

Building User Interfaces

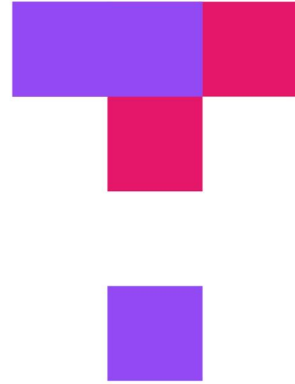
Designing for Accessibility

Professor Bilge Mutlu

What we will learn today?

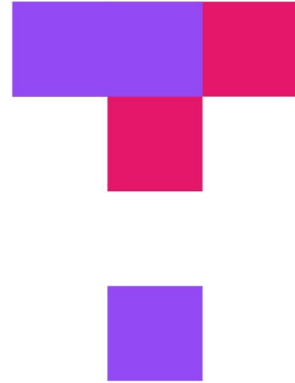
- >> What is accessibility?
- >> Accessible design
- >> Assistive technologies
- >> Accessible building
- >> Assignment preview

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*.

Disability¹

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.

¹CDC

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

Three Dimensions of Disability²

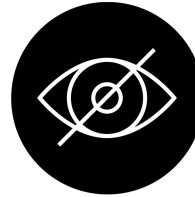
1. **Impairment** in a person's body structure or function, or mental functioning (e.g., loss of a limb, loss of vision, or memory loss)
2. **Limitation in activities** (e.g., difficulty seeing, hearing, walking, or problem solving)
3. **Restrictions in participation** in activities of daily living (e.g.,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

² Source: World Health Organization

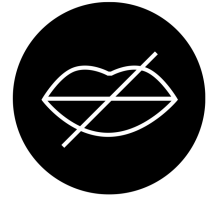
Types of Impairment: Anatomical³

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

³Image 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.

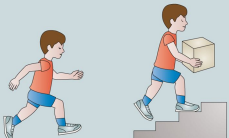
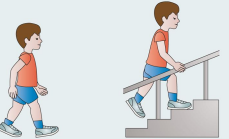
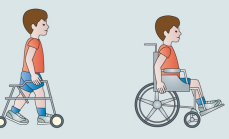
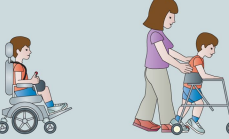

Variability⁴

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

increasing severity

GMFCS expanded and revised between 6 th and 12 th birthday: descriptors and illustrations	
	GMFCS level I Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited.
	GMFCS level II Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces. Children may walk with physical assistance, a hand-held mobility device or use wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.
	GMFCS level III Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when travelling long distances and may self-propel for shorter distances.
	GMFCS level IV Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.
	GMFCS level V Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements.













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 Impairment⁵













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

	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

⁵Image source: [Microsoft Inclusive Design Toolkit](#)

Temporary Impairment⁶













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

	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

⁶Image source: [Microsoft Inclusive Design Toolkit](#)

Situational Impairment⁷

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

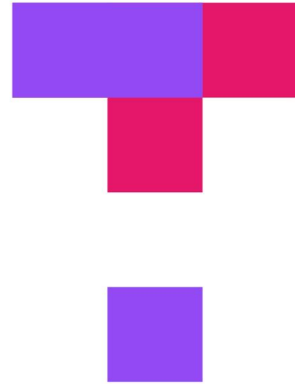
⁷Image source: [Microsoft Inclusive Design Toolkit](#)

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

Disability as **personal attribute**

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

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 Environment⁸

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

Between humans

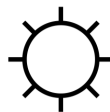


Can't type

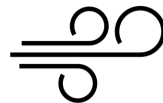


Can't hear

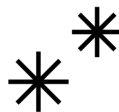
Human+ environment



Glare from sun



Windy



Cold

Human+ object



Left-handed user



Narrow door



Tall shelf

⁸Image source: [Microsoft Inclusive Design Toolkit](#)

Universal Design⁹

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.

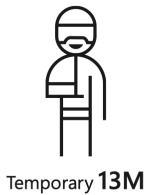
Think about
sidewalk ramps
push bars for doors / emergency exits

⁹Ron Mace, 1996

The Main Premise of Universal Design¹⁰

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!



Total: 21M+

¹⁰Image source: [Microsoft Inclusive Design Toolkit](#)

An Example: Closed Captioning¹¹

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




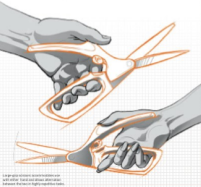
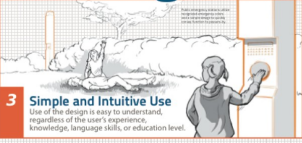
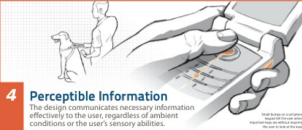
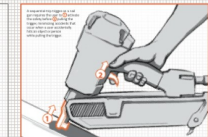

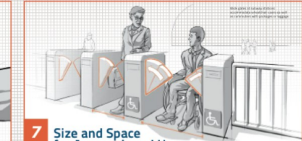
¹¹Image source: [Microsoft Inclusive Design Toolkit](#)

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

The Principles of Universal Design

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.

- 1 Equitable Use**
 The design is useful and marketable to people with diverse abilities.
 
- 2 Flexibility in Use**
 The design accommodates a wide range of individual preferences and abilities.
 
- 3 Simple and Intuitive Use**
 Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or education level.
 
- 4 Perceptible Information**
 The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
 
- 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 and Use**
 Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.
 

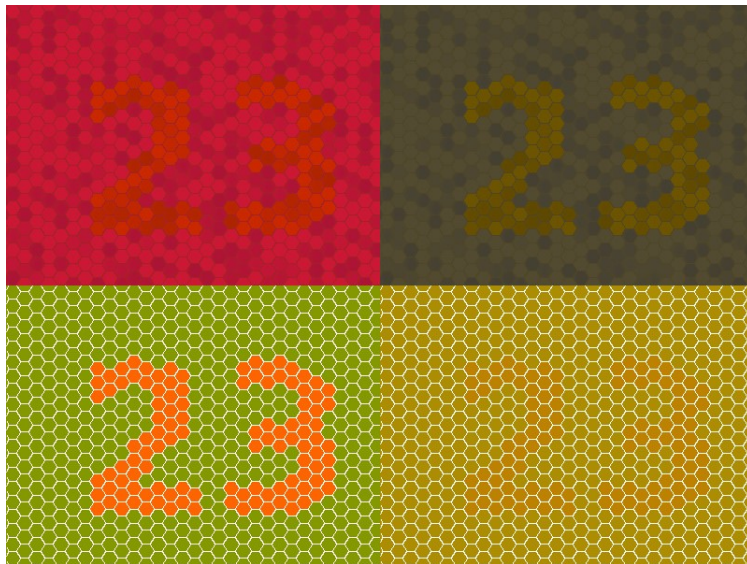
Center for Universal Design
 www.cud.wisc.edu
 608-263-1000

¹²Image 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. *— don't hide such menus behind locations not accessible by voice, for example*
4. Make the design appealing to all users.



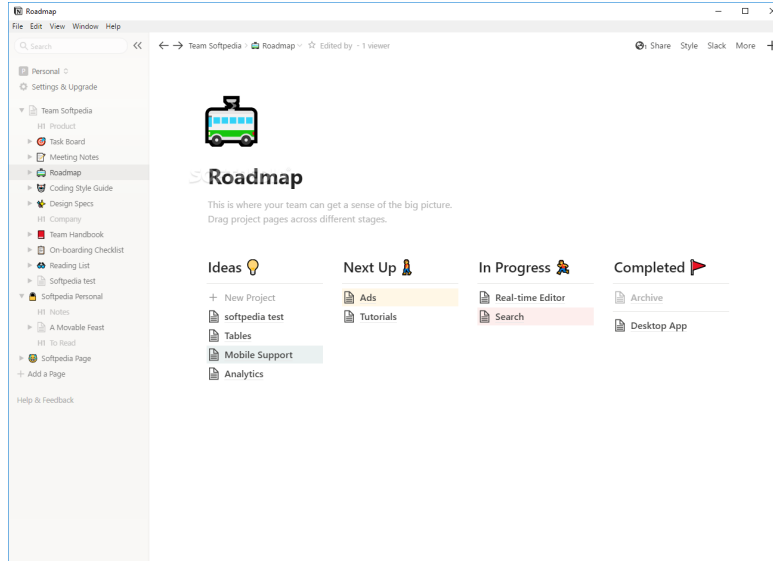
¹³Example source: [Interaction Design Foundation](#); Image source: Johannes Ahlmann

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
to fast, etc.



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.

Features Pricing Support Blog

Sign Up Free Log In

Find a plan that's right for you.

15,440 subscribers

gives recommendation

Starting Up

Create beautiful, professional campaigns for free. It's so easy, you can start sending today.

RECOMMENDED

Growing Business

Level up with marketing automation, targeting and segmentation, A/B testing, and team collaboration features.

Pro Marketer

Monitor and improve your performance with enterprise-level features like multivariate testing, comparative campaign reporting, and more.

¹⁵ Example source: [Interaction Design Foundation](#)

Principle 4: Perceptible Information

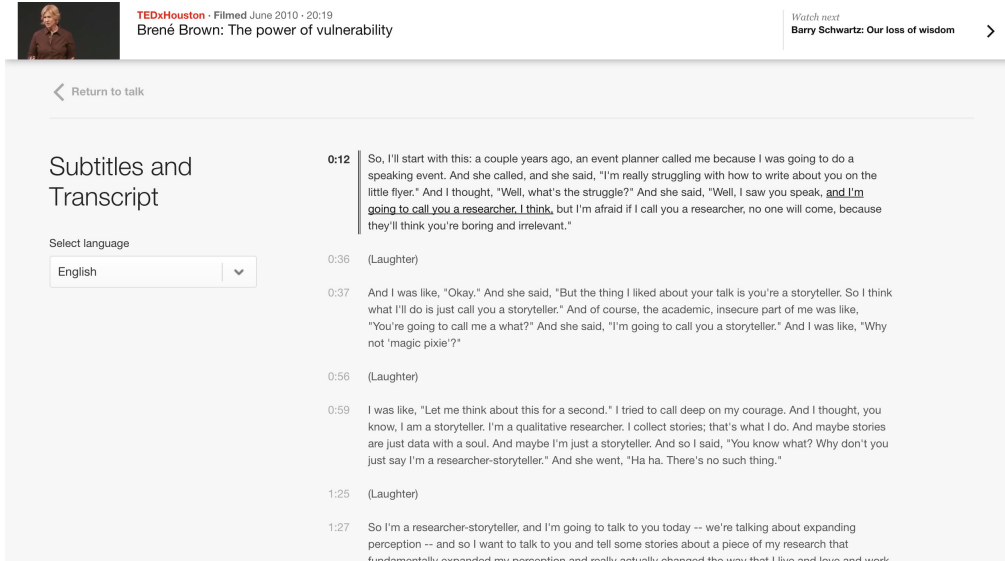
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.


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.




TEDxHouston · Filmed June 2010 · 20:19
Brené Brown: The power of vulnerability

[Watch next](#)
Barry Schwartz: Our loss of wisdom >

[Return to talk](#)

Subtitles and Transcript

Select language

English ▾

0:12 So, I'll start with this: a couple years ago, an event planner called me because I was going to do a speaking event. And she called, and she said, "I'm really struggling with how to write about you on the little flyer." And I thought, "Well, what's the struggle?" And she said, "Well, I saw you speak, and I'm going to call you a researcher, I think, but I'm afraid if I call you a researcher, no one will come, because they'll think you're boring and irrelevant."

0:36 (Laughter)

0:37 And I was like, "Okay." And she said, "But the thing I liked about your talk is you're a storyteller. So I think what I'll do is just call you a storyteller." And of course, the academic, insecure part of me was like, "You're going to call me a what?" And she said, "I'm going to call you a storyteller." And I was like, "Why not 'magic pixie'?"

0:56 (Laughter)

0:59 I was like, "Let me think about this for a second." I tried to call deep on my courage. And I thought, you know, I am a storyteller. I'm a qualitative researcher. I collect stories; that's what I do. And maybe stories are just data with a soul. And maybe I'm just a storyteller. And so I said, "You know what? Why don't you just say I'm a researcher-storyteller." And she went, "Ha ha. There's no such thing."

1:25 (Laughter)

1:27 So I'm a researcher-storyteller, and I'm going to talk to you today -- we're talking about expanding perception -- and so I want to talk to you and tell some stories about a piece of my research that fundamentally expanded my perception and really actually changed the way that I live and love and work

¹⁶ Image source: [Interaction Design Foundation](#)

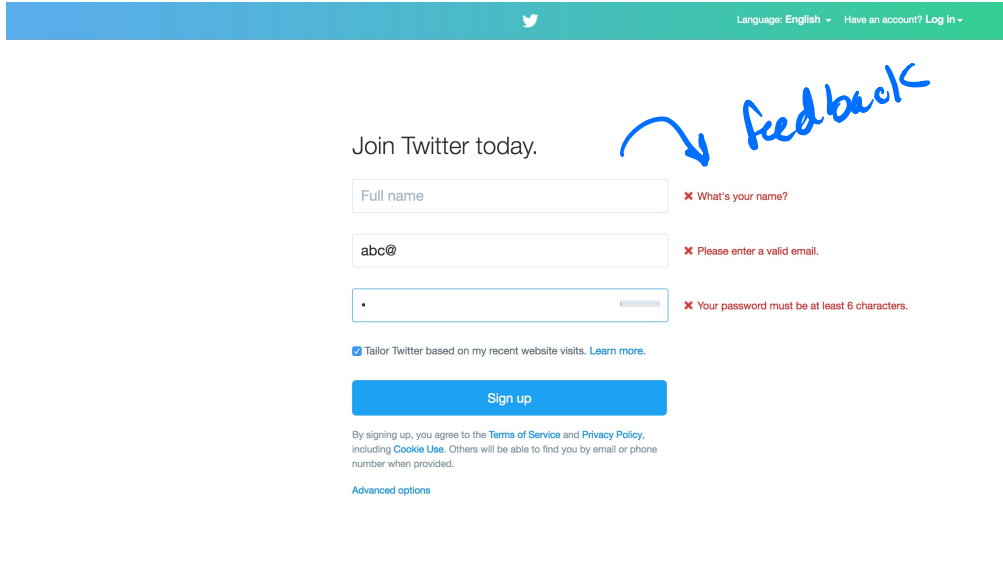
Principle 5: Tolerance for Error

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



The image shows the Twitter sign-up page. At the top, there is a blue header with the Twitter logo and a green bar with the text "Language: English" and "Have an account? Log in". Below the header, the text "Join Twitter today." is displayed. To the right of this text, there is a blue arrow pointing to the first input field, and the word "feedback" is written in blue cursive. The form consists of three input fields: "Full name", "Email address", and "Password". Each field has a red error message to its right: "What's your name?", "Please enter a valid email.", and "Your password must be at least 6 characters." respectively. Below the input fields, there is a checkbox labeled "Tailor Twitter based on my recent website visits. Learn more." and a blue "Sign up" button. At the bottom, there is a paragraph of text: "By signing up, you agree to the Terms of Service and Privacy Policy, including Cookie Use. Others will be able to find you by email or phone number when provided." and a link for "Advanced options".

Join Twitter today.

Full name ✖ What's your name?

abc@ ✖ Please enter a valid email.

• ✖ Your password must be at least 6 characters.

Tailor Twitter based on my recent website visits. [Learn more.](#)

[Sign up](#)

By signing up, you agree to the [Terms of Service](#) and [Privacy Policy](#), including [Cookie Use](#). Others will be able to find you by email or phone number when provided.

[Advanced options](#)

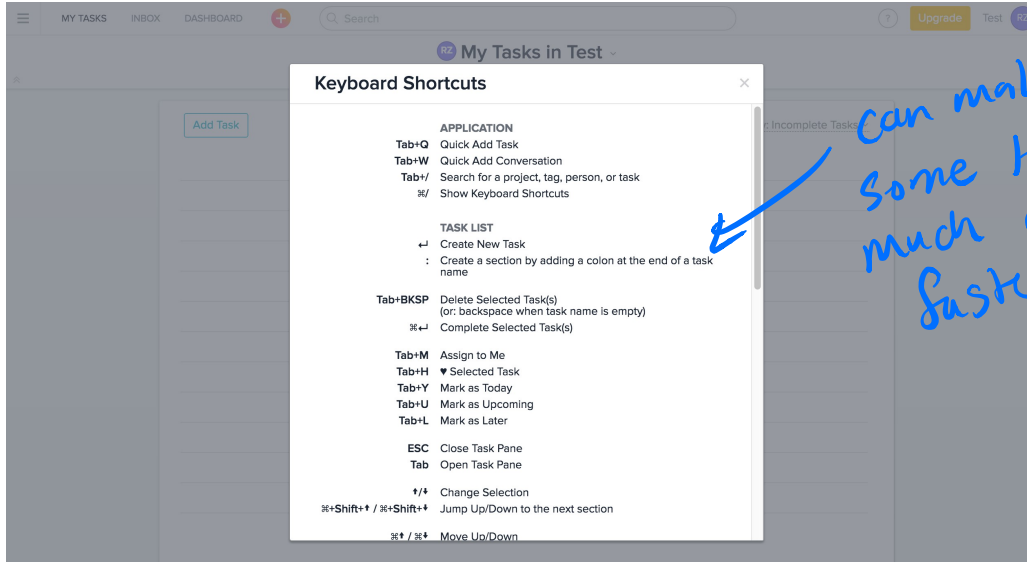
¹⁷ Image source: [Interaction Design Foundation](#)

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 Image source: [Interaction Design Foundation](#)

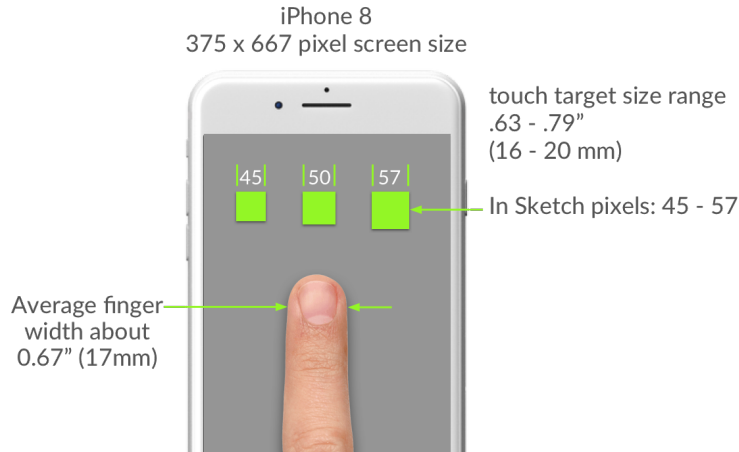
Principle 7: Size and Space for Approach and Use

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

Can users reach this feature?

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?

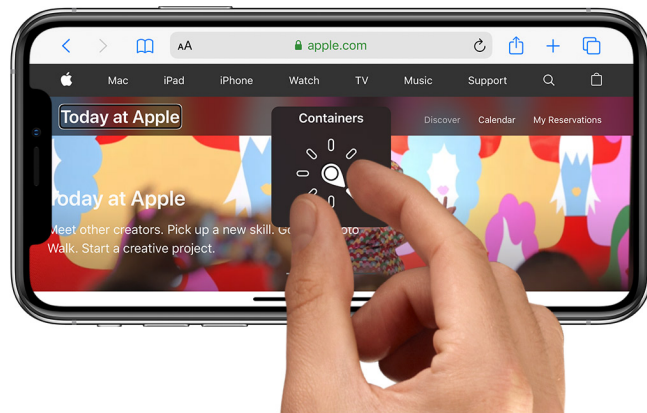
Definition: Specialized tools that close accessibility gaps.

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

Screen Readers²⁰

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

- >> JAWS for Windows
- >> VoiceOver for MacOS, iOS
- >> NVDA



²⁰ [Image source](#)

Screen Magnification²¹

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



magnifies
textbook

²¹ [Image source](#)

Text Readers²²

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 Web²³

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

magnetic pins



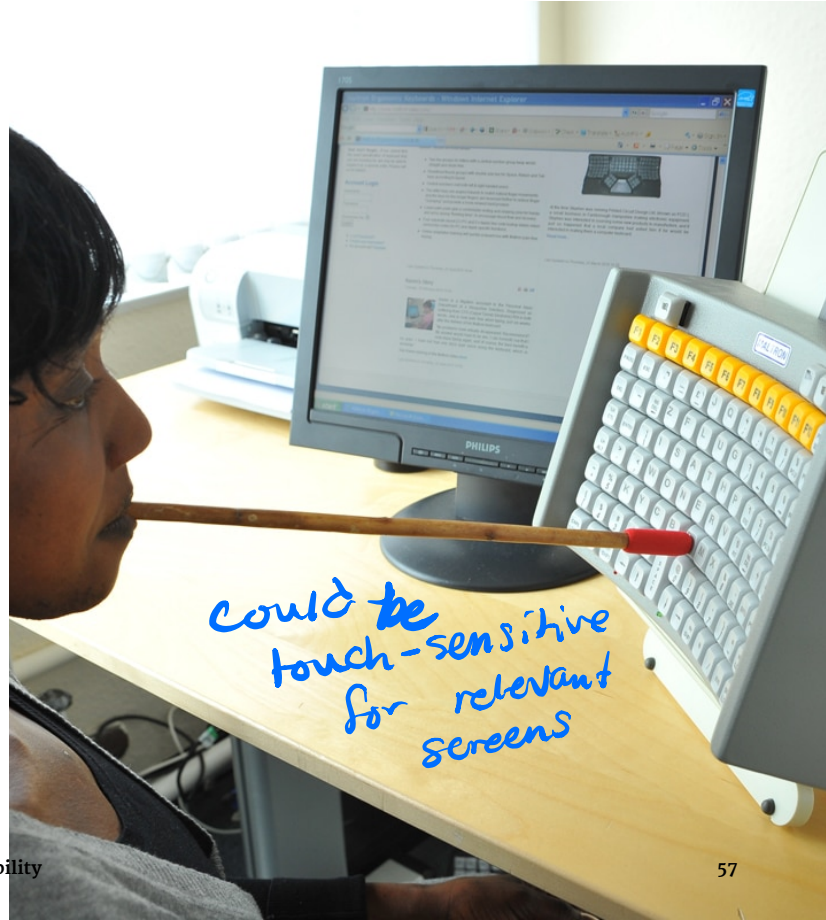
²³ [Image source](#)

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

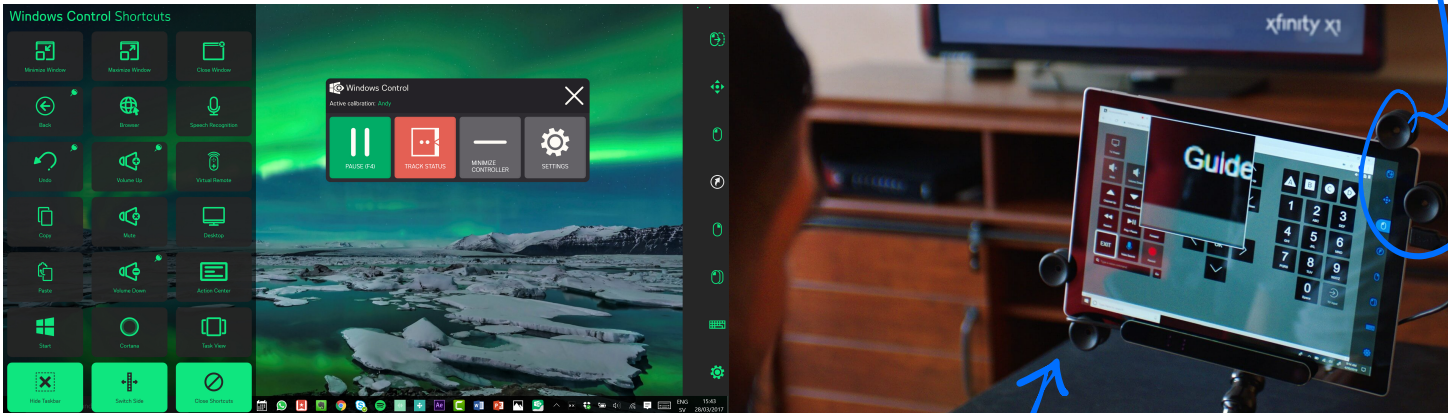
Head/mouth wands/ pointers²⁴



²⁴ [Image source](#)

Motion/eye tracking²⁵

Cameras



TV guide (concast)

²⁵ Image source: left, right

Single-switch (e.g., sip-
and-puff)²⁶

*frequently customized
for specific
ability*



²⁶ Image source

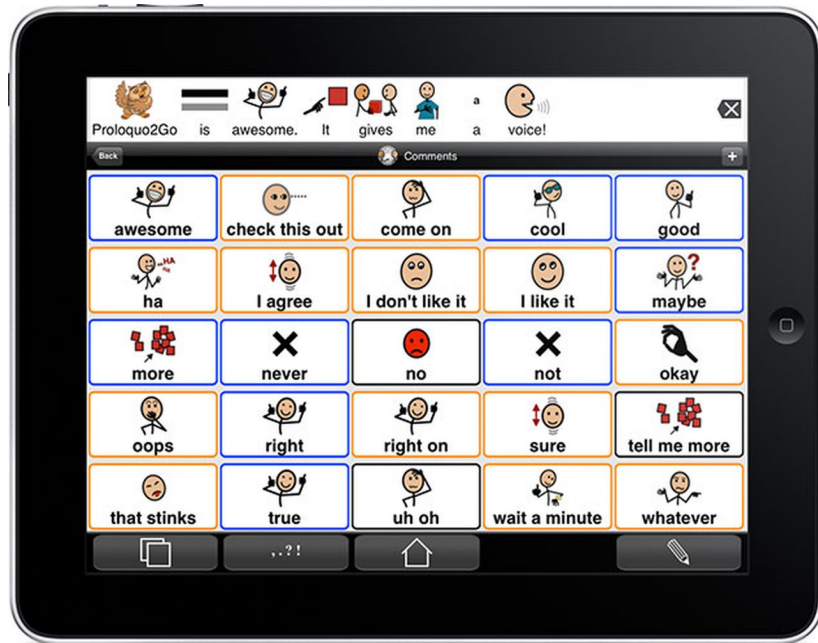
Speech input²⁷



²⁷ [Image source](#)

Alternative & Augmentative Communication²⁸

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

How to Navigate with VoiceOver



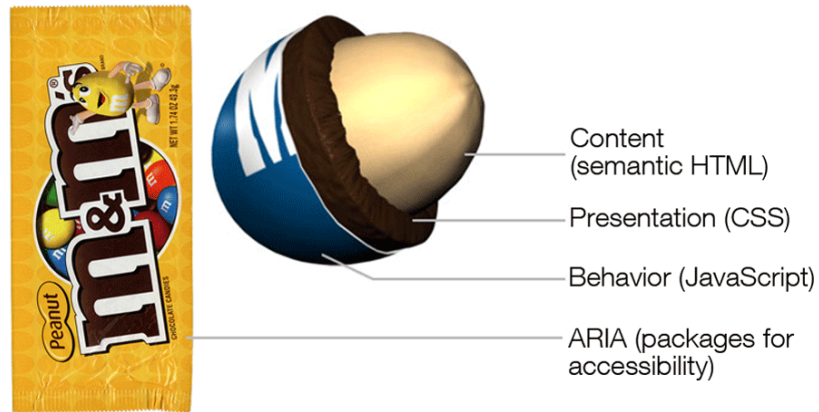
Task 1: Purchase a new iPhone on the Apple site.

Task 2: Send a new email to Apple support.

Accessible Building

Accessibility in Web Technologies³⁰

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



By Dennis Lembree based on illustration by Dave Stewart

³⁰ [Image source](#)

Accessible Rich Internet Applications (ARIA)³¹

aria is a set of HTML attributes that make web components available 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 Native³²

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. Discover 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