Building User Interfaces

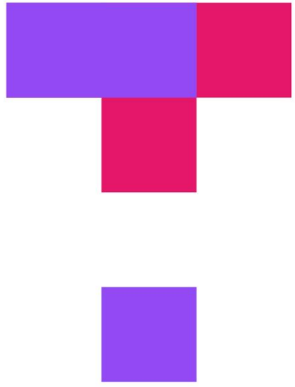
Designing for Accessibility

Professor Bilge Mutlu

What we will learn today?

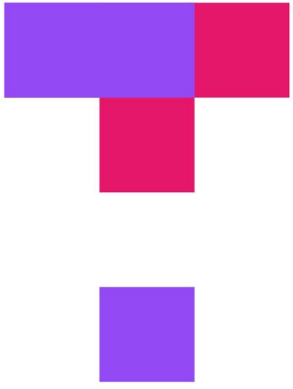
- What is accessibility?
- Accessible design
- Assistive technologies
- Accessible building
- Assignment preview

TopHat Attendance



TOP HAT

TopHat Questions



TOP HAT

What is accessibility?

Definitions

how well it works

how well it facilitates work

how much users enjoy / like

Usability: The effectiveness, efficiency, and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment. — ISO 9241-11

Accessibility: The usability of a product, service, environment, or facility by people with the widest range of capabilities. — ISO 9241-20

International Standards Organization

From Accessibility to Disability

Accessibility is the extent to which an interactive product is accessible by as many people as possible.

The primary focus of accessible design is making systems accessible to individuals with *disabilities*.

Disability[1]

Definition: A *disability* is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).

Disability can change over time with age or recovery, and the severity of the impact of disability can change over time. Fewer than 20% are born with a disability, although 80% of people will have a disability once they reach 85.

[1] CDC ← Centers for Disease Control (although Disability isn't necessarily disease-based)

Three Dimensions of Disability[2]

1. **Impairment** in a person's body structure or function, or mental functioning (e.g., loss of a limb, loss of vision, or memory loss)
2. **Limitation in activities** (e.g., difficulty seeing, hearing, walking, or problem solving)
3. **Restrictions in participation** in activities of daily living (e.g., working, engaging in social and recreational activities, and obtaining health care)

[2] Source: World Health Organization

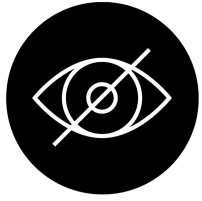
Types of Impairment: Anatomical[3]

1. Sensory impairment
2. Physical impairment
3. Cognitive impairment

see / hear / smell / etc

missing limbs / etc

learning impairments (can be from birth or acquired)



Can't see

Can't speak

Can't hear

Can't touch

[3] Image source: Microsoft Inclusive Design Toolkit

Sensory Impairment

Involves impairment in one or more senses, such as loss of vision or hearing.

Physical Impairment

Involves loss of function to one or more parts of the body, e.g., congenitally or after stroke or spinal-cord injury.

Cognitive Impairment

Includes cognitive deficits, such as learning impairment or loss of memory/cognitive function due to aging or conditions such as Alzheimer's disease.

Common Impairments

- Visual
- Motor/Mobility
- Auditory
- Seizures
- Learning

Visual Disabilities

Definition: Impairments in vision, including long-sightedness, blindness, and color blindness.

much broader than simple blindness

Motor/Mobility

Definition: Muscular or skeletal impairments in the hands or arms that affect user input as well as impairments that affect mobility, where users are in a wheelchair or bedridden, and thus the context of use.

Auditory

Definition: Deficits that affect hearing at different levels of severity, including deafness.

Can also be bandwidth-based

Seizures

Definition: Neurological impairments, such as photosensitive epilepsy, that result in sensitivity to light, motion, and flickering on screen, which might trigger seizures.

Consider unexpected animations on devices

Cognitive/Learning

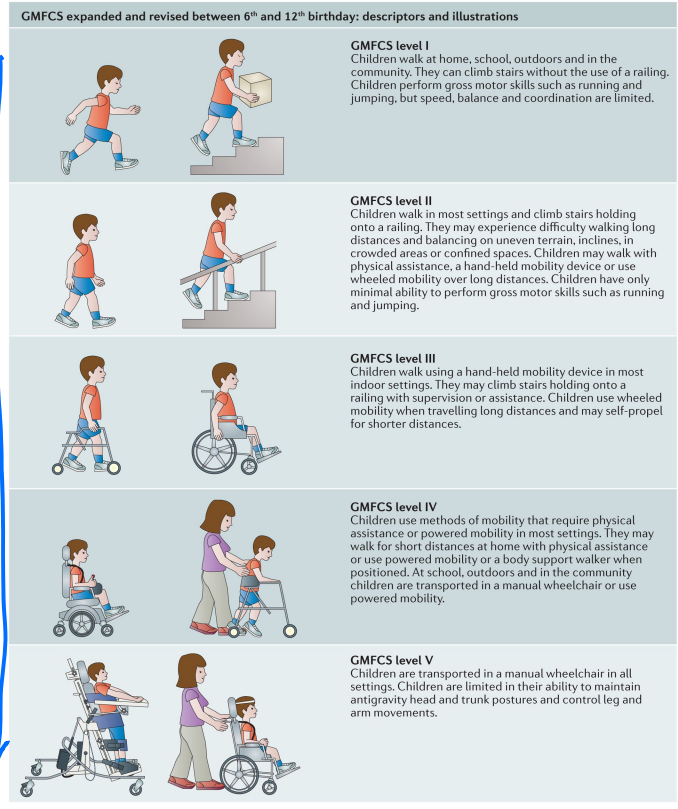
Definition: Congenital, developmental, and traumatic (e.g., traumatic brain injury) conditions that result in cognitive or learning challenges.

Variability[4]

Impairments can vary in severity or structure depending on the source and nature of the impairment.

Severity: Children with cerebral palsy can have basic mobility or completely depend on a caretaker.

Structure: Vision impairments can include color blindness, peripheral-only vision, no light



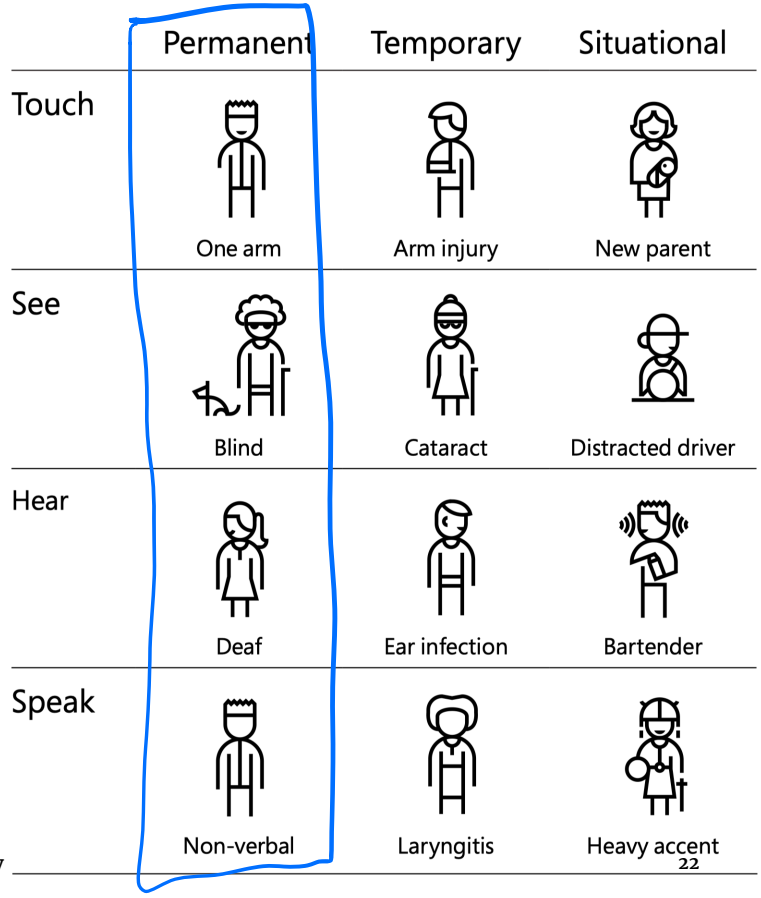
[4] Image source

Types of Impairment: Temporal

1. *Permanent* impairment → long-term or congenital
2. *Temporary* impairment → improve over time
3. *Situational* impairment → based on situation

Permanent Impairment[5]

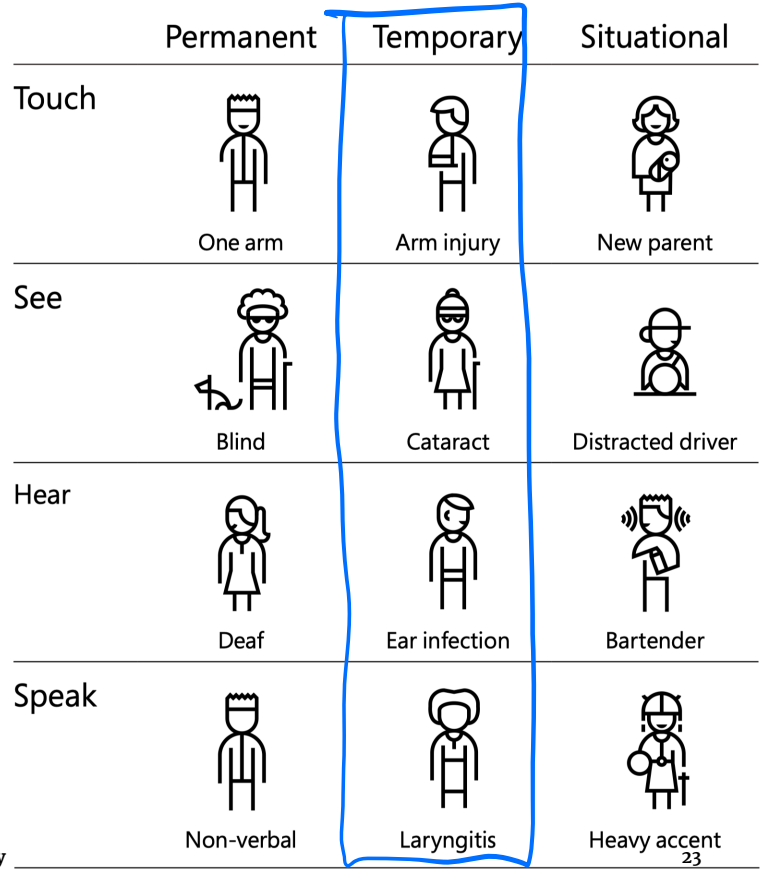
Congenital or long-term conditions, such as color blindness, missing body parts, etc.



[5] Image source: Microsoft Inclusive Design Toolkit

Temporary Impairment[6]

Impairments that improve over time, such as recovery after illness or accidents, e.g., a broken arm.



[6] Image source: Microsoft Inclusive Design Toolkit

Situational Impairment[7]

Impairments introduced by context, such as environments with low light or noise.

	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

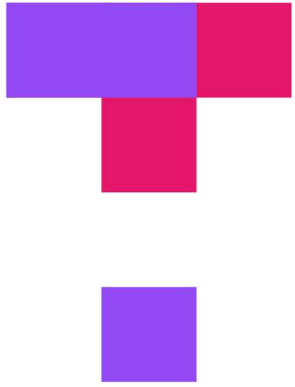
[7] Image source: Microsoft Inclusive Design Toolkit

How do we achieve accessibility?

Two ways to address accessibility problems:

1. Accessible design
2. Assistive technologies

TopHat Quiz



TOP HAT

Accessible Design

Context-dependent Model of Disability

Consider someone in an environment supportive / designed for/by them, where this may limit the effects of disability

Disability as **personal attribute**

In the context of health experience, a disability is any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being.

Disability as **context dependent**

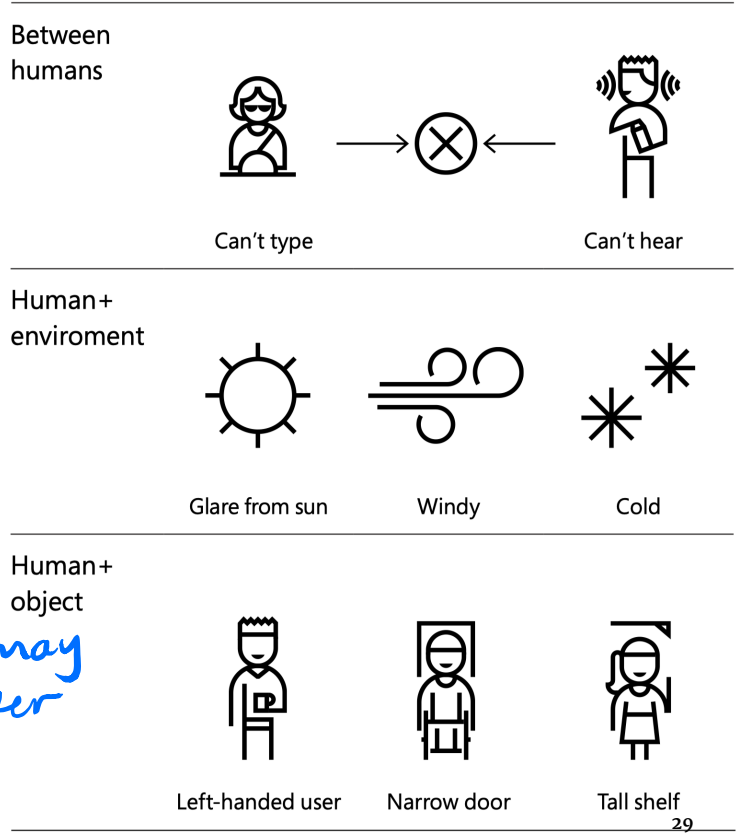
Disability is not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives.

Mismatch between Abilities and Environment[8]

Context-dependent disability results from a mismatch between abilities and the environment:

`Ability + Context = Disability`

a more generalized approach that actually considers more potential issues users may encounter



[8] Image source: Microsoft Inclusive Design Toolkit

Universal Design[9]

Definition: 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.

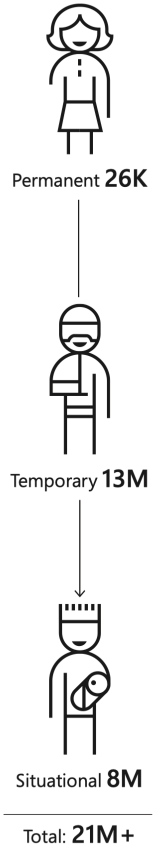
Think about sidewalk ramps

Push bars for doors / emergency exits

[9] Ron Mace, 1996

The Main Premise of Universal Design[10]

Design solutions that benefit some individuals may benefit the whole society. E.g., in the US, only 26K people are suffer loss of upper extremities. Designs that would benefit these 26K would also benefit another 21M people with temporary or situational disabilities.



helps a lot more than just permanent disability!

[10] Image source: Microsoft Inclusive Design Toolkit

An Example: Closed Captioning[11]

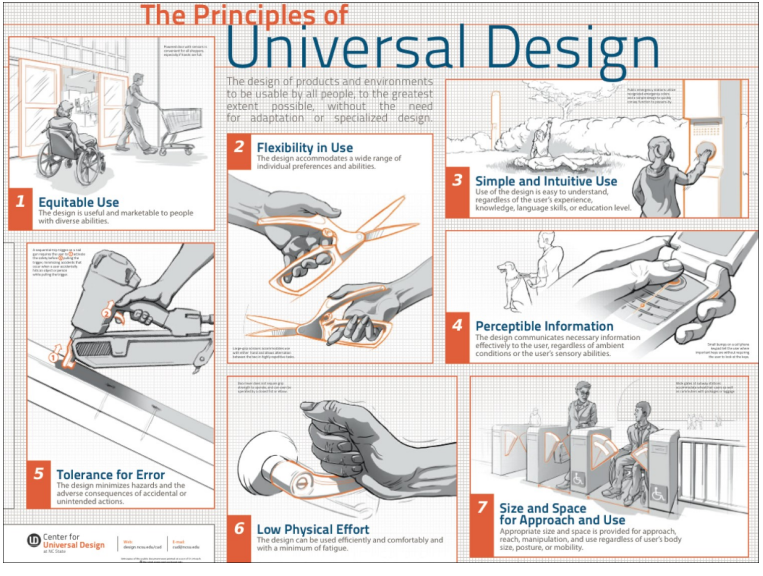
Although closed captioning was originally developed for individuals with hearing impairments, they now also benefit reading in noisy environments and learning to read.

[11] Image source: Microsoft Inclusive Design Toolkit

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 and use

12



[12] Image source: Interaction Design Foundation

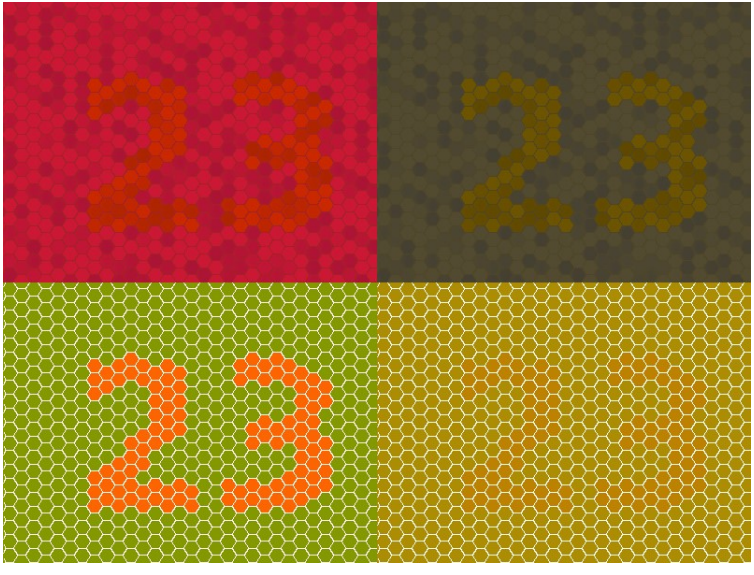
Principle 1: Equitable use

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

1. Provide the same means of use for all users: identical whenever possible; equivalent when not.
2. Avoid segregating or stigmatizing any users.
3. Provisions for privacy, security, and safety should be equally available to all users.
4. Make the design appealing to all users.

—don't hide such menus behind locations not accessible by voice, for example

13



[13] Example source: Interaction Design Foundation; Image source: Johannes Ahlmann

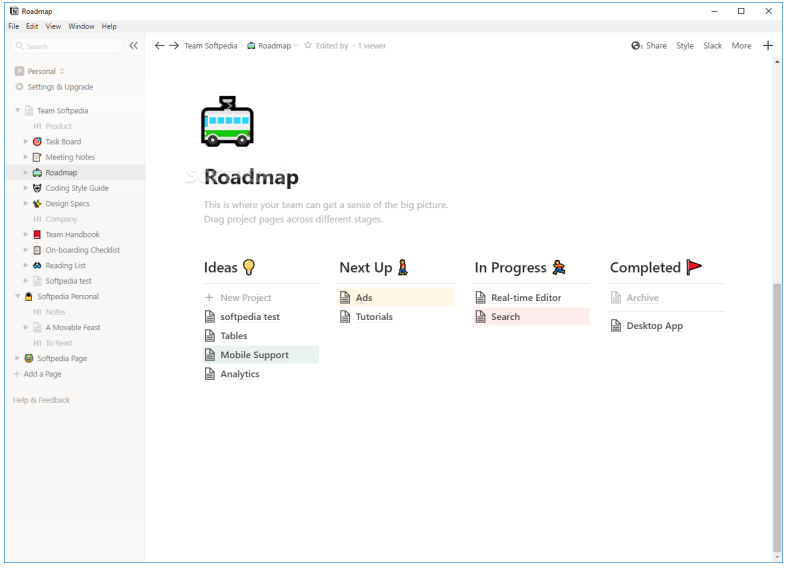
Principle 2: Flexibility in Use

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

1. Provide choice in methods of use.
2. Accommodate right- or left-handed access and use.
3. Facilitate the user's accuracy and precision.
4. Provide adaptability to the user's pace.

↑ Sometimes notifications disappear too fast, etc.

14



[14] Image source

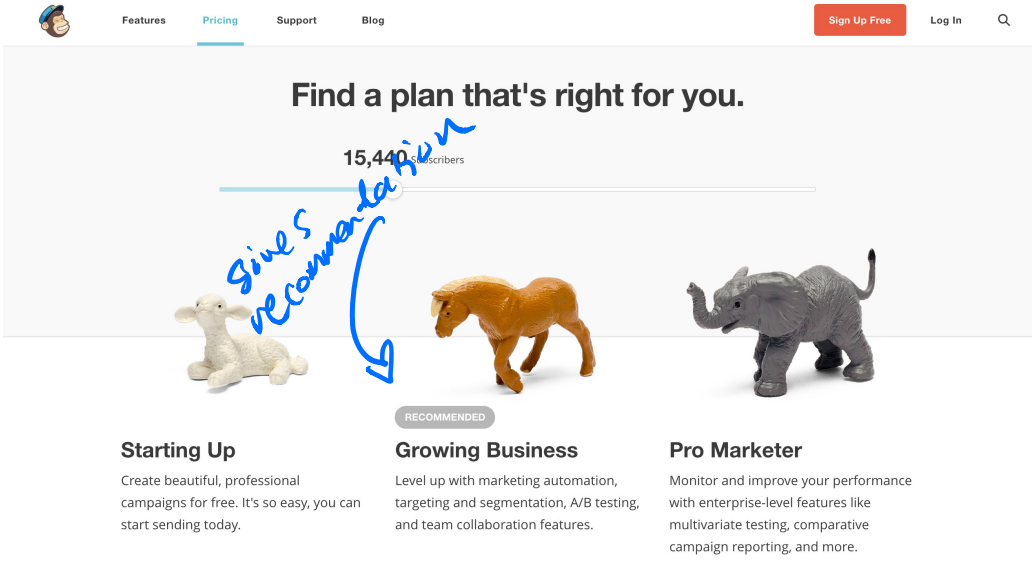
Principle 3: Simple and Intuitive Use

hard, but working on it makes a lot of improvements

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

1. Eliminate unnecessary complexity.
2. Be consistent with user expectations and intuition.
3. Accommodate a wide range of literacy and language skills.
4. Arrange information consistent with its importance.
5. Provide effective prompting and feedback during and after task completion.

15



[15] Example source: Interaction Design Foundation

Principle 4: Perceptible Information

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

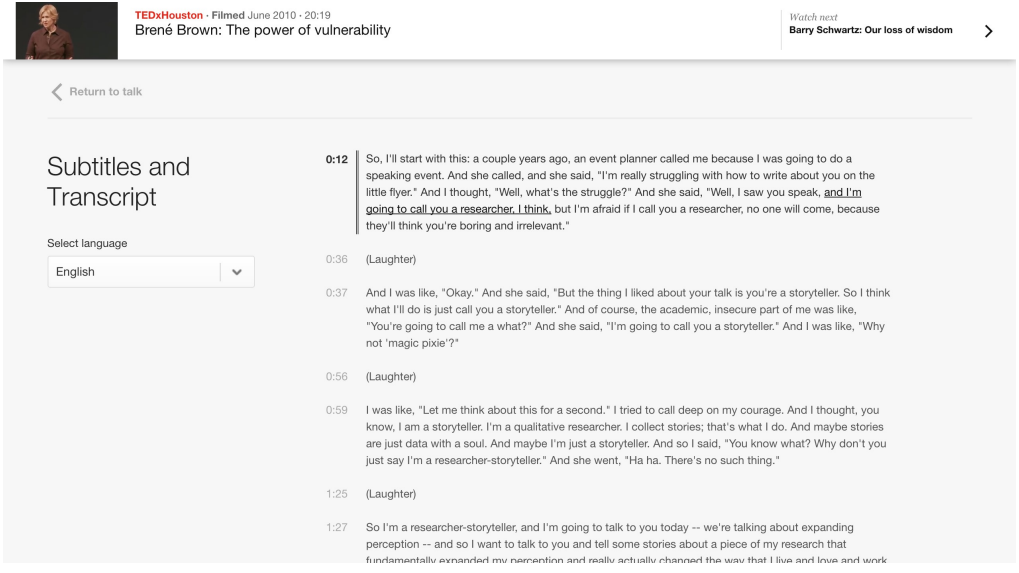
1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
2. Provide adequate contrast between essential information and its surroundings.
3. Maximize "legibility" of essential information

Visual hierarchy

Sometimes a good thing!

1. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
2. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

16



[16] Image source: Interaction Design Foundation

Principle 5: Tolerance for Error

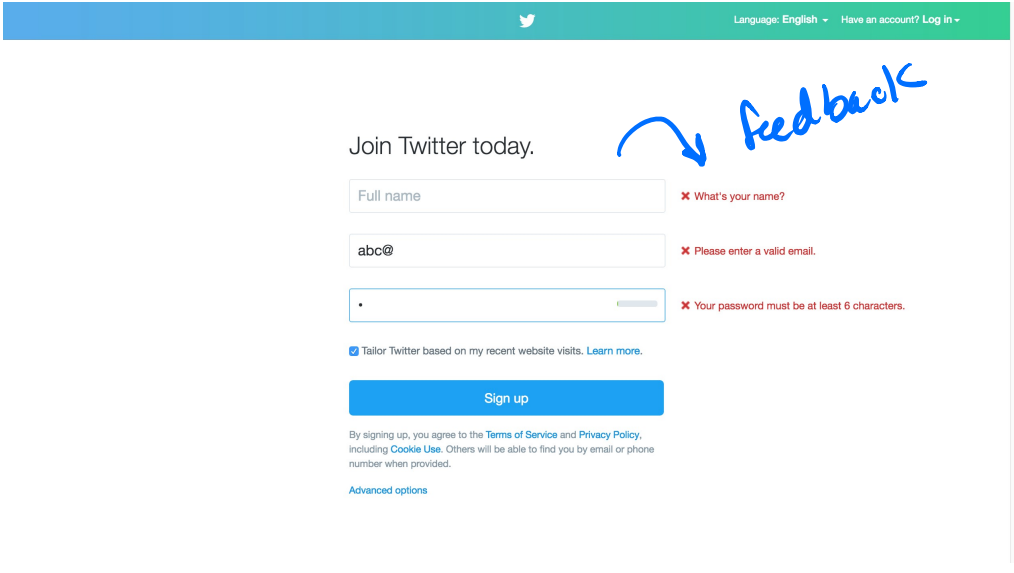
helps everyone, but effects of disability can make things worse

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

1. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
2. Provide warnings of hazards and errors.
3. Provide fail safe features.
4. Discourage unconscious action in tasks that require vigilance.

sometimes expert tools get accidentally engaged

17



[17] Image source: Interaction Design Foundation

Principle 6: Low Physical Effort

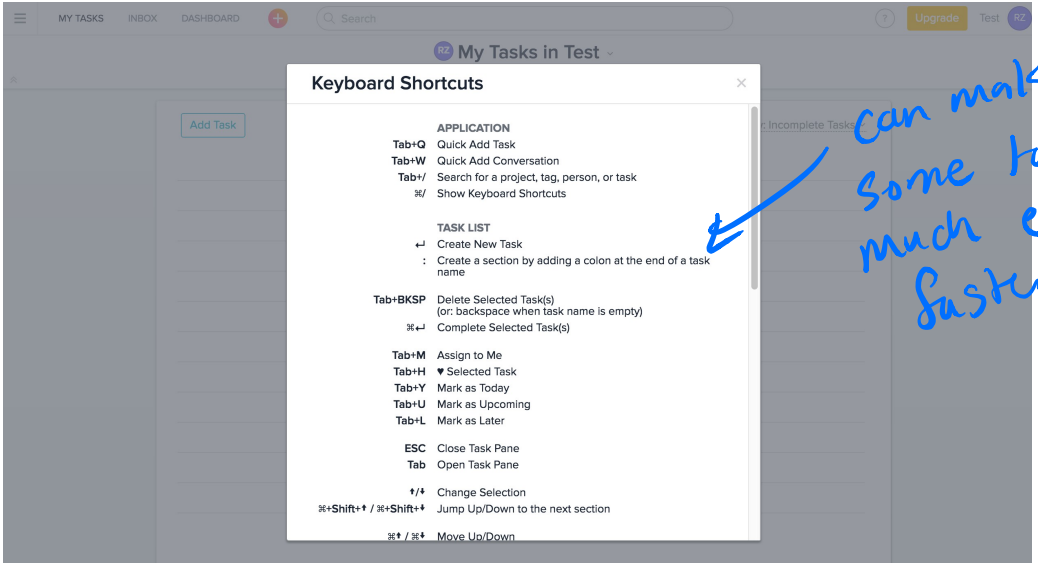
The design can be used efficiently and comfortably and with a minimum of fatigue.

» 1. Allow user to maintain a neutral body position.

1. Use reasonable operating forces.
2. Minimize repetitive actions.
3. Minimize sustained physical effort.

ergonomics!

18



[18] Image source: Interaction Design Foundation

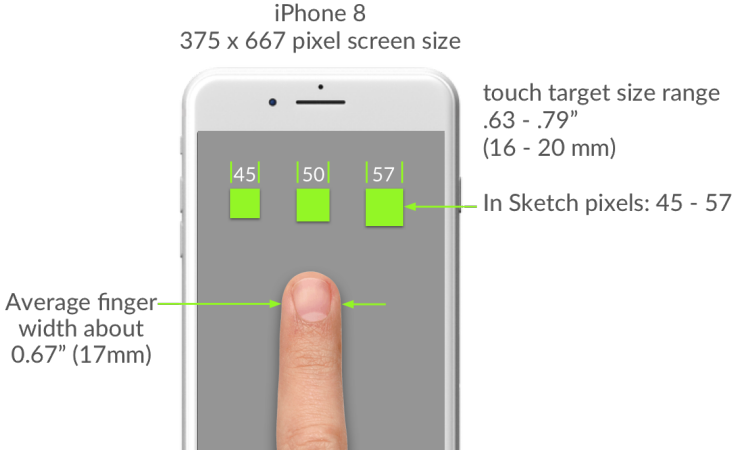
Principle 7: Size and Space for Approach and Use

Can users reach this feature?

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

1. Provide a clear line of sight to important elements for any seated or standing user.
2. Make reach to all components comfortable for any seated or standing user.
3. Accommodate variations in hand and grip size.

1. Provide adequate space for the use of assistive devices or personal assistance.[19]



Consider the size of buttons, or proximity

[19] Image source

Assistive Technologies

What are assistive technologies?

Definition: Specialized tools that close accessibility gaps.

Every impairment may have a different collection of needs. These help users customize for their personal needs

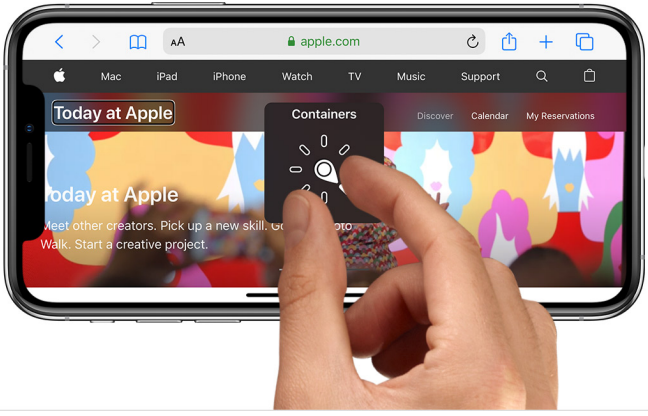
Screen Readers[20]

Definition: Software used by individuals with vision impairments to read screen content.

» JAWS for Windows

» VoiceOver for MacOS, iOS

» NVDA



[20] Image source

Screen Magnification[21]

Definition: Enlarges text or graphics on screens to improve visibility of content for individuals with limited vision.

[21] Image source

Text Readers[22]

Definition: Tools that read out loud text on screens to support vision and learning disabilities.

can be real-world or on device

[22] Image source

Braille for the Web[23]

Definition: A mechanical device that translates textual content on the screen into Braille.

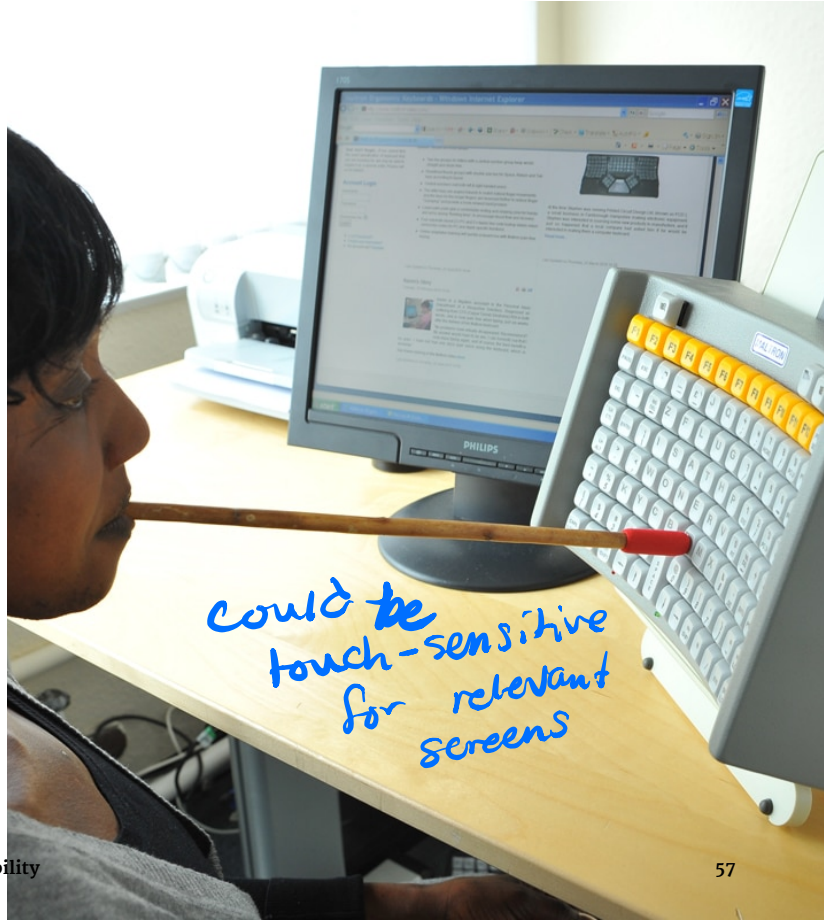
[23] Image source

Alternative Input Devices

Definition: Specialized tools that help individuals with motor impairments who cannot use a mouse or keyboard with pointing.

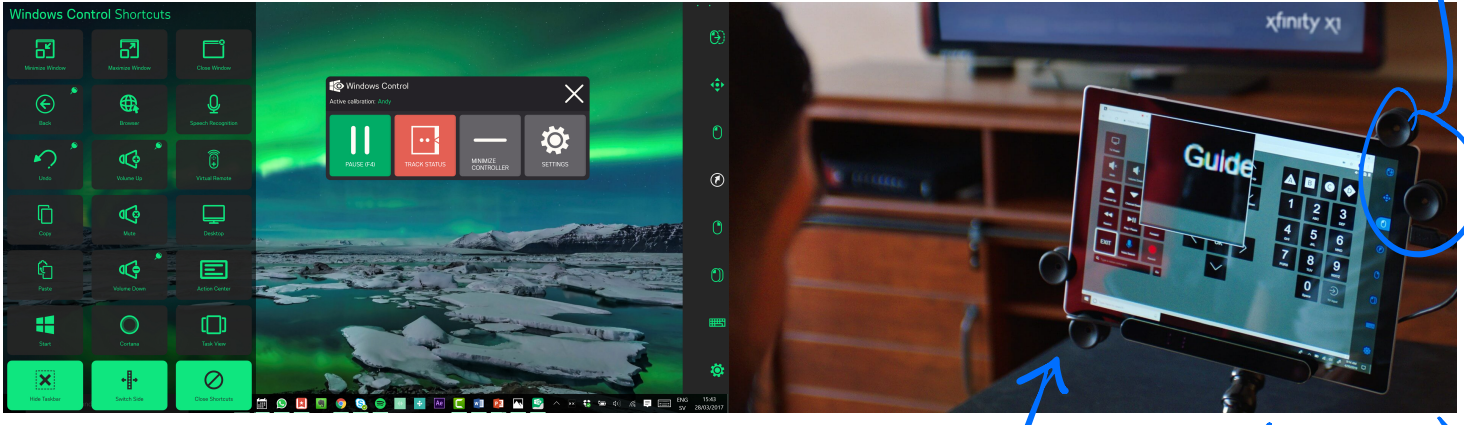
- Head/mouth wands/pointers
- Motion/eye tracking
- Single-switch (e.g., sip-and-puff)
- Speech input

Head/mouth wands/ pointers[24]



[24] Image source

Motion/eye tracking[25]



[25] Image source: left, right

Single-switch (e.g., sip-and-puff)[26]

frequently customized for specific ability

[26] Image source

Speech input[27]

[27] Image source

Alternative & Augmentative Communication[28]

Definition: Tools that help individuals who are unable to use verbal speech to communicate.

[28] Image source

Accessibility Testing Tools

» WAVE—evaluates the overall level of accessibility for any given website.

» Color Oracle— displays your site's colors in a manner similar to how a user with color blindness would see the page.

» Image Analyzer— examines website images and tests their compliance with accessibility standards.

In-class Activity

29

How to Navigate with VoiceOver

[29] Video source

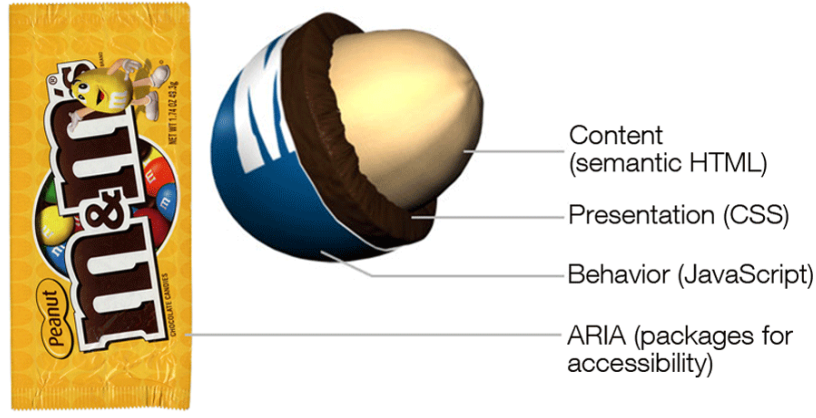
Task 1: Purchase a new iPhone on the Apple site.

Task 2: Send a new email to Apple support.

Accessible Building

Accessibility in Web Technologies[30]

From the *three-layered cake* to the *Peanut M&M*:



[30] Image source

Accessible Rich Internet Applications (ARIA)[31]

`aria` is a set of HTML attributes that make web components avialable to assistive technologies.

```
<div id="percent-loaded" role="progressbar" aria-valuenow="75"
     aria-valuemin="0" aria-valuemax="100">
</div>
```

[31] MDN Web Docs: ARIA

Accessibility in React Native[32]

RN provides us with access to assistive technologies that mobile platforms provide (e.g., VoiceOver on iOS or TalkBack on Android) through component attributes.

```
<View accessible={true}>
  <Text>List item one</Text>
  <Text>List item two</Text>
</View>
```

[32] React Native Accessibility

React Native Accessibility Properties

`accessible` attribute indicates whether the component is an accessibility element and, if so, groups its children in a single selectable component.

`accessibilityLabel` attribute defines screen reader descriptions of components.

`accessibilityHint` attribute helps users understand what will happen if they perform the action on the accessibility element.

React Native Accessibility Actions

Standard, e.g., `magicTap`, `escape`, `activate`, `increment`, `decrement`, `longpress`, or custom actions, handled by `onAccessibilityAction`.

```
onAccessibilityAction={(event) => {
    switch (event.nativeEvent.actionName) {
      case 'longpress':
        // take action
      ...
    }
  }}
```

Assignment Preview

Design Assignment 09: Accessible Design

Part 1. Discovery the accessibility of mobile platforms

Part 2. Designing accessibility features for your fitness app

Part 1. Discovery

- Choose an existing app from any domain (fitness, weather, social media, news)
- Choose three accessibility features on your mobile device, one from each of (1) *vision*, *physical/motor*, *hearing*
- Perform one task in the app with each feature enabled
- Describe the changes each accessibility feature provided

Part 2. Design

- Choose one *permanent*, one *situational* impairment that you would like to target with your app
- Determine the design requirements for each impairment
- Prepare wireframe mock-ups of your app design and versions of your app that meet these requirements
- Highlight and describe your accessible design features by annotating your prototype

What did we learn today?

- What is accessibility?
- Accessible design
- Assistive technologies
- Accessible building
- Assignment preview