

# Universal Design and Designing for Disability

Stanford University

**E110/210: Perspectives in Assistive Technology**

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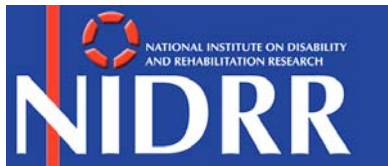


# Rehabilitation Engineering Research Centers (RERCs)

**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

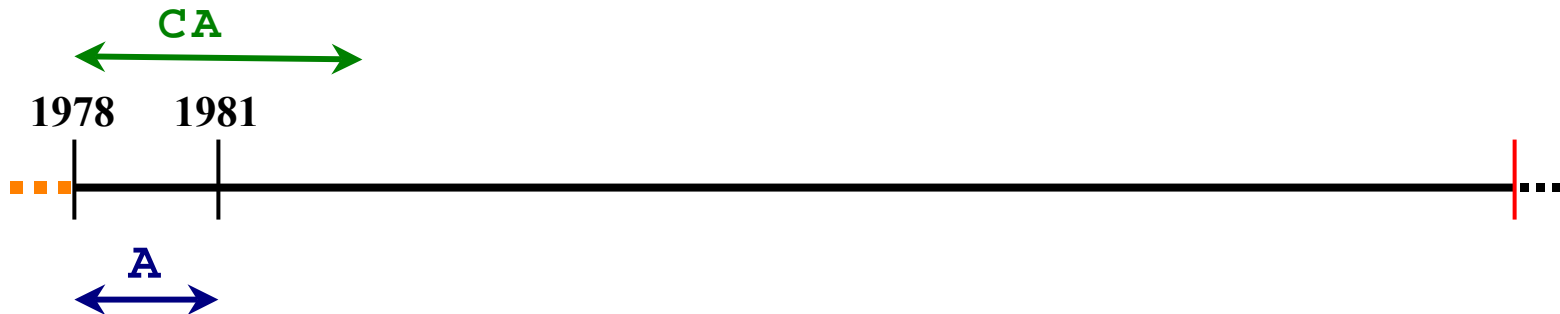
- **UNIVERSAL DESIGN**

- RERC-AMI



# My Professional Life

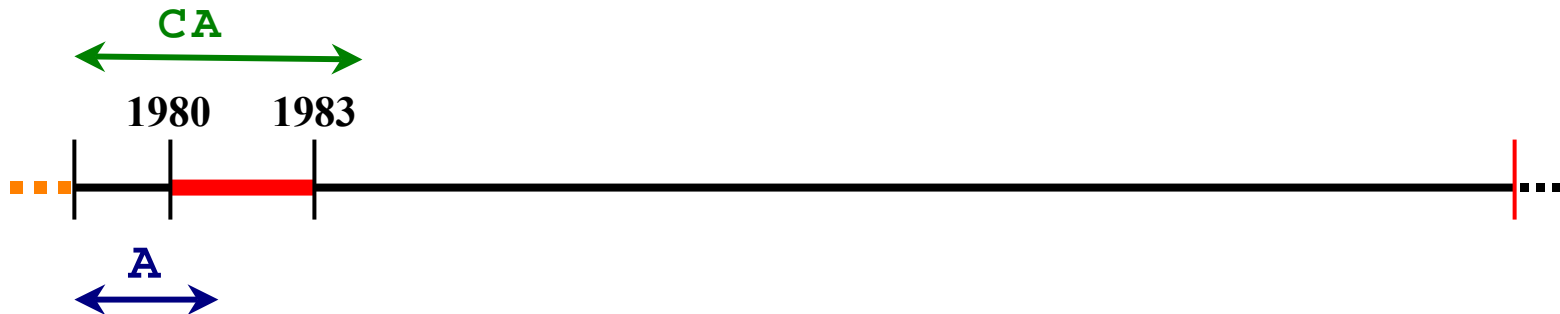
- 5 employers in 3 states
  - A. GFDS Engineers: 1978-1981



# My Professional Life

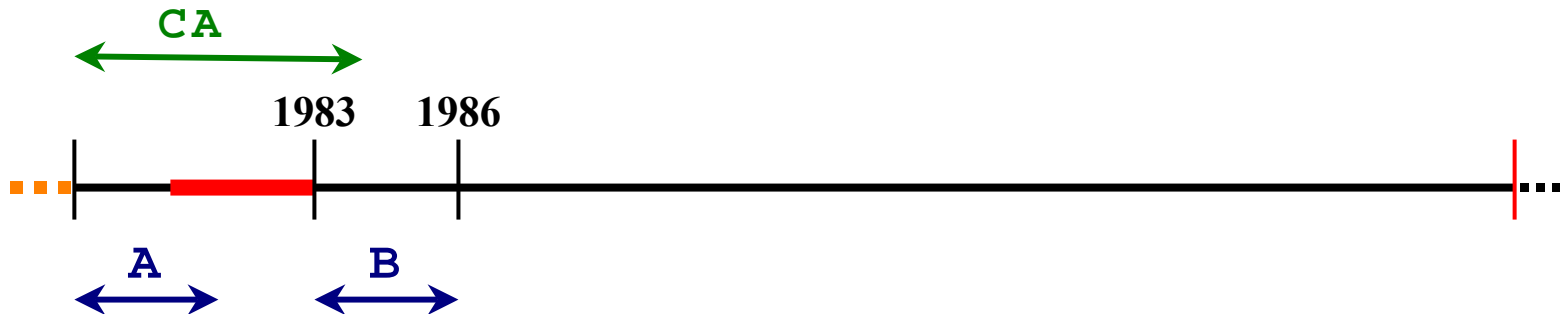
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# My Professional Life

- 5 employers in 3 states
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  - B. Raychem Corporation: 1983–1986



# My Professional Life

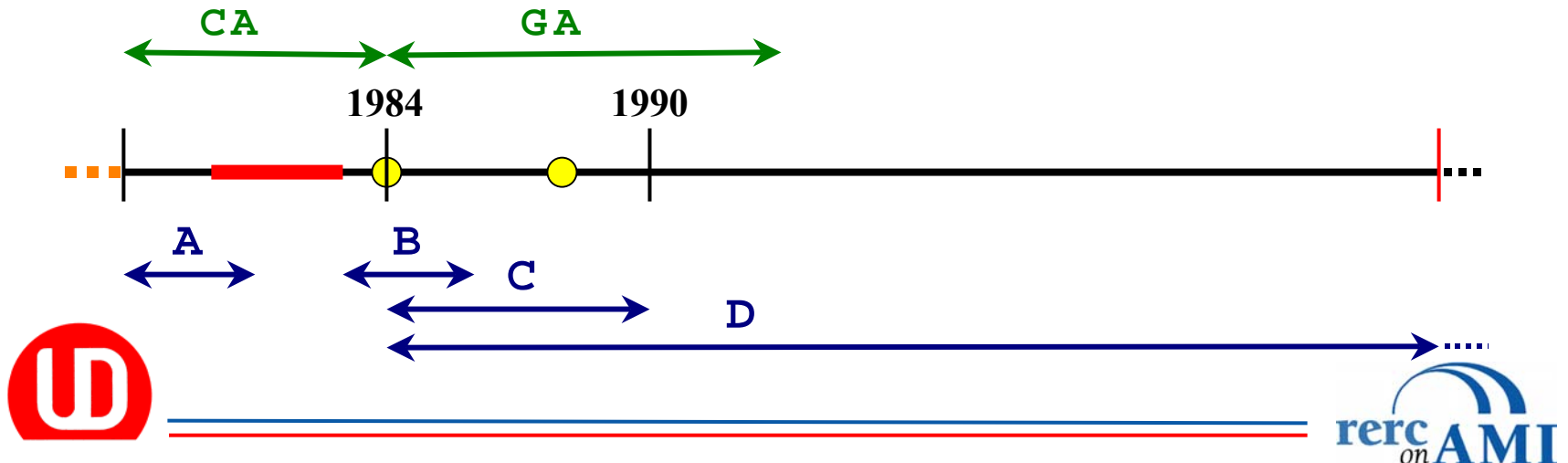
- 5 employers in 3 states

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C. Georgia Institute of Technology: 1984–1990 (*Hannah: 1988*)

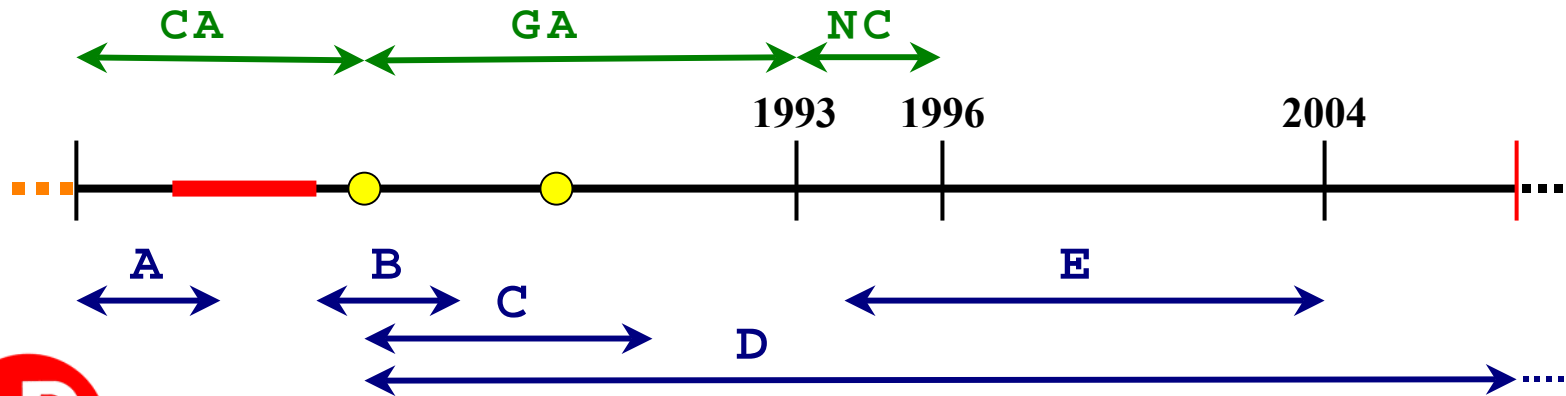
D. Self: 1984–present



# My Professional Life

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- D. Self: 1984–present
- E. North Carolina State University: 1994–2004

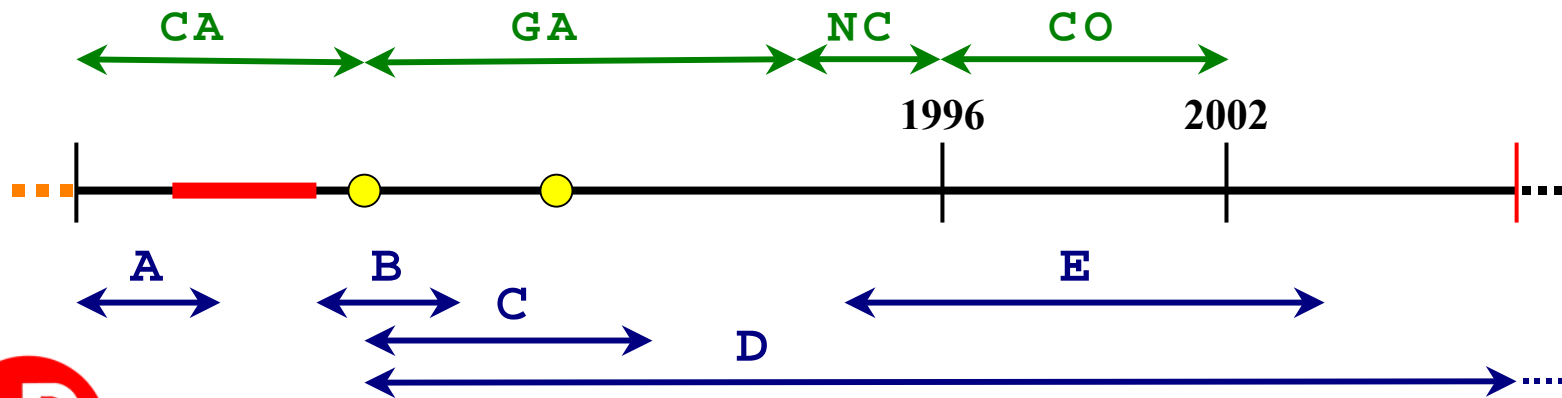




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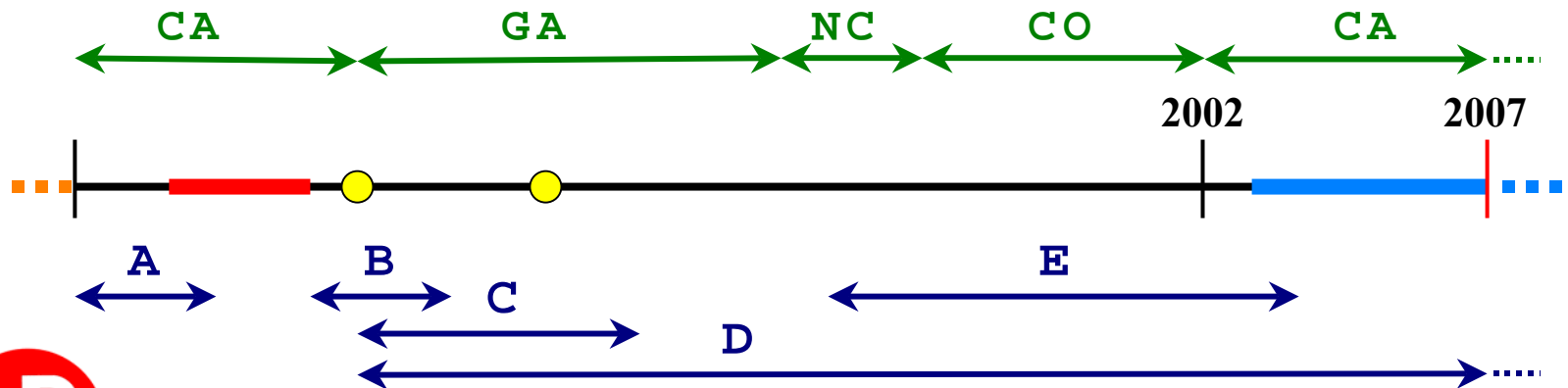
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D. Self: 1984–present

E. North Carolina State University: 1994–2004 (*Berkeley: 2003 ...*)



# Teaching Industrial Design at Ga Tech

- 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 NC S U



*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 NC S U

- Mostly sophomore studio
  - Height-adjustable toilet
  - Auxiliary captioning device for battery-powered TVs
  - Can opener for one-handed users
  - Telephone + answering machine + caller ID
  - Simple programmable home thermostat



# Accessible vs. Universal Design

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



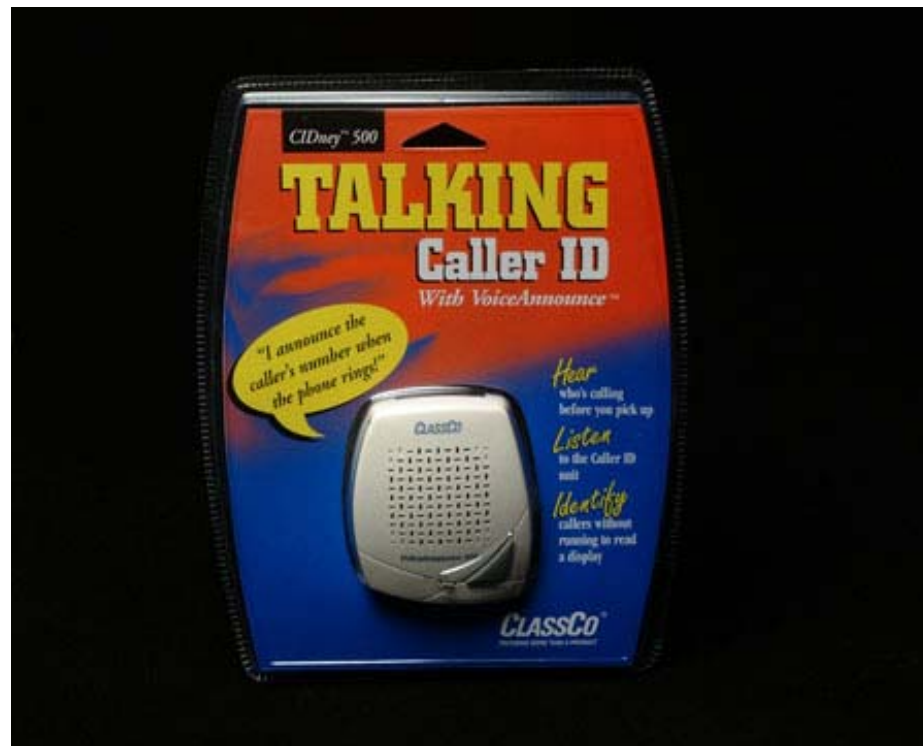
# Accessible or Universal?

- Magnifying glass



# Accessible or Universal?

- Talking caller ID





# Accessible or Universal?

- Television headphones



# Accessible or Universal?

- Vibrating pager



# Accessible or Universal?

- Big-grip utensils



# Accessible or Universal?

- Electric cart

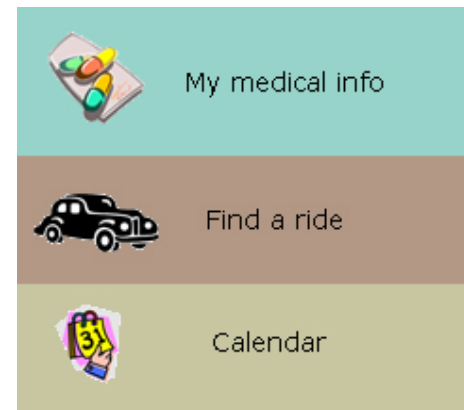


This picture show a cart with polished aluminum rims



# Accessible or Universal?

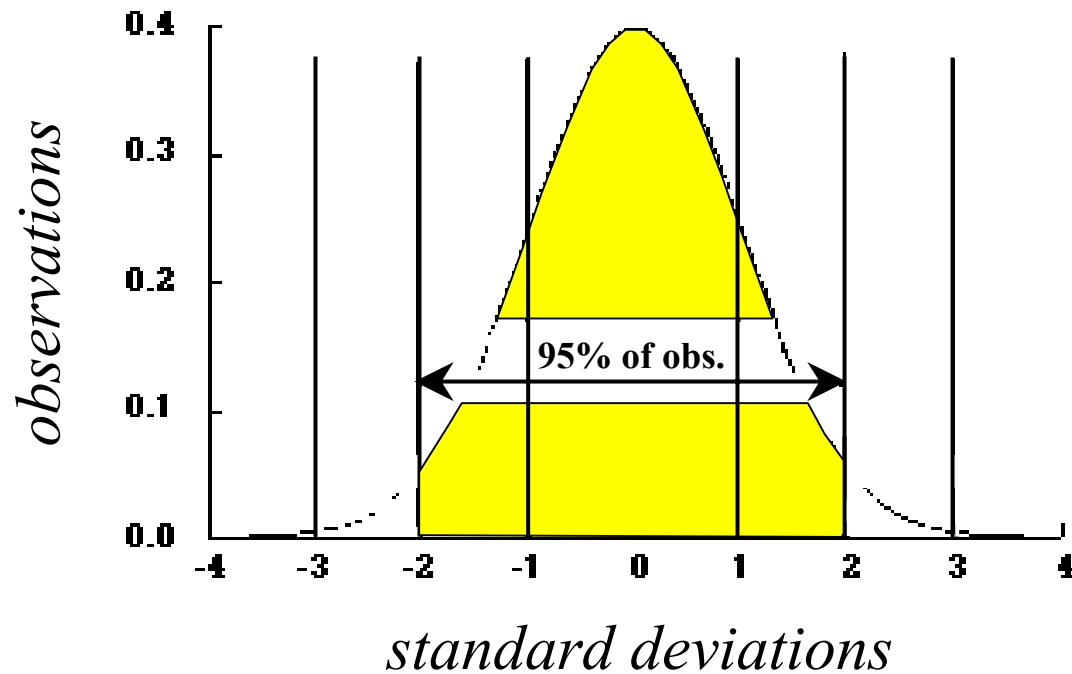
- Personal digital assistant (PDA)



Phone numbers



# "Normal" Distribution



# "Normal" Distribution

- Design for 95 % x 95% x 95 % x ... = few!
- 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://wiscinfo.doit.wisc.edu/ltde/access/ewers.htm>



# 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
- **Bettye 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

1

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

*Design for all*



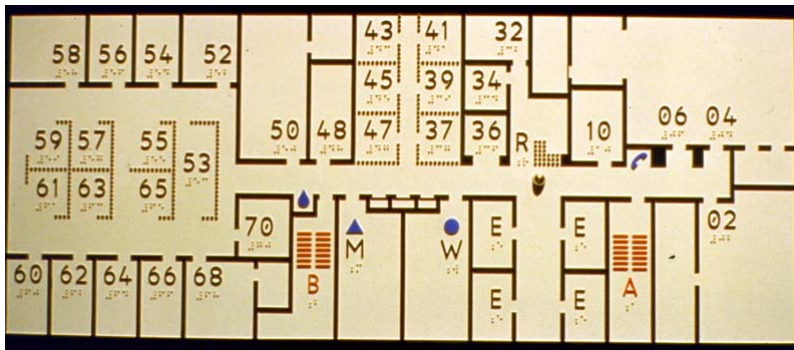
# Principle 1. Equitable Use

- a. Provide same means of use for all users.



# Principle 1. Equitable Use

b. Avoid segregating or stigmatizing users.



# Principle 1. Equitable Use

c. Make privacy, security and safety equally available to all users.



# Principle 1. Equitable Use

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.





## Principle 2. Flexibility in Use

b. Accommodate right- or left-handed access.



## Principle 2. Flexibility in Use

c. Facilitate user's accuracy and precision.



## Principle 2. Flexibility in Use

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.



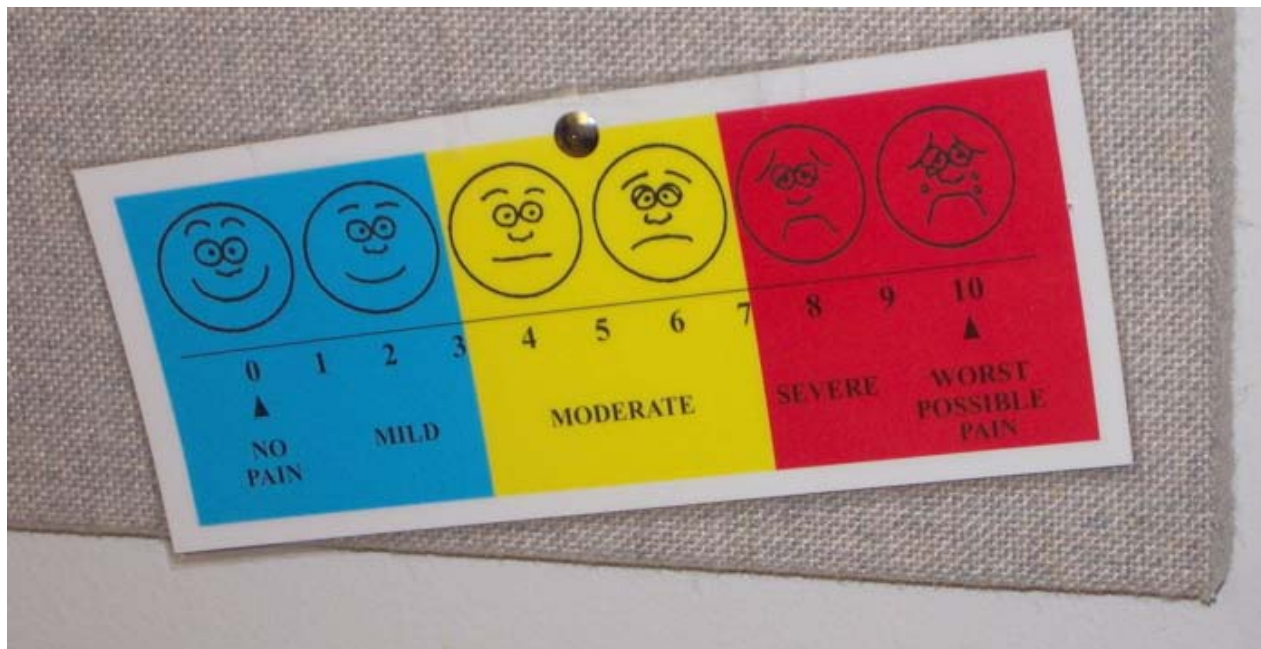
## Principle 3. Simple and Intuitive Use

b. Be consistent with user expectations and intuition.



## Principle 3. Simple and Intuitive Use

c. Accommodate a wide range of literacy and language skills.





## Principle 3. Simple and Intuitive Use

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*



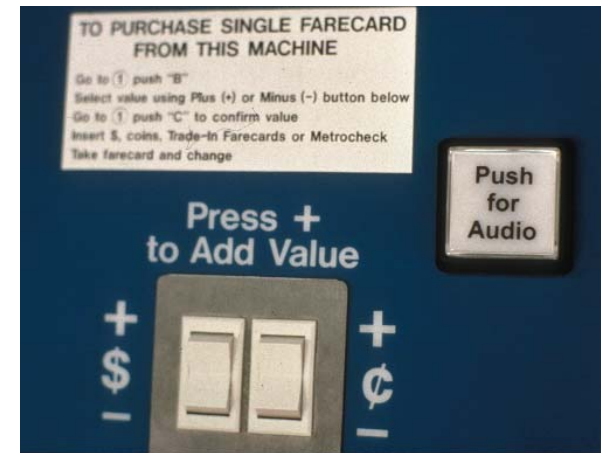
## Principle 4. Perceptible Information

- a. Use different modes for redundant presentation of essential information.



## Principle 4. Perceptible Information

- b. Maximize “legibility” of essential information (in all sensory modes).



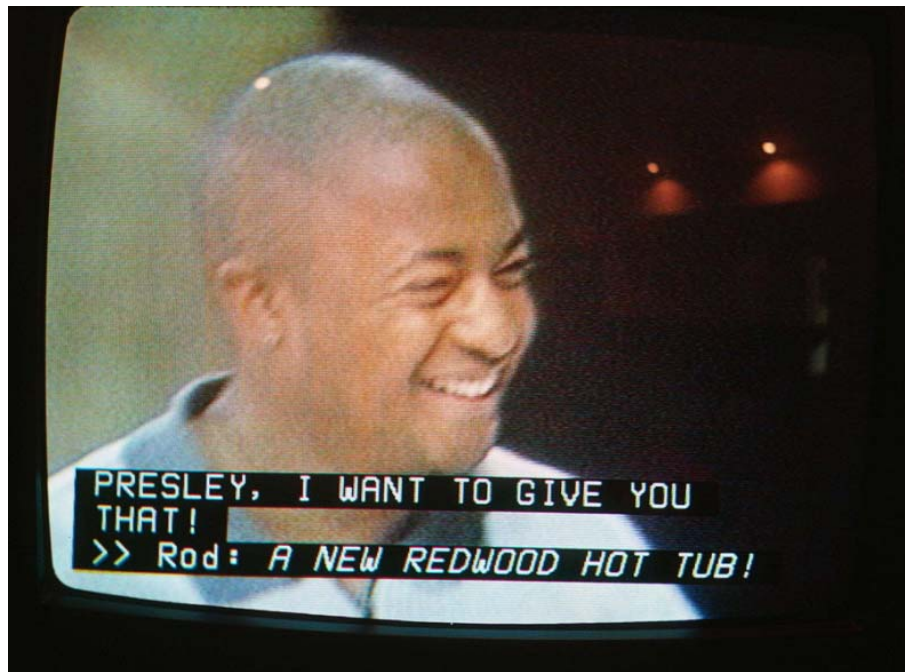
## Principle 4. Perceptible Information

- c. Differentiate elements in ways that can be described (make it easy to give directions).



## Principle 4. Perceptible Information

- 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.





## Principle 5. Tolerance for Error

b. Provide warnings of hazards and errors.



# Principle 5. Tolerance for Error

c. Provide fail-safe features.



## Principle 5. Tolerance for Error

- 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.



# Principle 6. Low Physical Effort

b. Use reasonable operating forces.





# Principle 6. Low Physical Effort

c. Minimize repetitive actions.



## Principle 6. Low Physical Effort

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.



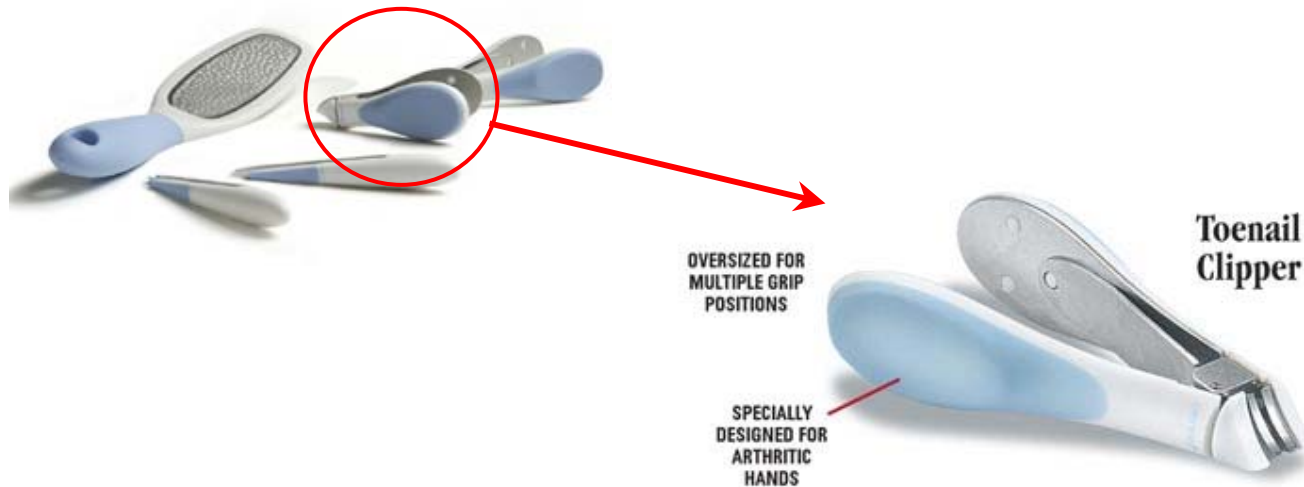
## Principle 7. Size and Space

- b. Make reach to all components comfortable for any seated or standing user.



## Principle 7. Size and Space

c. Accommodate variations in hand/grip size.

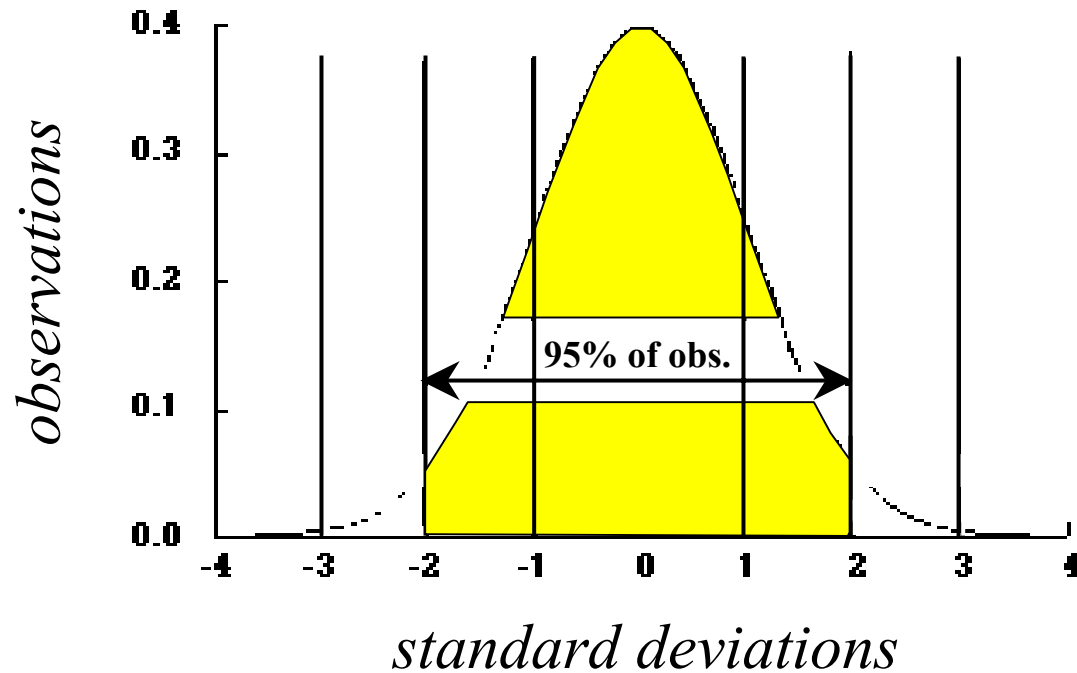


## Principle 7. Size and Space

- d. Provide adequate space for the use of assistive devices or personal assistance.

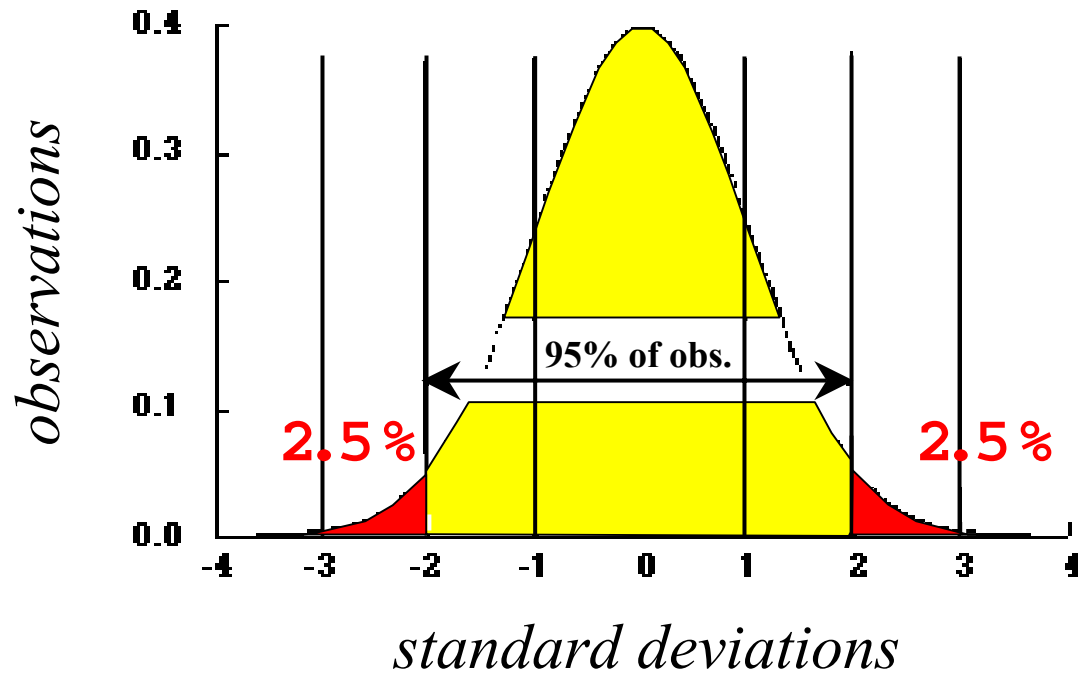


# "Normal" Distribution

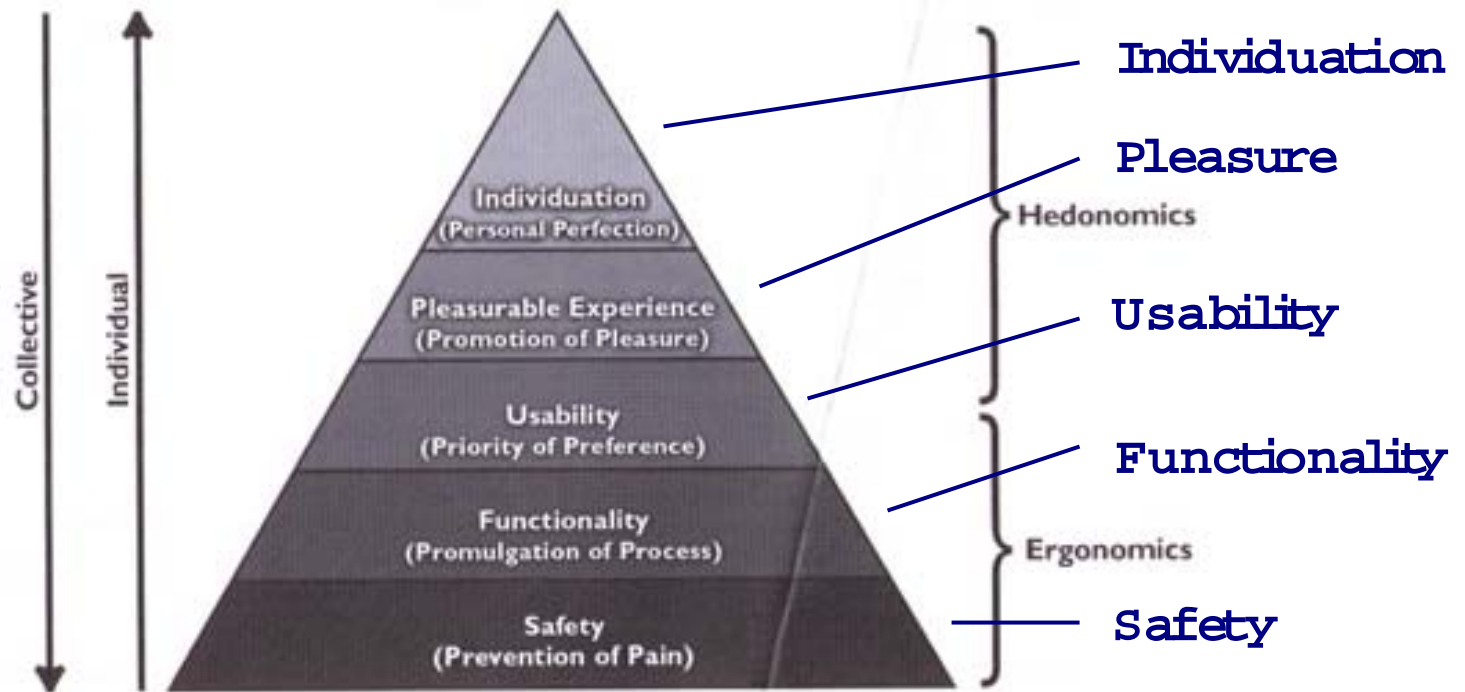


# "Normal" Distribution

- Push the "limits" !



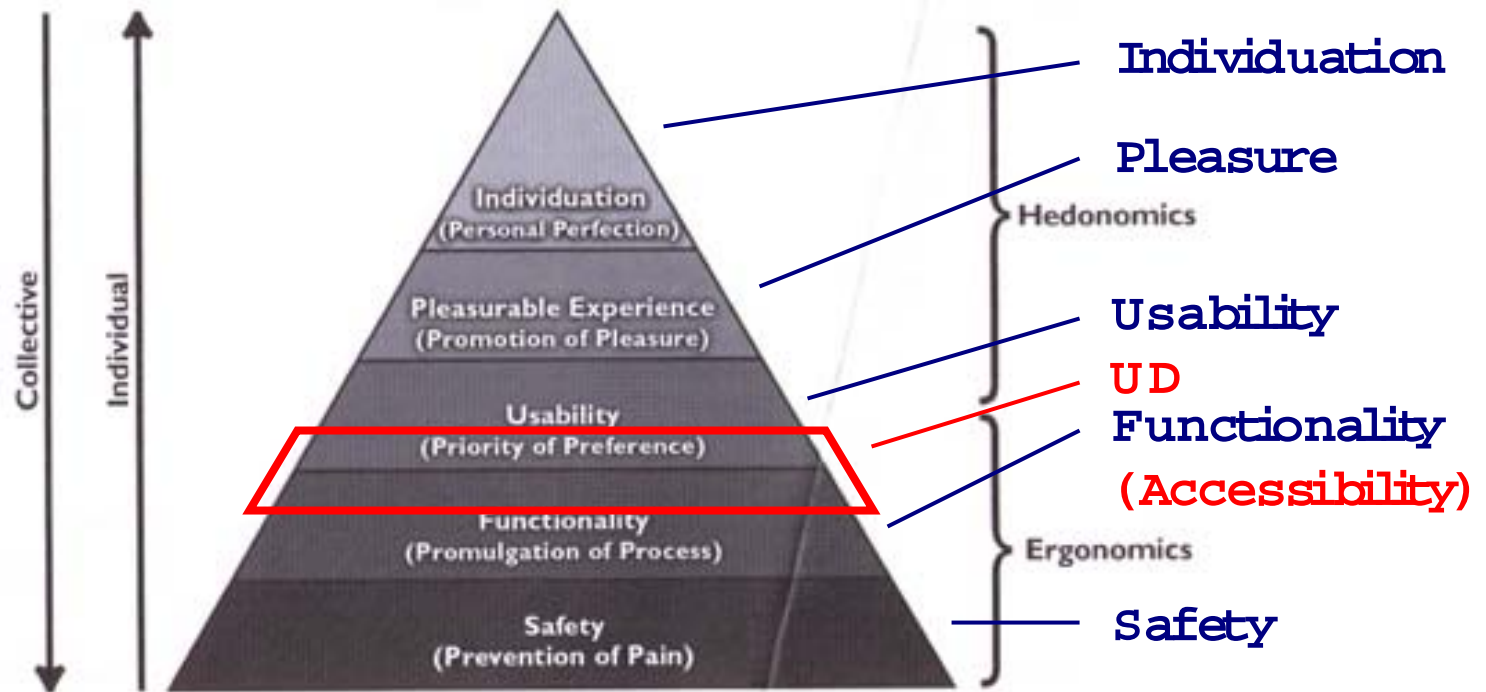
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*A hierarchy of ergonomics and hedonomic needs derived from Maslow's conception. The fact that these design imperatives match the social edict of "life, liberty, and the pursuit of happiness" has not escaped our attention (see Hancock, 1999).*



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# 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

## Vision:

*All persons should have access to  
healthcare products, facilities and services  
and to employment  
in the healthcare professions  
regardless of disability.*



# Medical Equipment Survey Results:

## *The Big 4*

### Type of Equipment

### • Moderate Difficulty

Examination tables (n = 291)	74.9 %
X-ray equipment (n = 258)	68.2 %
Rehab./exercise eq. (n = 203)	55.1 %
Weight scales (n = 222)	53.6 %



# RERC-AMI Student Design Competition

2004-2005

1. Accessible Weight Scale
2. Accessible Syringe Dosing Device
3. Accessible Ergometer



# RERC-AMI Student Design Competition

2005–2006

1. Accessible Blood Glucose Monitor Interface
2. Accessible Medication Dispensing Device
3. Patient Positioning Aid



# RERC-AMI Student Design Competition

2006-2007

1. Accessible Home Vital Signs Monitoring System
2. Accessible Infusion Pump Interface
3. Accessible Power-Assist Hospital Bed Back Angle Controller



# Contact Information

## The Center for Universal Design

- <http://www.design.ncsu.edu/cud>
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## RERC on Accessible Medical Instrumentation

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