CMPE 80A: Universal Access: Disability, Technology, and Society

Contact:
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What is this course about
► Overview of human-centered technology
  ▪ and of its potential for increasing the quality of life and independence of individuals with disabilities.
► Physical, psychological, and psychosocial aspects of disability
► Diversity and integration, legislation, accessibility.
► Universal design

Course Logistics
► Class meetings
  ▪ Mon/Wed 5:00-6:45 PM, Jack Baskin Aud 101
  ▪ Lectures, movies, demonstrations
► Assessment
  ▪ Pair assignments: 40% (10 of them)
  ▪ Group Project: 40%
  ▪ Attendance: 20% (unless there is a written documentation justifying non-attendance, non-attendance = 0 for that day)
► Pair assignments:
  ▪ Relevant to the topic presented that day
  ▪ Done in pair (pair can’t repeat for the quarter)
  ▪ Assignments need to be done by 09:55 the day after
  ▪ Delivered through email to the TA

Group projects
► Worth 40% of the grade – group grade
► Helping one person with special need at a time
► Done in a group of max 3 students
► Interview on the technology & tasks that they would like to use but can’t → need careful consideration, is it worth 40%?
► Guide them throughout the whole quarter
► Document the process on a facebook page (movies, pictures, blogs, etc)
► Report due in week 9
► Poster presentation in week 10

Ability Differences: We’re all disabled once
► When?
  ▪ Environment: in a foreign country, in a bouncing vehicle, in the dark
  ▪ Non-optimal health: lack of sleep, drunk, fever
  ▪ Injury: hit a finger with a hammer
  ▪ At the two extremes of our lives
  ▪ Changing role of technology: new products, unfamiliar interface
► Disability conditions:
  ▪ Transient: Noisy room
  ▪ Temporary: Broken arm
  ▪ Permanent: For most, this one is labeled a disability
American with Disabilities

2005 American Community Survey

0%
10%
20%
30%
40%
50%
60%
70%
80%
90%

5-15 16-64 65+
employment
go-outside-home
self-care
mental
physical
sensory

Ages

<table>
<thead>
<tr>
<th></th>
<th>5-15</th>
<th>16-64</th>
<th>65+</th>
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<tbody>
<tr>
<td>sensory</td>
<td>1.2%</td>
<td>2.8%</td>
<td>16.4%</td>
</tr>
<tr>
<td>physical</td>
<td>1.2%</td>
<td>7.2%</td>
<td>30.8%</td>
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<tr>
<td>mental</td>
<td>5.2%</td>
<td>4.5%</td>
<td>11.5%</td>
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<tr>
<td>self-care</td>
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<td>2.0%</td>
<td>9.7%</td>
</tr>
<tr>
<td>go-outside-home</td>
<td>0.0%</td>
<td>3.0%</td>
<td>16.6%</td>
</tr>
<tr>
<td>employment</td>
<td>0.0%</td>
<td>6.8%</td>
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How special are special needs?

Models of disabilities

► Medical Model
- Problem entirely with individual, not society
- Ideally: transform person with disability (pathological) into “normal”
- Stress on cure, hospitalization, rehabilitation
- Results in eugenics (the study of hereditary “improvements” of the human race by controlled selective breeding)
- Peter Singer, Princeton University: When the death of a disabled infant will lead to the birth of another infant with better prospects of a happy life, the total amount of happiness will be greater if the disabled infant is killed.
- Read R. Olkin’s “The Human Rights of Children with Disability”

► Environmental Model
- Environment (social or physical) may cause, define, or exaggerate disability
- Physical environment: historic town with uneven ground and no wheelchair access
- Social environment: Prejudice, discrimination, stigma → The chief handicap of the blind is not blindness, but the attitude of seeing people towards them, H. Keller
- Cultural environment → Foot binding in Manchurian China → Not being able to walk was a sign of distinction
- Economical barrier → no money to remedy disability

► Functional Model
- Disability defined by the functions that an individual can perform, typically work-related
- Example: A person using a wheelchair is not a disabled when the functional activity is computer programming
- Shift of U.S. economy from farming, mining and manufacturing to service and Information Processing has changed functional criteria for disability
- Cognitive disability has become more limiting than physical disability
- Older workers (or those coming back to work after war) have become “disabled”
**Overcoming barriers to access**

- Two main approaches:
  - Universal/inclusive design
  - Assistive technology
- **Universal design**
  - goes beyond the design of interactive systems and applies to all design endeavours.
  - grounded in a certain philosophical approach to design encapsulated by an international design community
  - if a design works well for people with disabilities, it works better for everyone
- Inclusive design is more pragmatic → doesn’t claim to cover the whole population

**Assistive Technology**

- Technology designed to be utilised in device or service to increase, maintain, or improve functional capabilities of individuals with disabilities
- Provide user with alternative technology to operate the system
  - allowing them to operate the system through an alternative interface (e.g. input device).
  - allowing them to modify some parts of the system.

<table>
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<tr>
<th>Accessible technology</th>
<th>Assistive technology</th>
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<tbody>
<tr>
<td>Convenient (doesn’t require people to own additional device)</td>
<td>Necessary for people with multiple disabilities</td>
</tr>
<tr>
<td>Removes the stigma of special aids</td>
<td>Sometimes more commercially/ practically viable</td>
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**Principles of Universal Design**

1. Equitable Use: The design does not disadvantage or stigmatize any group of users.
2. Flexibility in Use: The design accommodates a wide range of individual preferences and abilities.
3. Simple, Intuitive Use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
4. Perceptible Information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities → http://www.youtube.com/watch?v=SWtDmY0yUTE

5. Tolerance for Error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low Physical Effort: The design can be used efficiently and comfortably, and with a minimum of fatigue.
7. Size and Space for Approach & Use: Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

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**How we see the world**

**Eye Anatomy**
The eye works like a camera!

The Eye

► Non-retinal parts keep a focused, clear image of outside world anchored on the two retinas
  - 6 muscles (3 pairs working in opposition) per eye
  - If eyes not precisely aimed at same point, we see double
► Adjustment of focus is done by changing the shape of the rubbery, jelly-like lens
  - Performed by the ciliary muscles
  - At age beyond 45, lens becomes hard and we lose our ability to focus
► Diameter of the pupil controlled by two sets of muscles
  - Works like the diaphragm of a camera
► Self-cleaning of cornea by blinking lids and lubricating with tear glands

Retina

► Translates light into nerve signals
► Connects to the brain via the optic nerve
► At the back of the retina, photoreceptors
  - Rods: vision in dim light (not functional in bright light)
  - Cones: color, high resolution vision in bright light
► Fovea: small area with high density of cones (no rods)
  - Only 1% of the retina, but takes up 50% of the visual cortex in the brain
  - Outside fovea, cones are present but with lower density

Color Vision

► The light spectrum is electromagnetic energy spread over different wavelengths $\lambda$
  - The wavelength $\lambda$ of the light indicates the light color
► 3 types of cones (R,G,B)
  - Sensitive to different wavelengths
  - Each cone type sends a message to the brain depending on the wavelength of the light it receives
► Rods are sensitive over a wider light spectrum (380 to 700 nm)

Color Blindness

► 8-10% male and 0.5% female populations have some form of color deficiency
► Very rarely can only see B/W
► Protanope
  - 1% males, "red-weakness"
► Deuteranope
  - 5% males, "green-weakness"
► Tritanope
  - blue/yellow deficit
► Simulation: http://www.vischeck.com/vischeck/vischeckURL.php

Visual Acuity

► Ability to resolve fine detail
► Snellen scale (e.g., 20/20)
  - A score of 20/x means that the person’s performance matches that of a person with unimpaired vision at a distance of x
  - 20/40: you need twice the font size or half the distance to read what normal people can read at 20'
  - Acuity is always measured in 20/x even when measurements are taken at closer distances $\rightarrow$ 8/16 vision is equivalent to 20/40
  - 20/200 at the better eye = legally blind
**Near/Farsightedness**

- **Near:** Image focused in front of retina.
- **Farsighted:** Image focused beyond retina.
- **Normal vision:** Image focused on retina.

**Visual Field**

- Entire region of space off to all sides that is visible when the person is looking and facing straight ahead.
  - Measured in degrees.
  - Decrease with aging.

**Normal Visual Fields**

- Extends from the point of fixation out to:
  - ~95° towards one’s temple, ~60° towards one’s nose, ~50° above, ~65° below.
- Everything at 60° to the right/left is seen by both eyes.
  - The farthest 35° are seen by only one eye.
  - Overall: 190° of continuous visual field.
- Vision field corresponding to fovea: 3° (twice the width of your thumbnail at arm’s length).

**Visual Field Defects**

- **Peripheral visual field defects** (beyond 30°):
  - Only central vision remaining.
  - Greatest impact on safe visually guided travel and driving.
  - <20° visual field in the better eye defines legal blindness.
- **Central visual field defects**:
  - Only peripheral vision remaining.
  - Scotoma: dense and localized blind spot.
  - Makes reading difficult.
  - Acuity outside the fovea is limited.
  - Peripheral areas of retina cannot support rapid reading.
  - Need to shift gaze slightly to one side or another (eccentric viewing).
- Simulation of visual field defects:
  - [www.nei.nih.gov/photo/eyedis/VA05.mov](http://www.nei.nih.gov/photo/eyedis/VA05.mov)

**Contrast Sensitivity**

- **Contrast** = relative difference of brightness between foreground and background.
  - Affected by color, brightness/luminance.
- **Contrast sensitivity** = ability to detect various levels of contrast.
  - High contrast sensitivity allows one to detect low levels of contrast.

**Main Causes of Visual Impairment**

- **Macular degeneration**:
  - Affects the central visual field. Produces a scar that over time may involve a large area of the retina.
  - Can occur to young or (more typically) old (> 50) persons.
- **Cataract**:
  - Opacity of the lens (normally due to aging).
  - Cataract surgery (lens substitution) is now a standard procedure.
- **Glaucoma**:
  - Progressive loss of optic nerve cells, producing loss of visual field.
  - Progressive; early detection important.
Main Causes of Visual Impairment

► Diabetic retinopathy
  - Damage to fovea and outer retina due to long-standing diabetes
  - Laser therapy may be effective to stop the damage process

► Retinitis pigmentosa
  - Group of inherited disorders of the retina
  - Begins with night blindness (due to malfunctioning of the rods), followed by tunnel vision

► Optic neuropathy
  - Damage of the optic nerve due to blockage of blood supply or toxins

► Brain damage
  - Due e.g. to trauma, stroke or tumor

► For more info: http://www.nei.nih.gov/health/

Statistics

► 21.2 million Americans with vision loss
  - From “having trouble seeing” even with glasses, to blindness

► 1.3 million Americans legally blind
  - Of which, 58,000 are children (0-21)

► About 250,000 totally blind or with only some light perception

Statistics

► Mobility with vision loss:
  - 110,000 use long canes to get around
  - 7,000 use guide dog

► Almost 10% of persons with “severe visual impairment” use a wheelchair

► ~30% of persons with blindness make no independent trips outside the home

► http://video.guidedogs.com/soulmateshi.asx

Statistics

► Educational attainment:

- 10% of legally blind children use Braille as their primary reading medium

Statistics

► Employment rate (working age):
  - 47.5% with sensory impairment (ACS)
  - 55.3% with “difficulty seeing words or letters” (U.S. Census Bureau)
  - 19% of legally blind (NHIS)
  - 18% of out-of-school youth who received special education (NLTS)

► Family income:

Statistics

► Lenses and screen magnifiers for reading

► White cane for mobility
  - Sometimes used also by low vision individuals
  - Allows one to detect obstacles, identify materials (sound, texture)
  - Aural cues for mobility e.g.: listening to traffic sounds to infer when to cross an intersection

Basic Tools and Techniques
Crossing a Street

► Orientation and alignment cues (US Dept. of Transp.)
  - Detect slight slopes under foot and/or a detectable change in surface texture
  - Listen to direction that cars are traveling to align to cross
  - Listen to when the cars start moving in the closest lane as indication of time to cross
  - Maintain awareness of buildings, sun, other pedestrians, smells, and sounds which provide information
  - Ask sighted people
  - Smart crossing button
  - Japan’s crossing

Basic Accommodation Tools

► Braille print / Embossed paper
► Audible pedestrian signals at traffic intersections
  - Sound type depends on crossing orientation
► Detectable warning surfaces
  - E.g. bumps on curb ramps
► Auxiliary aids are regulated in public settings by the American with Disabilities Act (ADA)

Braille

► Each Braille character or (cell) is made up of 6 dot positions
  - Arranged in a vertical rectangle of 2 columns of 3 dots each
► Typing:
  - Perkins Brailler (manual)
  - Embosser (used as a printer)