Universal Design Guidelines for Public Programs in Science Museums

Results from the December 2007 Charrette

Produced by the NISE Network

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This report was based on work supported by the National Science Foundation under Grant No. ESI-0532536. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the author(s) and do not necessarily reflect the views of the Foundation.

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Introduction

There is no such thing as a “typical” museum visitor. Visitors are a diverse group, and included among them are people with and without disabilities. Developing educational experiences that meet the needs of this diverse population can be a challenge. One way to address this challenge is to utilize a concept called universal design, which is a framework used to create products and environments that reflect the needs of a broad range of users. The guidelines presented in this report focus on the universal design of public programs. These guidelines describe ways educators can develop and implement programs such as interpretation carts, stage demonstrations and science theater so that they are inclusive of the wide range of visitors who visit museums and provide access for all to the rich learning experiences museums afford.

About universal design

According to the Center for Universal Design, universal design is defined 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 (Center for Universal Design, 2002).*

Universal design should not be confused with a one-size-fits-all design approach. Instead, universal design encourages the adoption of designs that promote flexibility and choice, thus enabling different users to interact with the same design in different ways. Multiple organizations have developed principles of universal design that can be used to guide the design of products, environments and curricula so that they are inclusive of people with disabilities (Bowe, 2000; Rose & Meyer, 2002; Story, 1998), and all of these guidelines focus on providing users with multiple options, flexibility and choice.

Another common feature of universal design is an emphasis on cognitive access and social inclusion, focusing beyond physical access (Blamires, 1999). For museums, this means we strive to create learning environments where people with and without disabilities can:

- Successfully move around a physical space and interact with design elements in a comfortable and inviting way;
- Understand the main ideas and concepts presented in an exhibition or program; and
- Participate in learning as a part of a social group, working alongside friends and family members who may or may not have a disability.

Universal design is not the only method used to create museum experiences for people with disabilities. Other approaches include accessible design and assistive technology. While the terms universal design, assistive technology, and

accessible design are often used interchangeably, there are subtle differences in these approaches that define the end product (Story, Mueller, & Mace, 1998). Assistive technology focuses on personal products tailored to meet specific needs, such as a wheelchair. Accessible design generally refers to designs that adhere to specific codes (such as ADA). Universal design strives to create experiences that are accessible to users along a broad spectrum of abilities and disabilities. Prior research has found that when designs are created to be inclusive of people with disabilities, the result is an end product that is improved for people without disabilities as well (Danford, 2003, 2004; Davidson, 1991; Reich, 2006).

In many ways, universal design as an approach for inclusion is more suited to museum environments than assistive technology or accessible design. One reason is that museums are learning environments where people visit and learn in social groups such as families or school groups (Ash, 2002; Borun & Dritsas, 1997; Leinhardt, Crowley, & Knutson, 2002), and universal design enables people with disabilities to participate in learning alongside people without disabilities. Another reason is that universal design offers flexibility and choice with regards to what interactions people choose to participate in and how they choose to participate, and the ability for visitors to choose when and how they learn is an essential aspect of museum learning (Falk & Dierking, 2000).

About the guidelines and how they were developed

Museum educators can use the following set of guidelines to develop and implement programs that reflect universal design and are inclusive of visitors with and without disabilities. This document is a work in progress, and we expect these guidelines will grow and change as we develop and test more programs that reflect the principles of universal design. In this way, this document should be considered the beginning of a conversation, not an end point. These guidelines are also not exhaustive and do not provide details on all of the ways you can design a program that is inclusive of visitors with disabilities. Every program and situation is different, and the best way to ensure that a program is inclusive of the broadest possible audience is to involve people with disabilities from your local community in the development of that program.

The guidelines were developed through a design charrette held at the Museum of Science, Boston on December 6 and 7, 2007 on behalf of the Nanoscale Informal Science Education Network (NISE Net). A design charrette is an intensive effort to develop a new or innovative design that takes place over a short period of time and involves people of diverse backgrounds and areas of expertise. During this charrette, four experts from the field of universal design who have disabilities worked together with 20 museum professionals representing six museums to revise and refine four public programs (including stage demonstrations, interpretation carts, and a science theater play) to make these programs more inclusive of visitors with disabilities. During this process, museum evaluators captured comments made by the universal design experts and the museum

professionals about ways to improve these programs, and then grouped these comments into similar categories. To do this, we used the framework for Universal Design for Learning developed by CAST (http://www.cast.org) loosely as a guide (Rose & Meyer, 2002). Afterwards, five museum visitors representing various disabilities viewed the programs and provided further feedback. The guidelines were then revised again.

Framework for considering the universal design of public programs
Three main concepts emerged from the charrette that museum educators can use to frame their thinking when developing and implementing museum programs that are inclusive of people with and without disabilities. These main concepts include the following:

A. ***Repeat and reinforce the main ideas and concepts*** by communicating the message through multiple media and representing these ideas in different ways. Learners have different preferences and needs for receiving information. Some learn best by listening, others by touching and still others through visual images. Reinforcing the main ideas by presenting them through various media is therefore an important part of universal design. Learners also have different capabilities for attending to content as they have varying attention spans and differing abilities when it comes to remembering details (such as visitors with cognitive disabilities or attention disorders). Also, what a learner remembers is not just a function of physical capabilities, but also of their surrounding context. For example, a woman holding a crying six-month old on her lap will have a different level of ability to remember details than if she attended the museum on her own. For these reasons, frequent repetition of main ideas and concepts by presenting and re-presenting core concepts in different ways is an essential part of creating inclusive programs.

B. ***Make multiple entry points and multiple ways of engagement available.*** Visitors have different levels of understanding of the content, and different life experiences. This influences the types of concepts, analogies, and examples that resonate with visitors. For example, not every visitor knows what sound a heart makes, because some visitors have never heard this or any other sound. Also, not everyone knows what it is like to ride a two-wheeled bike (either because of where they live or their physical capabilities) so only relying on that one analogy may limit who can understand your message. For this reason, it is important to present multiple examples to provide visitors many ways to connect to the content. In addition to those initial connections, continued engagement is also critical and there is a need to consider multiple ways to sustain visitors' interest and enjoyment.

C. ***Provide physical and sensory access to all aspects of the program*** (materials, presentations, room set-up, etc.) Museum visitors are diverse in their physical abilities. They vary in terms of how they navigate through an area as some will walk, some visit in wheelchairs, and others push around

wheeled vehicles like strollers. They also vary in terms of how much and what they can see, how much and what they can hear, and how comfortable they are sitting for a long period of time. Educators, therefore, should design programs and their accompanying materials with this variation in mind. For example, if a program includes a PowerPoint presentation, it is important to consider whether the text in that PowerPoint is large enough, legible enough, and has a high enough contrast to be viewed by visitors with low vision. Similarly, if the program includes tactile models for visitors to pass around, those models should be light-weight and easy for visitors of a broad range of upper body mobility to handle.

Structure of the guidelines

For the final guidelines, each recommendation made during the charrette was connected to one of the three concepts listed above. In addition, based on feedback from the educators, the recommendations were organized according to the stage of the program development (planning, design, set-up and implementation) as a method for aiding educators in implementing the suggested guidelines. As you read the guidelines, you'll notice that not every stage includes an emphasis on all three concepts, and that some concepts are more prevalent in certain stages than others. What also emerged during the charrette were ideas that were not necessary for developing programs that reflect universal design, but could be potentially useful if museum educators want to go that extra step to create a program that is truly inclusive of all learners. These ideas are identified as "Taking it to the next level" in the guidelines.

In addition to the full set of guidelines that describes the findings from this two day event, we have included some additional tools and resources in the appendices. Appendix A provides a list of helpful Web-based resources. Appendix B offers stories from each of the four educators who led the reviewed programs that summarize their own lessons learned through the charrette. Appendix C contains a universal design program critique form that is designed to help museum educators compare their programs to the universal design guidelines. You can use it as a starting point for assessing the inclusiveness of your program. To truly determine if your program is inclusive of people with disabilities, however, we recommend that you invite people with disabilities to view and provide feedback on the program.

Finally, when reading this document, many of the recommendations will probably seem familiar to you as good educational practices in general, and may not appear to be specific for people with disabilities. That is intentional. Universal design reflects a notion that there is no such thing as a "general" or "normal" visitor, and therefore it does not differentiate between what will work well for one particular audience as compared to another. Instead, the intent is to create a program that is accessible to the broadest possible range of visitors and does not unintentionally exclude any one individual based on narrow notions of what a normal visitor is like.

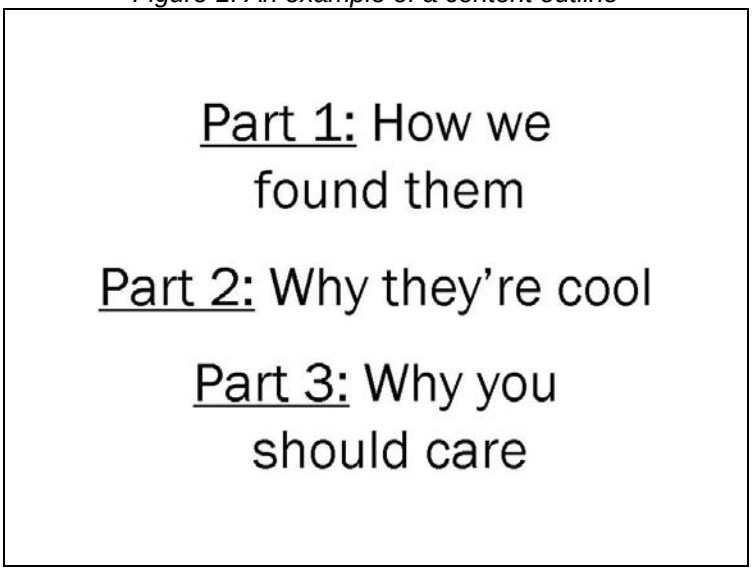
Universal Design Guidelines for Public Programs in Science Museums

1. Things to consider when you are developing the program:

A. *Repeat and reinforce the main ideas and concepts*

- Explicitly state your overarching main idea and other core concepts and use these to guide what is included in the program.
  - Narrowing down your ideas enables you to have enough time to frequently repeat the core concepts during the program and prevents against information overload.
- Break down the program into defined chunks and segments that relate to one core concept at a time.
  - Consider ways to present each concept by engaging multiple senses.
- Develop a content map or outline of your presentation that describes what concepts you will present that can be shared with the audience.
  - Content maps help visitors to follow along with presentations, aids memory for visitors who are receiving all of their information aurally (such as those who are blind), and places new vocabulary in context (which especially helps visitors who are hard of hearing and have difficulty discerning unfamiliar or unexpected words and phrases). (See Figure 1 for an example content outline)

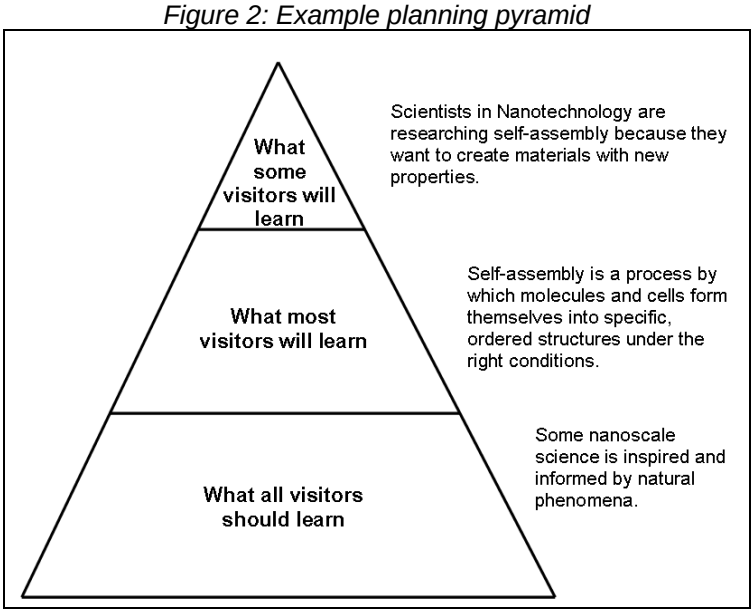
Figure 1: An example of a content outline



B. *Make multiple entry points and multiple ways of engagement available to visitors*

- Connect the content to a range of prior experiences.
  - Don't just rely on one real-world example. Try connecting what you are presenting to a few different examples from everyday life.
- Think about ways to make it fun and engaging for all learners.
  - Make sure you can get the jokes if you can't see the stage or hear the presentation.
  - Don't just rely on just visual or auditory enhancements to jazz up your program, use both.
- Consider multiple analogies for representing the same idea.
  - Use language like "You can think of X as being like a Y, but you can also think of X as being like a Z in these ways…"
- Use examples and non-examples.
  - "X is like a Y, but it is not like a W."
- Build multiple layers into the program so that different learners can enter at different places and take away different levels of messages.
  - *Taking it to the next level*: Develop a planning pyramid. A planning pyramid outlines the main idea you think everyone should know by the end of the program, and then lists related concepts that only smaller portions of the audience may come away with following their participation. This will help to ensure that younger visitors, visitors with developmental disabilities, and content novices will learn as well as visitors who are already familiar with the content. (See Figure 2 for an example of a planning pyramid)

Figure 2: Example planning pyramid



C. *Provide physical and sensory access to all aspects of the program (materials, presentations, room set-up, etc.)*

- Develop concise key phrases that support your main ideas that can be presented visually and aurally.
  - Use these during the program to punctuate main ideas and introduce the audience to new vocabulary.

2. Things to consider when designing props and materials:

A. *Repeat and reinforce the main ideas and concepts*

- Develop materials that clearly represent the main ideas visually, aurally, and tactilely while being careful not to add too much "noise" into the presentation. (See Figure 3)
  - Simultaneously presenting conflicting information can make presentations hard to follow. When using multiple modes of communication, be sure that what is communicated in each mode supports and reinforces each other and relates to the same idea.

Figure 3: Tactile models of snowflakes

- Use visual images to support what you say.
  - Graphs, pictures, charts, animations and videos can reinforce messages delivered aurally and aid understanding for visual learners, visitors who have difficulty attending to aural information, and visitors who are deaf and/or hard of hearing. (See Figure 4 for example graphs)

Figure 4: Graph with pictures to communicate the relationship between temperature, supersaturation, and snowflake shape

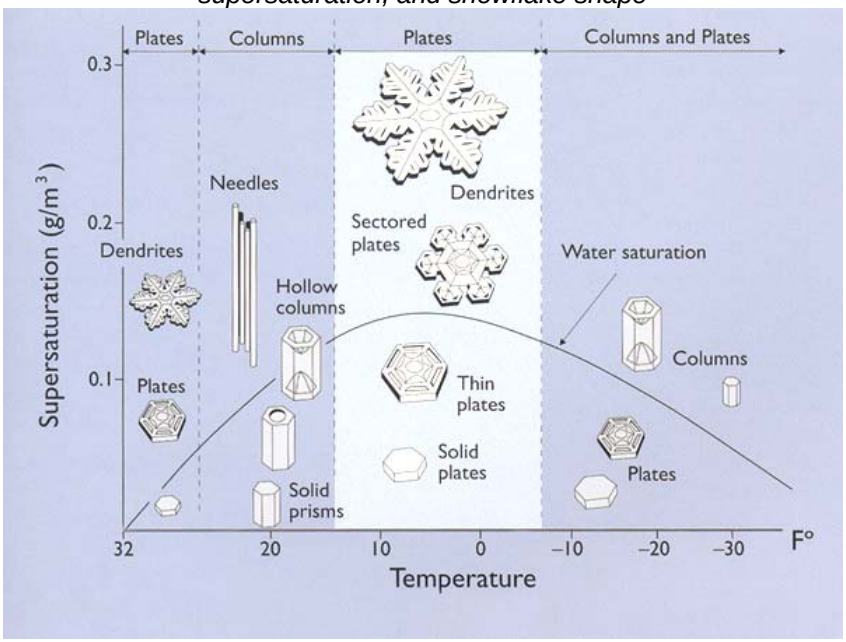


Image courtesy of Kenneth Libbrecht, Caltech (www.snowcrystals.com)

- Use models that include concrete representations.
  - For example, if you are using something to model a virus, try to make it look like a virus so that the visitors identify it as such.
  - This will help visitors who have difficulty grasping abstract ideas.
- Have hands-on activities and/or tactile elements that can be passed around that reinforce main ideas and/or engage audience. (See Figure 5)
  - Be sure to add texture and raised lines to these models to highlight important areas you want visitors to pay attention to.
  - Hands-on activities are appreciated by many learners, particularly those who are blind or have low vision.

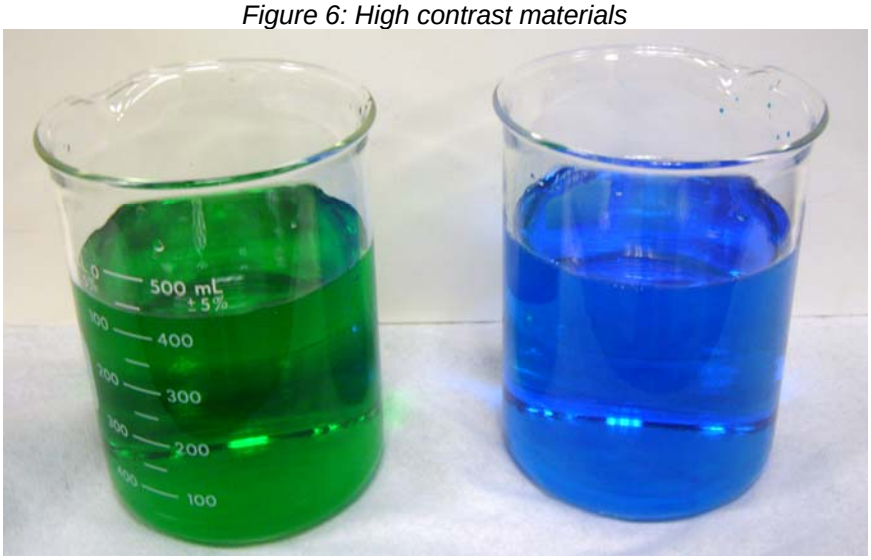
Figure 5: Carbon nanotube model

- *Taking it to the next level:* Make available information about the program (handouts) that visitors can use 1) before the program to learn more about what content will be presented, 2) during the program to follow along with what is presented, or 3) after the program to remind them of the content as it was presented. These handouts should include both visuals and text.

B. *Provide physical and sensory access to all aspects of the program (materials, presentations, room set-up, etc.)*

- Use large and high contrast text and images for all graphics and fonts that are easy to read.
  - Consider the visual accessibility of all materials, including flash cards, slideshow graphics, print on models, and drawings.
  - For guidance on making text visible, visit the Lighthouse, Inc. Website: http://www.lighthouse.org/accessibility/
  - Print accessibility is not only important for visitors who have low vision, but also for visitors who are dyslexic and read by identifying the shape of the word.
  - Use demonstration materials and models that can be seen by many at a distance (large and high contrast is best).
  - Example: If using a clear beaker, use colored water to make the demonstration easy to see from a distance. (See Figure 6)

Figure 6: High contrast materials



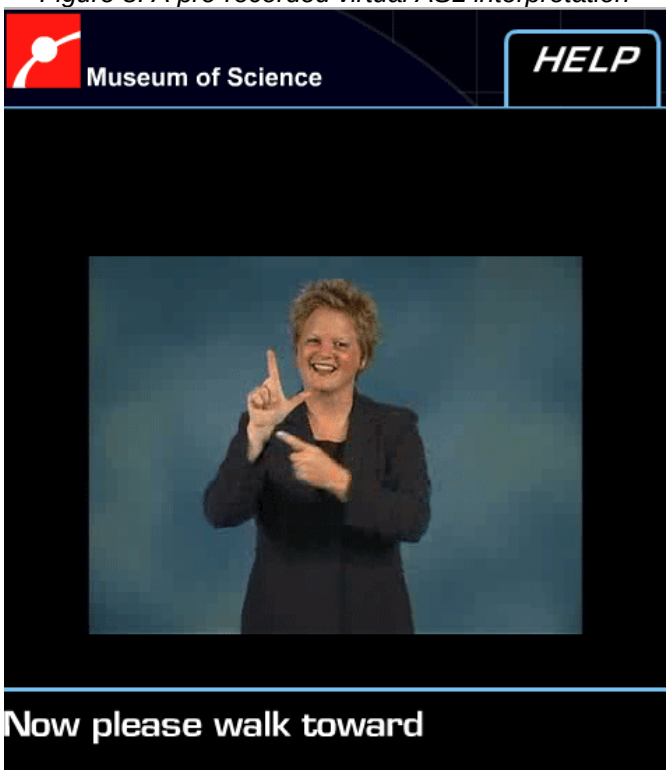
- Caption all video presentations.
  - For information about how to caption digit media, visit the National Center for Accessible Media Website: http://ncam.wgbh.org/richmedia/strategies/CC.php.
- Use color to impart meaning or draw distinction. (See Figure 7)
  - Color can be used to draw visitors' eyes towards a certain element on a model, or to a specific area of a chart or picture.

- This can help visitors who have low vision, visitors who have difficulty interpreting graphic information, and visitors for whom a certain image is unfamiliar.

Figure 7: Color helps visitors distinguish between the different sizes of rods

- Tactile models should be easy to handle and manipulate and should communicate information through touch as well as vision. (See Figure 3 for examples of tactile models)
  - Close your eyes: can you figure out what this is a model of?
  - The best models are those that require only one hand to manipulate.
- *Taking it to the next level:* Consider adding additional materials for people who are deaf, such as a video that presents ASL interpretation or a script people can read that includes images from the presentation. This is particularly useful for presentations with predefined scripts, such as science theater shows. (See Figure 8 for an example of a virtual ASL interpretation)
- *Taking it to the next level:* Provide large font handouts of text and PowerPoint slides that visitors who have low vision can use to view the text up-close with their own personal magnifying devices as they follow along with the program.

Figure 8: A pre-recorded virtual ASL interpretation



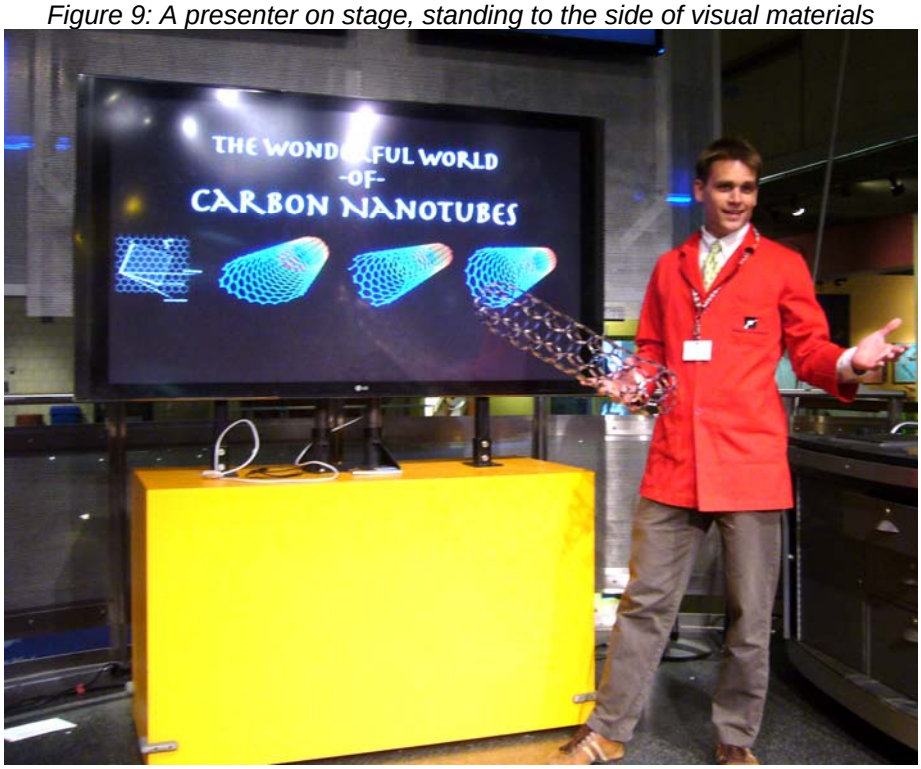
3. Things to consider when setting up and prepping your presentation:[1]

B. *Provide physical and sensory access to all aspects of the program (materials, presentations, room set-up, etc.)*

- Provide good visibility of your (the presenter's) face at all times.
  - Face the audience while speaking.
  - Stand in a well-lit area that does not cast shadows on your face.
  - Keep your face pointed forward, and avoid turning your face (and your voice) away from the audience.
  - This will be especially important for visitors who are hard of hearing and rely on lip reading to understand the spoken word.
- Make sure there is enough room for you to present without getting in the way of the visitors' view of the slide presentation or other accompanying materials. (See Figure 9)
  - Practice standing at different places on the stage, and ask a colleague to view you from different angles of the audience to determine the best position for you and the screen/materials.

[1] The Smithsonian Accessibility Guidelines (http://www.si.edu/opa/accessibility/exdesign/) include a number of recommendations for designing programmatic spaces so that they are inclusive of visitors with disabilities. We recommend that anyone who is designing a new programmatic space review these guidelines. Listed here are additional steps educators can take when setting up and prepping their presentations so that the actual implementation and use of the space is as accessible as possible.

Figure 9: A presenter on stage, standing to the side of visual materials



- If presenting materials on an interpretation cart, make sure those items can be viewed by people from a range of heights (including seated positions).
  - Pull up a wheelchair (with the foot rests extended) and see if you can still reach and use the materials on the cart.
- *Taking it to the next level*: Consider the seating that is available.
  - If benches with backs are not available for long presentations, consider bringing folding chairs with backs as this will help older adults and those who suffer from chronic back pain.
  - If presenting your program on a cart, bring some stools to assist a variety of visitors, including younger visitors, people with lower back pain, and people with low vision who need to be close to materials.
  - If "good" seating areas are limited, provide preferential seating for people with disabilities.
- *Taking it to the next level*: Ask an ASL interpreter to join you for your presentation, and then market the experience to the deaf community.

4. Things to consider when delivering your presentation:

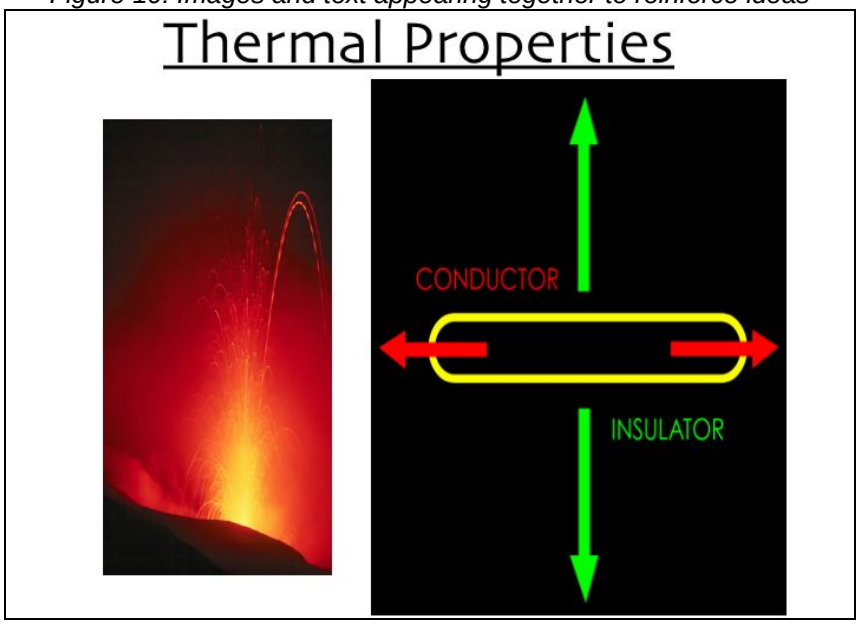
A. *Repeat and reinforce the main ideas and concepts*

- Repeat key ideas by telling the visitors what you will tell them, telling them, and then telling them what you told them.

- This helps visitors with cognitive disabilities, as well as visitors who are blind and are relying exclusively on verbal information as this helps them to remember what was said without visual cues.

– Punctuate the delivery of spoken key ideas with the use of images and text that reinforces those ideas. (See Figure 10)

Figure 10: Images and text appearing together to reinforce ideas



- Use flash cards, PowerPoint slides, and other visuals to present the key ideas and words identified in the planning stage.

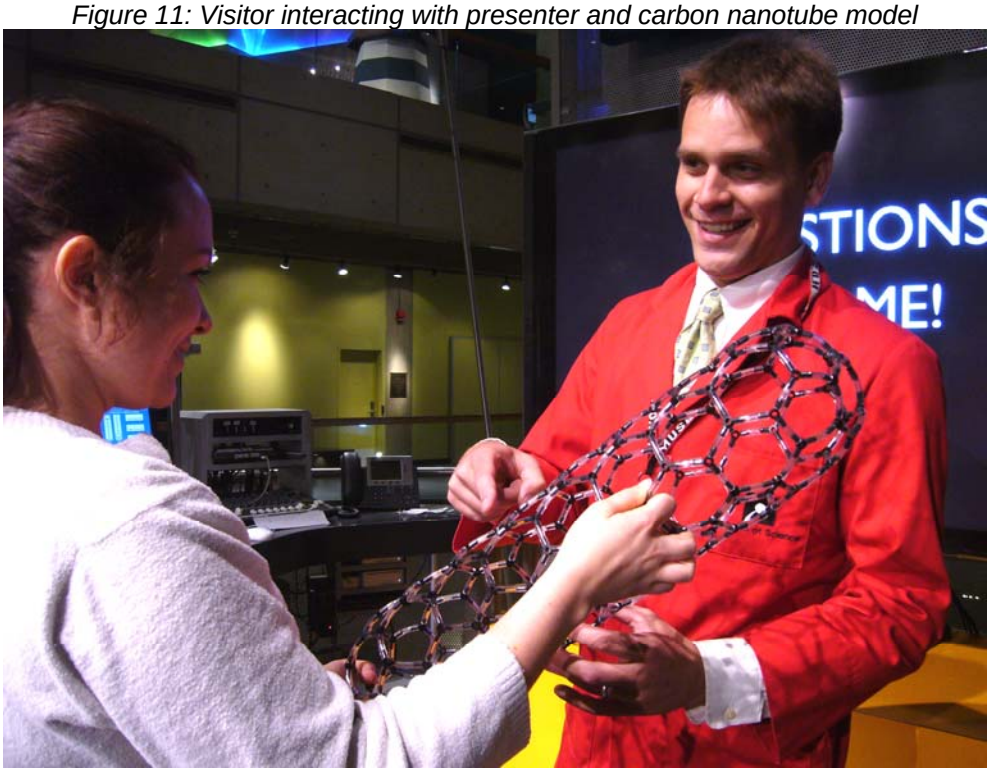
– Check-in with the audience along the way.
- Pause during key points in the presentation to ask for questions before moving on.
- Ask questions of the audience to check-in and see what they are thinking about what you presented so far.

– *Taking it to the next level*: Offer opportunities for members of the audience to preview the materials a few minutes before or after the program, either by providing them with a list of the key ideas and vocabulary linked to images or the ability to touch the materials used in the program (this is especially important for visitors who are blind).

B. *Make multiple entry points and multiple ways of engagement available to visitors*

– Find ways to engage audience members in the program.
- Engage visitors in hands-on activities, ask them to serve as helpers, or pass around tactile models. (See Figure 11)

Figure 11: Visitor interacting with presenter and carbon nanotube model



- Ask questions during the program that encourage visitors to connect what you are discussing to situations from their everyday lives.
  - This can be an effective way to introduce examples and non-examples.

C. *Provide physical and sensory access to all aspects of the program (materials, presentations, room set-up, etc.)*

- Make announcements that inform visitors of available accessibility options and encourage all learners to participate in the program.
  - For example, if you know there are places in the seating areas that are more comfortable for people with lower back pain or where it is easier for those who are hard of hearing to hear, tell the audience about them and encourage visitors to move there.
  - Visitors with disabilities have a history of being excluded from learning, so unless you send an explicit message about the accessibility of your program, they will just assume that it is not accessible. Inform the audience if you have tactile models or other materials available for handling/viewing.
- Consider the rhythm of the program, providing extra time for people to process important ideas with intentional pauses and breaks.
  - This applies to both the live presenter, videos, or animations.
  - Allow for additional pauses when passing out materials so that audience members can take their time as they examine them.

    - If you have an ASL interpreter, more frequent breaks and a slower pace is needed to allow time for translation.
- Use auditory descriptions of models and images.
    - Ask a colleague to listen to your program with their eyes closed. Can they still understand the content?
    - Visit the Website for Audio Description International for more information on how to describe visual images for visitors who are blind: http://www.adinternational.org/.
- Place and keep all elements of the program in a well-lit area that has a narrow field of view.
    - All elements should stay in the same sight lines so they can be viewed simultaneously.
    - Elements to consider are the presenter, the interpreter, and any visual materials such as a slide show.
    - This is especially important for visitors who have low vision and have a narrow field of view, and visitors who are deaf or hard of hearing and receive all of their information visually, including language.

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Appendix A:

Helpful Web-based resources

For more information about…

The Principles of Universal Design

- The original principles of universal design (mostly applies to the design of products and buildings): http://www.design.ncsu.edu/cud
- The principles of universal design for learning (mostly applies to classroom curriculum): http://www.cast.org

Methods for creating more accessible presentations/media:

- Guidelines for legible text: http://www.lighthouse.org/accessibility/
- Guidelines for captioning: http://ncam.wgbh.org/richmedia/strategies/CC.php
- Guidelines for audio description: http://www.adinternational.org/

Museum accessibility and inclusion:

- Smithsonian accessibility guidelines: http://www.si.edu/opa/accessibility/exdesign/start.htm
- Museum of Science universal design framework http://www.mos.org/exhibitdevelopment/access/index.html
- Association of Science -Technology Center's Accessible Practices: http://www.astc.org/resource/access/

The Nanoscale Informal Science Education Network:

- The NISE Net Website: http://www.nisenet.org

Appendix B: Lessons learned by museum educators

B1: Lessons learned from “Snowflakes—Nano at its Coolest”

B2: Lessons learned from “Nano Dreams and Nano Nightmares”

B3: Lessons learned from “The Wonderful World of Carbon Nanotubes”

B4: Lessons learned from “Surface Area”

Appendix B1:

Lessons learned from "Snowflakes—Nano at its Coolest"

Rae Ostman
Sciencenter

Program description

"Snowflakes" is a public presentation that introduces nanoscale science by considering how snowflakes form, why they have six sides, and whether it's true that no two snowflakes are alike. Visitors learn that the complex structure of snowflakes results from the nanoscale arrangement of water molecules in the ice crystal, and that snowflakes are an example of self-assembled systems being studied in the field of nanoscale science. During the course of the program, visitors look at images of snowflakes, handle models, and observe real ice crystals forming in a chilled chamber.

Inclusive features

Several original features of the program design helped to make it inclusive of all visitors:

1. Using snowflakes—a familiar, interesting subject for many visitors—as an entry point to nanoscale science.
2. Organizing the program into discrete chunks.
3. Providing an overview of program content and organization at the beginning, and periodically reminding visitors.
4. Repeating learning objectives throughout presentation.
5. Asking questions of the audience throughout the presentation.

Additional changes were made to the program as part of the workshop, in order to make it more inclusive of visitors with disabilities:

1. Redesigning the slides to be easy to see and understand.
2. Verbally describing visual elements of program.
3. Covering the major points of the verbal presentation through text on the slides.
4. Passing around tactile models of key images.
5. Providing individual access to visual material for visitors with disabilities, through additional screens or printed handouts of the slides.

Lessons learned

Good program design benefits everyone. While there are many specific things educators can do to accommodate individuals with particular disabilities, there are also a handful of things we can easily do to support learning by all visitors. Universal design at its most basic includes:

1. Providing an outline of program content at the beginning of the presentation, reminding visitors of what you're covering as you proceed, and reviewing the major points at the end of the program.
2. Inviting the audience to participate, and checking in with them periodically to make sure they're with you.
3. Repeating the main ideas several times, and in several different ways.
4. Making sure your learning objectives are accessible through more than one sense: at least sight and hearing, and ideally also touch. Describe the things you show, show pictures or models of the things you describe, and provide tactile models where possible.
5. Pay careful attention to basics like whether the audience can see and hear well, and be sure to let visitors know of any accommodations you have available.

These five things are principles of good program design and visitor service. They help all visitors learn, and are especially critical to visitors who have disabilities. Being conscientious about them will make all your programs better.

Appendix B2:
Lessons learned from “Nano Dreams and Nano Nightmares”

Stephanie Long and Jennifer Scott
Science Museum of Minnesota

Program description

The Science Museum of Minnesota presented the program, "Nano Dreams and Nano Nightmares", a live performance featuring actors and puppets, for the NISE Accessibility Workshop in Boston, MA in December 2007.

Changes made

Some of the changes done to this live theater program, in direct response to this Workshop, include:

1. Making sure that the script hits the teaching points over and over. A good guideline was the mantra "Tell them what you're going to tell them, tell them, then tell them what you told them."
2. Streamlining the teaching points—choosing one to three main points to concentrate on, and making them as clear and simple as possible.
3. Slowing verbally down at those teaching points, and making sure they're clear, focused, and easy to understand.
4. Even though we don't use visuals with this program at SMM, PowerPoint slides were added to this production at MOS. The power point slides should be simple, with minimal text. Also, having large white text on dark backgrounds helps to make the slides much more accessible.
5. One of the best decisions made at the workshop was to lower the age of this program's target audience. Our previous target audience was too broad. By lowering the age, it helped us to focus on three simple teaching points, making those teaching points clear. Overall, the program is a much better piece because of this.

Appendix B3:

Lessons learned from "The Wonderful World of Carbon Nanotubes"

Tim Miller
Museum of Science, Boston

Program description

"Carbon Nanotubes" is a stage-based public presentation designed for medium-to-large audiences. It discusses the history of the discovery of the carbon nanotubes, explains some of their useful and unique properties, and presents a broad survey of some of the current and future applications in which they may be useful to society. This is a lecture-style program, with very little audience participation, that makes heavy use of physical models and projected images.

Inclusive features

The program was originally designed with a number of features intended to make the content as accessible as possible to a broad audience.

1. Careful "signposting," articulating the main points of the program at the beginning, middle, and end.
2. Approaching the significance of the material from multiple contexts: historical, social, scientific.
3. Use of large physical models and demonstrative gesture that complemented and reinforced the projected imagery.
4. The selection of large, high-resolution, high-contrast images.

Changes made

As a result of the feedback from the workshop participants and advisors, several changes were made to the design and delivery of the program to increase its accessibility.

1. The substitution (where possible) of physical models that are not just visible, but tactile, so that visitors have an opportunity to explore them with touch.
2. Decreasing the pace of the presentation, to allow visitors being assisted by an ASL interpreter to absorb both the spoken word and the visual information.
3. Using verbal descriptions of the physical modeling and gesture, in addition to showing them visually.
4. Using color and contrast to highlight particular features of both the models and the images, in order to draw the audience's attention, rather than merely gesturing.

5. Providing additional supplementary materials that are available upon request to visitors with particular needs, e.g. large printed handouts of the material, additional viewing screens, etc.

Lessons learned

By far the most important outcome of this workshop was the realization that changes made in order to reach one particular audience group almost always benefited the audience as a whole. A good example of this was the slowing to accommodate an ASL interpreter. By slowing the pace enough to allow deaf visitors to first absorb the words, and then view and digest the content of the images, hearing visitors reported a higher rate of comprehension as well, since they were given more time to explore the content. For certain visitors, very specific changes to a program may be required, but there are a few simple design tenets that will benefit all visitors. They include:

1. Articulate the main segments or theses of the program at the beginning, as you arrive at them, and again at the end of the program. This both reinforces the main ideas, and helps keep the audience's attention.
2. It is important for all visitors to be able to see and hear the program to the best of their ability. This means that the presenter's face, the images, the models, and any other program materials should be as clearly visible and audible as possible.
3. Visitors connect with content they find significant, so programs should provide as many modes of significance (sometimes referred to as "points-of-entry") as possible. This helps make the program relevant to visitors across a broad range of perspectives and learning styles.
4. Programs are more accessible the greater number of sense they engage. Models and phenomenon can engage more than just our vision and hearing. The can also use the sense of touch, and some programs may even be able to engage our sense of taste and smell. These senses can and should complement and reinforce one another, as together they can offer an opportunity for a broader and deeper understanding.

The principles derived from this workshop are not overly complicated, nor are they expensive or time-consuming to implement. Instead they are a compact set of easily understood and employed ideas that can help improve the experience of public programs for visitors of all levels of ability.

Appendix B4:

Lessons learned from “Surface Area”

Anders Liljeholm
OMSI

Program description

This cart demo features multiple examples of smaller particles reacting more quickly and powerfully than larger particles, due to their increased surface area. Visitors count tactile dead germ models, see a potato change color, see alka-seltzer foam, and see and hear lycopodium explode.

Inclusive features

Several original features of the program design helped to make it inclusive of all visitors:

1. The presenter describes visual features verbally, for example telling visitors “what I am holding is a cube marked with lines across the surface…”
2. The program includes tactile models, including cubes and germ models that can be touched by all visitors, including visitors with low vision.
3. The presenter repeats the learning objectives throughout presentation.
4. The program design features multiple examples of the same concept, with different sensory modes of interaction – The alka-seltzer foaming, the potato color change, the dead germ model, and the lycopodium explosion all illustrate the same idea: small things act differently, because they have more surface area.

Additional changes were tried as part of the workshop, to see if they made the program more inclusive of visitors with disabilities:

1. Adding visual organizers, highlighting the main points of the presentation. These took the form of paper table tents that captured the big idea of each part of the presentation. Two table tents were used at the end of each section to reinforce the main idea of the larger demonstration.
2. Additional props for further illustration. We printed out pictures of germs, and thought the demo could eventually include a plush germ with taxidermy eyes.

Lessons learned

This charrette process brought out two important things to keep in mind for future program review: have the presenter prepare and choose a program that needs feedback. This program had been developed over a year before the charrette, and I had not practiced it recently. Much of the feedback that was given reflected things that were meant to be in the program, but accidentally left out. Therefore,

when presenting a program for feedback, make sure it's the best version possible of the program. Great value can also be had by critiquing a fresh, new program. In meetings since this charrette, I have presented programs that were not as well developed, and the benefits from the feedback were greater. Future programs should be evaluated earlier in the development process, with universal design considered very early on, if not at the very beginning.

Appendix C:
Universal design program critique form

Universal design program critique form

This form is designed to help museum educators compare their programs to the universal design guidelines. You can use it as a starting point for assessing the inclusiveness of your program by asking colleagues to complete the form while viewing the program and discussing it afterwards. To truly determine if your program is inclusive of people with disabilities, however, we recommend that you invite people with disabilities to view the program and provide feedback through an evaluation study. We also recommend that you utilize the full guidelines document when developing your program.

Universal Design Guideline	Comments
Repeat and reinforce main ideas and concepts	
❒ Explicitly state overarching main idea and supporting concepts visually and aurally.	
❒ Present a content map (outline) visually and aurally.	
❒ Actively engage visitors with the content visually, aurally, and tactilely.	
❒ Deliver one core concept at a time.	
❒ Repeat core concepts frequently during the program.	
❒ Punctuate the delivery of key ideas by presenting them visually, aurally and tactilely.	
❒ Check in with the audience along the way.	
❒ Provide handouts that summarize main ideas and concepts with text and images.	
Provide multiple entry points and multiple ways of engagement	
❒ Enable learners to enter at different places and take away different messages.	
❒ Actively engage audience members in the program.	
❒ Ask questions that encourage visitors to relate the content to their everyday life.	
❒ Connect the content to a range of prior experiences and everyday life examples.	
❒ Use multiple analogies to represent the same idea.	
❒ Provide examples and non-examples.	
❒ Engage more than one sense when delivering jokes and special effects.	

Universal Design Guideline	Comments
Provide physical and sensory access to all aspects of the program	
❒ Provide good visibility of the presenter's face.	
❒ Position the presenter so that he/she does not block the presentation.	
❒ Speak slowly and provide extra time for people to process important ideas.	
❒ Provide auditory descriptions of models and images.	
❒ Make announcements that inform visitors of available accessibility options.	
❒ Position materials so they can be viewed by visitors of a range of heights.	
❒ Place all elements of the program (presenter, props & presentation) in a well-lit area.	
❒ Use high-contrast demonstration materials & models that can be seen at a distance.	
❒ Provide tactile models that are easy to handle and manipulate.	
❒ Use color and/or tactile designs to impart meaning on models & images.	
❒ Use large, high contrast, easy to read text and images for all graphics.	
❒ Caption video presentations.	

Notes: