

Universal Design and Designing for Accessibility

Stanford University
ENGR 110/210:
Perspectives in Assistive Technology
January 15, 2008

Molly Follette Story, M.S.

*Co-Director, RERC on Accessible Medical Instrumentation;
President, Human Spectrum Design, LLC*



Rehabilitation Engineering Research Centers (RERCs)

**RERC on Universal Design
and the Built Environment
at North Carolina State University**

RERC on Accessible Medical Instrumentation

Funding provided by:



**National Institute on Disability and Rehabilitation Research,
U.S. Department of Education**



Topics

- My professional life
- **UNIVERSAL DESIGN**
- RERC-AMI



My Professional Life

- 1. Structural Engineer**
 - GFDS Engineers, San Francisco, 1978-1981



My Professional Life

1. **Structural Engineer**
2. **Product Design Engineer**
 - Raychem Corporation, Menlo Park, 1983-1984



My Professional Life

1. **Structural Engineer**
2. **Product Design Engineer**
3. **Consultant (self-employed)**
 - Raychem Corporation, Atlanta, GA, 1984-1985
 - Raychem Corporation, Raleigh, NC, 1985-1987
4. **University Instructor**
 - Georgia Institute of Technology, Atlanta, GA
 - Industrial Design Department, 1984-1990



My Professional Life

1. **Structural Engineer**
2. **Product Design Engineer**
3. **Consultant** (self-employed)
4. **University Instructor**
5. **Research Associate Professor**
 - North Carolina State University, Raleigh, NC
 - Industrial Design Department, 1994-2000
 - The Center for Universal Design, 1994-2002



My Professional Life

1. **Structural Engineer**
2. **Product Design Engineer**
3. **Consultant** (self-employed)
4. **University Instructor**
5. **Research Associate Professor**
6. **Consultant** (self-employed)
 - RERC on Accessible Medical Instrumentation, 2002-2008
 - Various companies, 1984-present



Teaching Industrial Design at GaTech

- Mostly sophomore studio
 - **Problem:** the students were designing for themselves
 - **Solution:** make them design for any other user group
 - Preschoolers
 - Elders
 - Homeless people
 - People with disabilities



Universal Design at NCSU



Universal Design is the design of all products and environments to be usable by people of all ages and abilities, to the greatest extent possible.

– Ronald L. Mace, FAIA, 1991



Teaching Industrial Design at NCSU

- Mostly sophomore studio:
 - **Height-adjustable toilet** (*mobility*)
 - **Auxiliary captioning device for battery-powered TVs** (*hearing*)
 - **Can opener** (*one-handed users*)
 - **Telephone + answering machine + caller ID** (*vision*)
 - **Simple programmable home thermostat** (*cognition*)



Accessible vs. Universal Design

- **Accessible Design:**
for people with disabilities
- **Universal Design:** for everyone,
including people with disabilities
- Critical differentiating characteristic:
INTEGRATION



Accessible or Universal?

- Magnifying glass



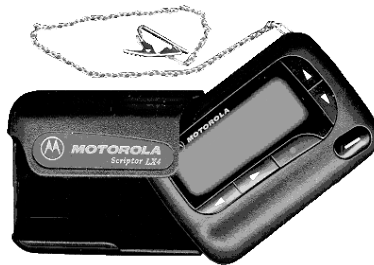
Accessible or Universal?

- Television headphones



Accessible or Universal?

- Vibrating pager



Accessible or Universal?

- Big-grip utensils

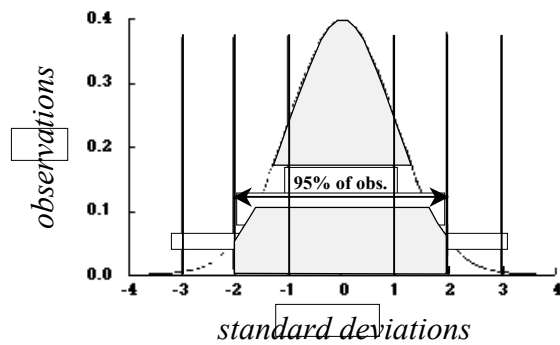


Accessible or Universal?

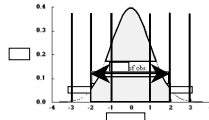
- Electric cart



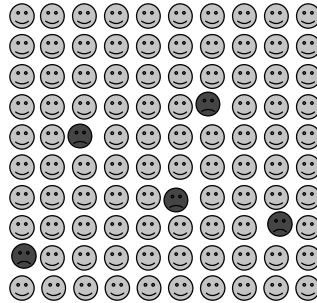
“Normal” Distribution



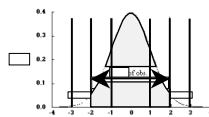
“Normal” Distribution



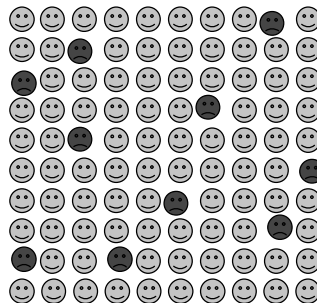
- Design for 95% x 95% x 95% x ... = few!



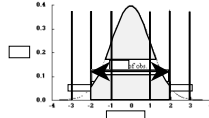
“Normal” Distribution



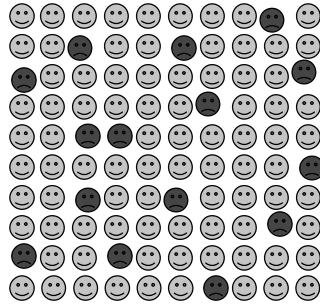
- Design for 95% x 95% x 95% x ... = few!



“Normal” Distribution



- Design for 95% x 95% x 95% x ... = few!



“Normal” Distribution

- People on one end of a bell curve may be on the other end of another bell curve.
 - **Hearing**
 - Superior observation skills
 - **Vision**
 - Superior listening skills
 - “Intro to the Screen Reader with Neal Ewers”
<http://www.doit.wisc.edu/accessibility/video/intro.asp>



The Principles of Universal Design

Authors:

- **Ron Mace** (the late) • The Center for Universal Design, N.C.S.U.
- **Mike Jones** • Shepherd Spinal Center, Atlanta, Georgia
- **Molly Story** • C.U.D. at N.C.S.U. & Human Spectrum Design
- **Jim Mueller** • J.L. Mueller, Inc., Washington, D.C.
- **Gregg Vanderheiden** • Trace R & D Center, U. of Wisc.–Madison
- **Jon Sanford** • V.A.M.C.–Atlanta & Georgia Inst. of Technology
- **Betty Rose Connell** • Veterans Affairs Medical Center–Atlanta
- **Ed Steinfeld** • I.D.E.A. Center, S.U.N.Y.–Buffalo
- **Abir Mullick** • I.D.E.A. Center, S.U.N.Y.–Buffalo
- **Elaine Ostroff** • Founder, Adaptive Environments Center, Boston



The Principles of Universal Design

1. **Equitable Use**
2. **Flexibility in Use**
3. **Simple and Intuitive Use**
4. **Perceptible Information**
5. **Tolerance for Error**
6. **Low Physical Effort**
7. **Size and Space for Approach & Use**



Principle 1. Equitable Use

The design is useful and marketable to people with diverse abilities.

Design for all



Principle 1. Equitable Use

- a. **Provide same means of use for all users.**
- b. **Avoid segregating or stigmatizing users.**



Principle 1. Equitable Use

- c. Make privacy, security and safety equally available to all users.
- d. Make the design appealing to all users.



Principle 2. Flexibility in Use

**The design accommodates
a wide range of individual
preferences and abilities.**

Design for each



Principle 2. Flexibility in Use

- a. Provide choice in methods of use.
- b. Accommodate right- or left-handed access.



Principle 2. Flexibility in Use

- c. Facilitate user's accuracy and precision.
- d. Provide adaptability to the user's pace.



Principle 3. Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

Design for the mind



Principle 3. Simple and Intuitive Use

- a. **Eliminate unnecessary complexity.**
- b. **Be consistent with user expectations and intuition.**



Principle 3. Simple and Intuitive Use

- c. Accommodate a wide range of literacy and language skills.
- d. Arrange information consistent with its importance.



Principle 3. Simple and Intuitive Use

- e. Provide effective prompting and feedback during and after task completion.



Principle 4. Perceptible Information

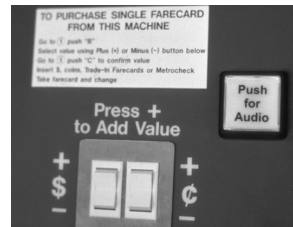
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Design for the senses



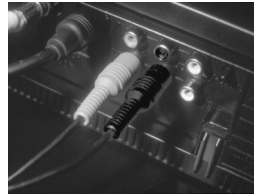
Principle 4. Perceptible Information

- a. Use different modes for redundant presentation of essential information.
- b. Maximize “legibility” of essential information (in all sensory modes).



Principle 4. Perceptible Information

- c. Differentiate elements in ways that can be described (make it easy to give directions).
- d. Provide compatibility with a variety of techniques or devices.



Principle 5. Tolerance for Error

**The design minimizes hazards
and the adverse consequences
of accidental or unintended actions.**

Design for error



Principle 5. Tolerance for Error

- a. Arrange elements to minimize hazards and errors.
- b. Provide warnings of hazards and errors.



Principle 5. Tolerance for Error

- c. Provide fail-safe features.
- d. Discourage unconscious action in tasks that require vigilance.



Principle 6. Low Physical Effort

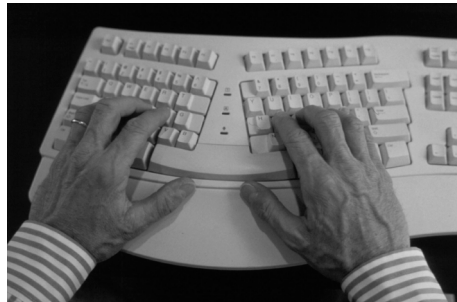
The design can be used efficiently and comfortably, with a minimum of fatigue.

Design for limited strength and stamina



Principle 6. Low Physical Effort

- a. **Allow user to maintain a neutral body position.**
- b. **Use reasonable operating forces.**



Principle 6. Low Physical Effort

- c. Minimize repetitive actions.
- d. Minimize sustained physical effort.



Principle 7. Size and Space

Appropriate size and space are provided for approach, reach, manipulation and use regardless of user's body size, posture, or mobility.

Design for body sizes



Principle 7. Size and Space

- a. Provide a clear line of sight to important elements for any seated or standing user.
- b. Make reach to components comfortable for any seated or standing user.

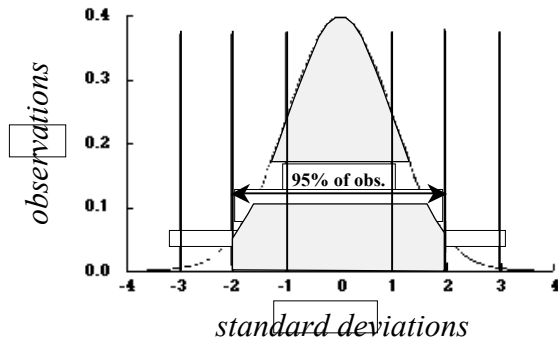


Principle 7. Size and Space

- c. Accommodate variations in hand/grip size.
- d. Provide adequate space for the use of assistive devices or personal assistance.

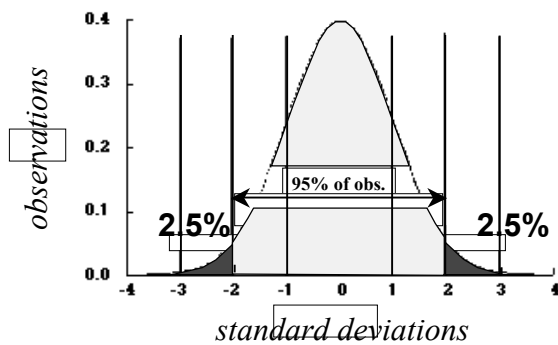


“Normal” Distribution

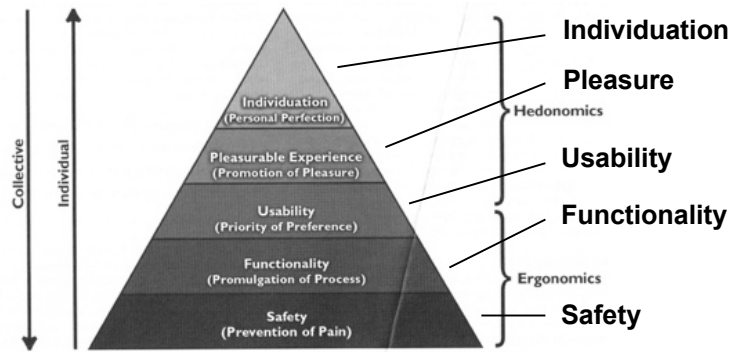


“Normal” Distribution

- Push the “limits” !



Hierarchy of Ergonomics and Hedonomics (Hancock, 1999)



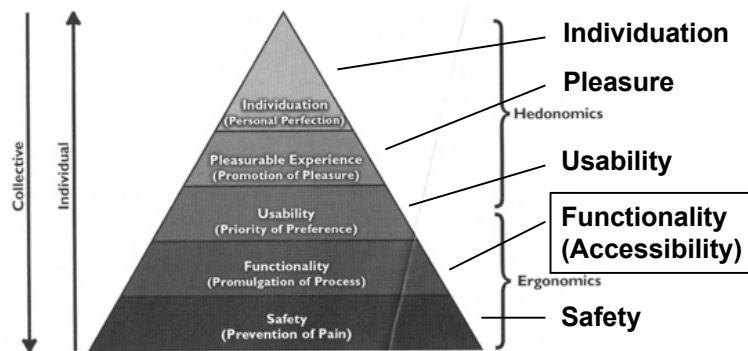
A hierarchy of ergonomics and hedonomic needs derived from Maslow's conception. The fact that these design imperatives match the social edict of "life, liberty, and the pursuit of happiness" has not escaped our attention (see Hancock, 1999).



WINTER 2005 • ERGONOMICS IN DESIGN 11



Hierarchy of Ergonomics and Hedonomics (Hancock, 1999)



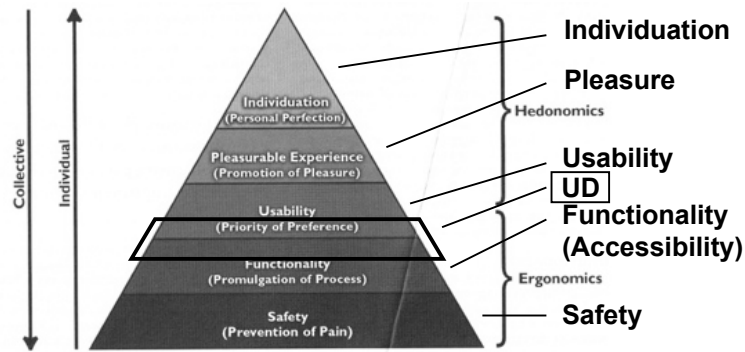
A hierarchy of ergonomics and hedonomic needs derived from Maslow's conception. The fact that these design imperatives match the social edict of "life, liberty, and the pursuit of happiness" has not escaped our attention (see Hancock, 1999).



WINTER 2005 • ERGONOMICS IN DESIGN 11



Hierarchy of Ergonomics and Hedonomics (Hancock, 1999)



A hierarchy of ergonomics and hedonomic needs derived from Maslow's conception. The fact that these design imperatives match the social edict of "life, liberty, and the pursuit of happiness" has not escaped our attention (see Hancock, 1999).



WINTER 2005 • ERGONOMICS IN DESIGN 11



Universal Design...

... will never suit all people in all circumstances, but it ...

- Can benefit most users;
- May cost little or nothing additional;
- May reduce the need for some assistive technologies; and
- Can increase social inclusion.
- *It can also increase the market for AT.*



RERC on Accessible Medical Instrumentation

Project: Radiology Equipment



Equipment:

- X-ray, CT scan, fluoroscopy machines

Subjects:

- 20 walking aid users: able to walk >10 ft but <1/4 mi.



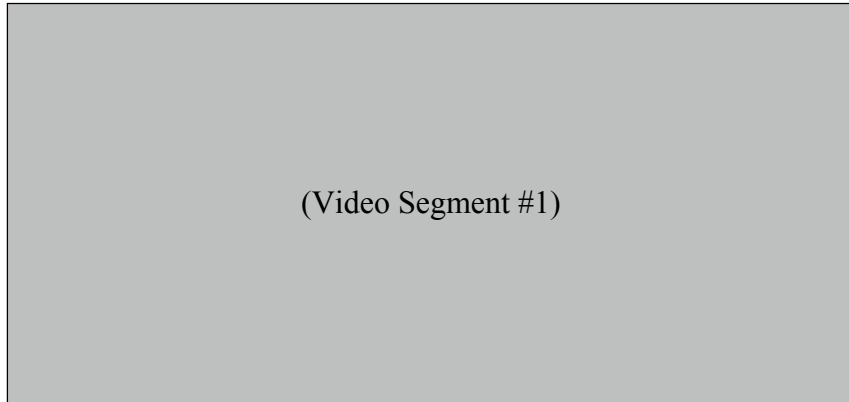
Video Data:

PAT2026 lying down on x-ray table

- In her late 60s
- **Stroke survivor**
- **Partial paralysis on her left side**
- Arthritis
- Chronic pain in knees
- Uses a **walker**



Video Data: PAT2026 lying down on x-ray table



Post-Test Video Review

with Subject PAT2026

- “And then she helped me stretch out.
It wasn't that hard.”



Video Data:

PAT2009 sitting up on x-ray table

- In his 50s
- Cerebral palsy
- Some paralysis
- **Some weakness on the right side**
- Arthritis in his hands
- Some chronic pain
- Uses a **cane**



Video Data: PAT2009 sitting up on x-ray table

(Video Segment #2)



Post-Test Video Review

with Subject PAT2009

- “The table was fine, getting on and off because it was lower. **The problem I had was the mat** that was underneath me was **kind of slippery**, of course I'm a little heavier, someone lighter might not be as much of a problem. But turning, because of that mat on the slippery metal surface, made it a little tougher to try to turn and keep that mat underneath me.”
- “**The width of the platform**... you have to be careful. In turning, **you don't have much width** to maneuver with, because of the machine. And that has to be considered, especially if you're sliding on the platform.”



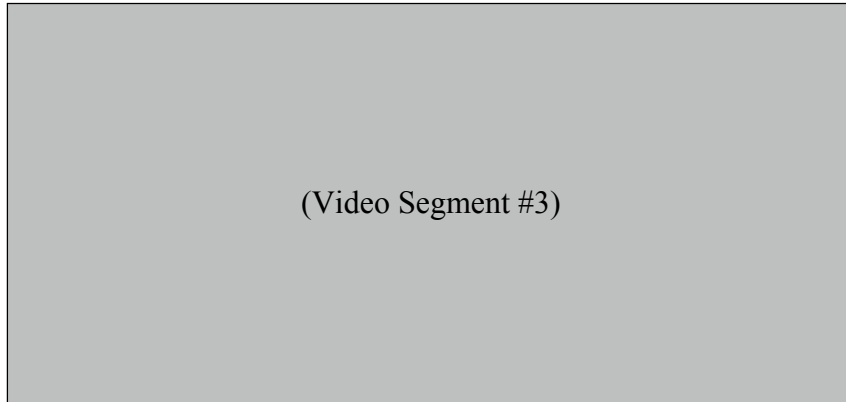
Video Data:

PAT2013 getting onto fluoroscopy platform

- In her 50s
- Cerebral palsy
- History of herniated disk in lumbar region
- Some paralysis
- Some arthritis
- Chronic pain in neck, shoulder, low back, hip
- Uses **2 canes**
- **Legs angle out from the knees**



Video Data: PAT2013 getting onto fluoroscopy platform



(Video Segment #3)



Post-Test Video Review

with Subject PAT2013

- “You see I'm having a lot of difficulty getting on that little extended piece that pulls out because it's not big enough, **it's not wide enough, and it doesn't extend far enough....**
- “And actually **I just need a bigger and wider surface**, that I can grab on and hold on and turn myself around, and push with all my weight on my arms.
- “And she's trying to help me by holding my legs, which is **keeping me from doing it**, so I told her to put her hands down, so that I could use my arms to get myself up there.”



Contact Information

The Center for Universal Design

- <http://www.design.ncsu.edu/cud>
- cud@ncsu.edu

RERC on Accessible Medical Instrumentation

- <http://www.rerc-ami.org>
- info@rerc-ami.org

Molly Follette Story

- molly@humanspectrumdesign.com

