- Incorporate audio and tactile feedback with the movement of the controls if specific settings or stops are important.

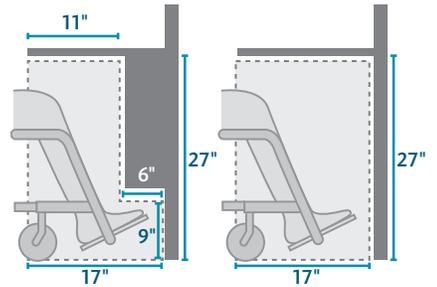
# Software Development

(IIT, Technical Designer, Graphic Designer)

- Standardize the user interface across interactives within an exhibition, and across the Museum, whenever possible.
- This includes using a clear, consistent layout for presenting information within interactives.
- Choose an easy-to-read font and appropriate graphics. (Follow guidelines in "Graphic Design" section of this document.)
- Provide the option to read aloud text appearing on the screen.
- Write text that makes sense when read aloud and not viewed

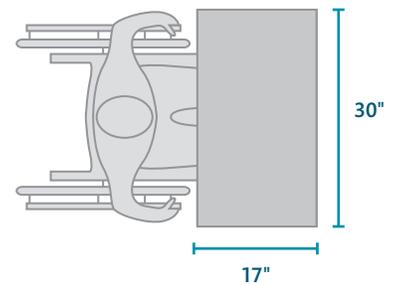
*Fig. 9*

**Wheelchair pull under – options**  
minimum measurements



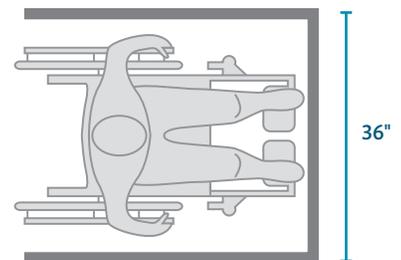
*Fig. 10*

**Pull under**  
minimum measurements



*Fig. 11*

**Pull in**  
minimum measurements



graphically (for example, "Return to main menu" rather than "Main Menu").

- Present information in a clear, consistent, and repetitive layout. Menu text should consistently be presented in a left-to-right or top-to-bottom layout throughout the interactive. *Fig. 14.*
- If possible, limit the number of choices available on the screen at any one time to between five and seven.
- Give visitors control over the pace at which they receive information, including warnings when a computer times out.
- Use open captions for videos and non-text-based audio.
- Use alternatives to color-coded cues.
- Minimize use of flickering and quick-moving images.
- For computer interactives using physical buttons: *Fig. 13*
  - Use clear mapping between the buttons and screen images.
  - Place buttons on a slanted surface near the edge of the table.
  - Clearly label buttons.
  - On-screen elements shouldn't look like touchscreen elements.

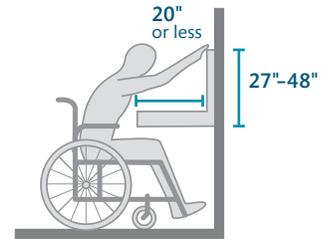
## Video and AV *(IIT, Media Producer)*

- Write descriptive content into the narrator's script, so that visitors who are blind have a sense of what is happening on screen. For visual-only videos, provide audio description.
- Minimize use of flickering and quick-moving images.
- Narrate menu text and have these files interruptible when visitor selects a video.
- Open caption all videos as follows:
  - Shoot and edit videos to allow adequate space on-screen for captions.
  - Place captions at the bottom of the screen.
  - Synchronize audio content with captioning.
  - Include sound effects in captions, when applicable to the content.
  - Show no more than two lines of captions on-screen at any one time.
  - Erase the captions from screen all at once; do not erase them by scrolling.
  - Write caption text in a sans serif font with proportional spacing.
  - Caption speakers' exact words. (Eliminating words to facilitate ease

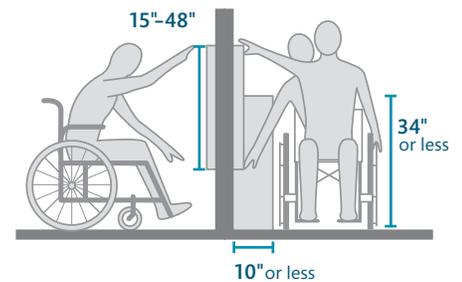
**Fig. 12**  
**Reach**

When possible minimize forward reach

Obstructed

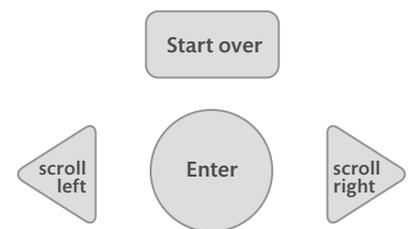


Unobstructed



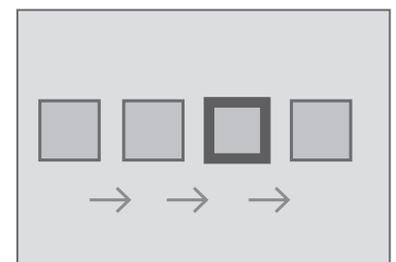
**Fig. 13**

**Screen-based button layout**



**Fig. 14**

**Screen design**



of reading should be balanced against the confusion created when captions do not match audio or lip movement.)

## Graphics *(Graphic Designer)*

- Font should be discussed with UDEC as part of the graphic planning for the exhibit.
- The font should allow for capitals and lower-case characters.
- Body text should **not** be in the following font styles: script, distressed, handwriting, distorted, overly decorative, stencil, etc. unless it is used as a design element only and the content can be found elsewhere.

*Fig. 15*

- Font should have regular/roman weights and italics.
- Body text should be set at a minimum of 24 pt; ideal text size is 28-32 pt. *Fig. 16*
- Body text should be set in the regular/roman weight of the typeface, not bold or italics. *Fig. 17*
- Leading (line-spacing) should be 20% larger than the font size. *Fig. 18*
- Line length for paragraphs of body text should be 45-55 characters. If longer line lengths are needed, 65 characters is the maximum length. *Fig. 18*
- Body text should be left-justified, with no hyphens at the end of lines. *Fig. 19*
- Italics should only be used when grammatically necessary.
- Body text and essential content should not be set in all caps. Titles and design elements may be set in all caps, used sparingly.
- Background behind text should be as plain as possible—solid backgrounds are strongly preferred, i.e., no images, gradients, or patterns.
- Contrast between text and background should ideally be 70% for text sizes smaller than 36pt. *Fig. 20*
- To accommodate visitors who are colorblind, no red/green or blue/yellow color combinations should be used.
- Attach tactile parts to labels when the activity uses loose parts.
- Labels should be printed with a non-glare finish.
- Labels intended only to be read (non-interactive) should be hung between 42"-70", and centered at 52"-54".
- Use slant labels when placing labels on a table surface. Use a 60°

*Fig. 15*

### Typeface choice for body text

Use simple **sans serif** and serif typefaces

Don't use these styles:

*Script*

*Handwriting*

**STENCIL**

(exceptions for titles made on a case by case basis)

*Fig. 16*

### Minimum size body text

(exceptions for small ID labels)

22pt body text

### Ideal size for body text

28–32 pt  
body text

*Fig. 17*

### Type styles for body text

Do not use ALL CAPS

Do not use **bold**

Use *italics* sparingly

*Fig. 18*

### Line length and leading

Line length: 45–55 characters

The ideal line length is about this many characters  
Leading should be at least 120% of type size  
120%

*Fig. 19*

### Hyphenation

No hyphenating words

slant for those viewed while standing; use a 30° slant for those viewed while seated. *Fig. 21*

## Artifacts/Objects *(Exhibit Designer, Exhibit Developer)*

- Use touchable artifacts for items essential to the exhibition's main theme, or include touchable replicas of artifacts, with comprehensive audio description.
- Display artifacts against a simple, high-contrast background (at least 70% contrast between foreground and background).
- For cases mounted flat on a pedestal or deck, the top of the case should be a maximum of 36" above floor level.
- When possible, provide at least 100 lux (10 fc) of light on an artifact. If sensitive materials require less than 50 lux (5 fc), position the item to allow visitors to approach it as closely as possible, and present the artifact in an alternate format (reproduction or photograph) that can be viewed in a brighter location.
- Mount objects so they do not protrude more than 4", or so that they are cane-detectible (bottom edge below 27").

## Evaluation *(Evaluator)*

Have a broad range of users been included in evaluating exhibit concepts and prototypes throughout the exhibit development process?

- During Concept Development phase, the exhibit team will consider whether including people with disabilities in early formative evaluation, such as focus groups, would be pertinent.
- Conduct evaluations of Stage 2 prototypes with people with a wide range of abilities and disabilities for usability, learning, and engagement. Ideally, test a cluster of prototypes rather than single components.
- The exhibition team will ensure that the component adheres to the UD requirements for exhibition design to the greatest extent possible, as stated in the above section, when this evaluation takes place.
- Evaluators will recruit people with a range of disabilities—e.g., sensory, physical, cognitive disabilities—for evaluation.
- Evaluators will use think-aloud protocols or other usability testing methods to identify potential barriers to inclusion, in addition to general formative evaluation interview.

*Fig. 20*

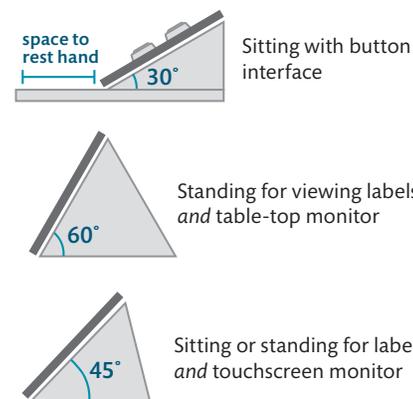
### Contrast for body text

Contrast should be between 70% and 95%

*Fig. 21*

### Slant surface angles

Recommendations



- Evaluators will include relevant exhibit team members during data collection.
- Evaluators will facilitate brainstorming of solutions to barriers identified with exhibit team.
- When conducting formative evaluation with visitors recruited from the general visiting public, evaluators will note when contextual disabilities impair their usage or understanding of exhibit components (e.g. loud background noise interferes with the ability to hear audio), or when specific accessibility-related feedback is shared.

# Appendix A

## Audio Labels

The best audio labels are written with all users in mind, not just those with visual impairments. While it is true that audio labels give someone who can't see an auditory description of what is there, we know from our research that many different types of visitors use our audio labels. They are particularly helpful for sighted visitors who want to read along with the audio text, for younger children learning to read, for those who might speak English as a second or third language, or for those who have learning disabilities. It is important to consider all users when writing audio labels.

Any text on the exhibit component should be read aloud word for word as it is printed. This is particularly important when a visitor is reading along with the audio. Some flexibility is allowed; for example, if you need to modify a bulleted or numbered list (e.g. voicing number one, number two, etc. or adding numbers if they aren't in the written label) in order to improve a visitor's retention of the content. However, it is best if the text label is written with the audio label in mind. The printed text should be written so it can be read aloud. This also helps parents and others who choose to read the label aloud to a group. The best way to achieve this is to read it aloud as you write it and make changes based on how it sounds.

Buttons for our audio labels are uniformly a one-inch square button located on the far left side of the component.

### One-button audio labels

This section summarizes our current consensus on best practices. We have many years of experience with one-button audio labels. Based on evaluations with visitors with disabilities, we propose the following by way of standardizing our practice. An initial button press starts the recording. A second button press always interrupts the recording to bring you back to the beginning.

1. State the title/name of component.
2. "You are going to hear the written text of the label. Keep listening for a description of ..." followed by a brief description of the component.
3. Read aloud the written text of label.
4. "Keep listening for a description of ..." what to do, how to use the computer or the objects, etc.
5. Describe component/artifact/area. See "Use descriptive language" below for more tips.
  - a) What to do/how to do it
  - b) What you can't see - artifact/description
  - c) Way-finding (e.g. nearby components, overall exhibit layout)

### Two-button audio labels

We have only recently begun to experiment with two-button audio labels, so this represents our best thinking of what we would like to try next. We will continue to amend all of this as we learn more.

The decision to use one- or two-button systems is currently determined by the length of the printed label and whether or not it can be broken up into discrete, stand-alone sections.

The first button (a one-inch square button) is used to provide an overview of the component/area and to read any introductory text. Each time it is pressed, it starts this same text again from the beginning. It also resets the triangular button to the first selection. The second button (a small triangle) is used to scroll through additional items. These may be descriptions of individual object labels or additional sections of text. Each time the button is pressed it interrupts the current selection and moves on to the beginning of the next section.

### **Square button**

1. State the title/name of component.
2. "You are going to hear the written text of the label. Keep listening for a description of ..." followed by a brief overview of parts of activity/component, including reading text of an intro label if appropriate.
3. "On this audio phone are two buttons: a square button on the left and a triangular button on the right. Press the square button at any time to hear this introductory label and a description of the activity. Press the triangular button at any time to listen to ..." then describe audio tracks.

### **Triangular button**

1. Start each section with something along the lines of, "This is the [first/second/etc.] of n [labels/artifacts]", modifying as appropriate for the context.
2. In one sentence/phrase describe what the section is about, and say "Keep listening to hear more details. To go to the next [item/artifact description/etc.], press the triangular button."
3. Read the text/description and give a more detailed description of the artifact/graphics.
4. "To hear the next [item/artifact description/story/etc.], press the triangular button again. To hear the introductory label, press the square button on the left."

## **Bilingual audio labels**

We have only started thinking about bilingual printed and audio labels. We look forward to learning from our more experienced colleagues as we move into this area.

## **General guidelines**

Start the audio label with a brief overarching statement that says what the component is about and also orients visitors as to what they can do at an interactive.

For example, statements such as: "How do you prevent a disease from spreading within a fish tank? Use this computer simulation model to figure it out." tells visitors what it is they are expected to do (stop a disease from spreading in a fish tank) and how they will do it (by using a computer simulation).

Provide detailed information on “What to do” at the end of the audio label, rather than at the beginning. Limits of auditory working memory mean that it is harder to remember what you are supposed to do at an interactive if, following the directions, you then need to listen to two minutes of content.

Every word counts. Audio labels should be as short as possible – 2-3 minutes maximum – so that the listener does not have to work hard to remember a very long label. Think about which details are important to tell visitors about through audio, and which details are less important.

For example, the color of an interactive may not be important, unless it is being used as an orienting device. Some people with low vision can see color, so do not ignore it altogether. When describing an artifact, color and texture are important and should be included.

If an activity has a part that cannot be done by a visitor who is blind or has low vision, mention that this part of the activity is there and generally what it’s about.

For example, the pyramid activity in Making Models has a tactile pyramid model and a photo activity. Most of the description is about the tactile pyramid, but the audio label indicates that the photos are there and why. This is important so that a visitor who is blind can be included in the whole experience by at least knowing about the photos, even if they can’t participate in that part of the experience.

## **Use descriptive language**

- Order of description tends to go from left to right. Describe the items on the left first and then move to the right. For example, “To the right of this audio phone is a widget. Farther to the right is another widget.”
- You can also use a clock face as an orienting device. For example, “At 2 o’clock you’ll find a round button...”
- Refer to exact tactile clues as much as possible. Say “round button”, not just “button”, so that visitors are certain that they are doing/touching what you are expecting them to touch.
- When describing an artifact, mention the color (particularly if the color is important to doing the activity). Don’t forget texture (shiny, dull, soft, etc.).
- Oddly-shaped items can be described by comparing them to other things or by “breaking up” the item into pieces. For example, “the Mars meteorite is a thin wafer the size of a stick of gum.” Or, “this glass vase has a base shaped like a grapefruit with a long neck extending out of it like a goose’s.”
- Use the word “label” instead of the phrase “graphic panel.” Include details such as “label with text and pictures” as necessary.

## Resources

<http://www.adinternational.org/>

<http://www.artbeyondsight.org/mei/verbal-description-training/>

[http://ncam.wgbh.org/experience\\_learn/educational\\_media/stemdx](http://ncam.wgbh.org/experience_learn/educational_media/stemdx)

<http://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards.pdf>

Unless marked as recommendations, all listed legal requirements are taken from the 2010 ADA Standards for Accessible Design.

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