Building User Interfaces

Designing for Accessibility

Professor Bilge Mutlu

What we will learn today?

— What is accessibility?
— Accessible design
— Assistive technologies

What is accessibility?

Definitions

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

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

Three Dimensions of Disability[2]

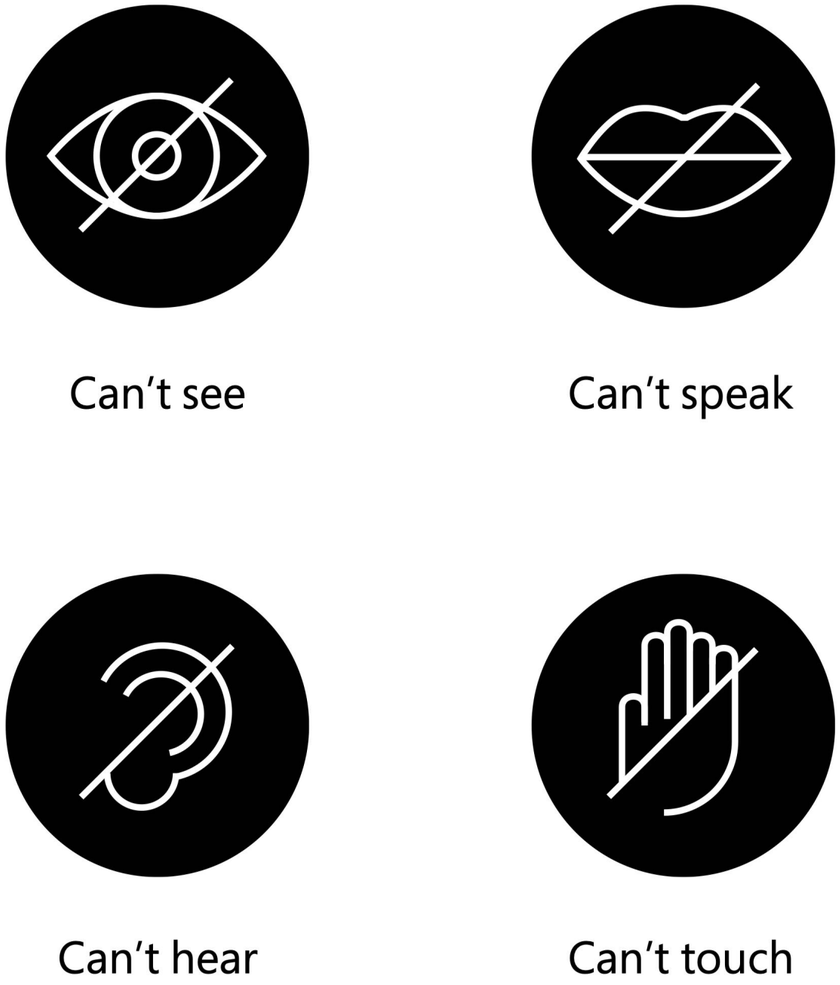
1. **Impairment** in a person's body structure or function, or mental functioning (e.g., loss of a limb, loss of vision, or memory loss)
2. **Limitation in activities** (e.g., difficulty seeing, hearing, walking, or problem solving)
3. **Restrictions in participation** in activities of daily living (e.g.,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

ADL / tADL

[2] Source: World Health Organization

Types of Impairment: Anatomical[3]

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



[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.

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.

Seizures

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

Cognitive/Learning

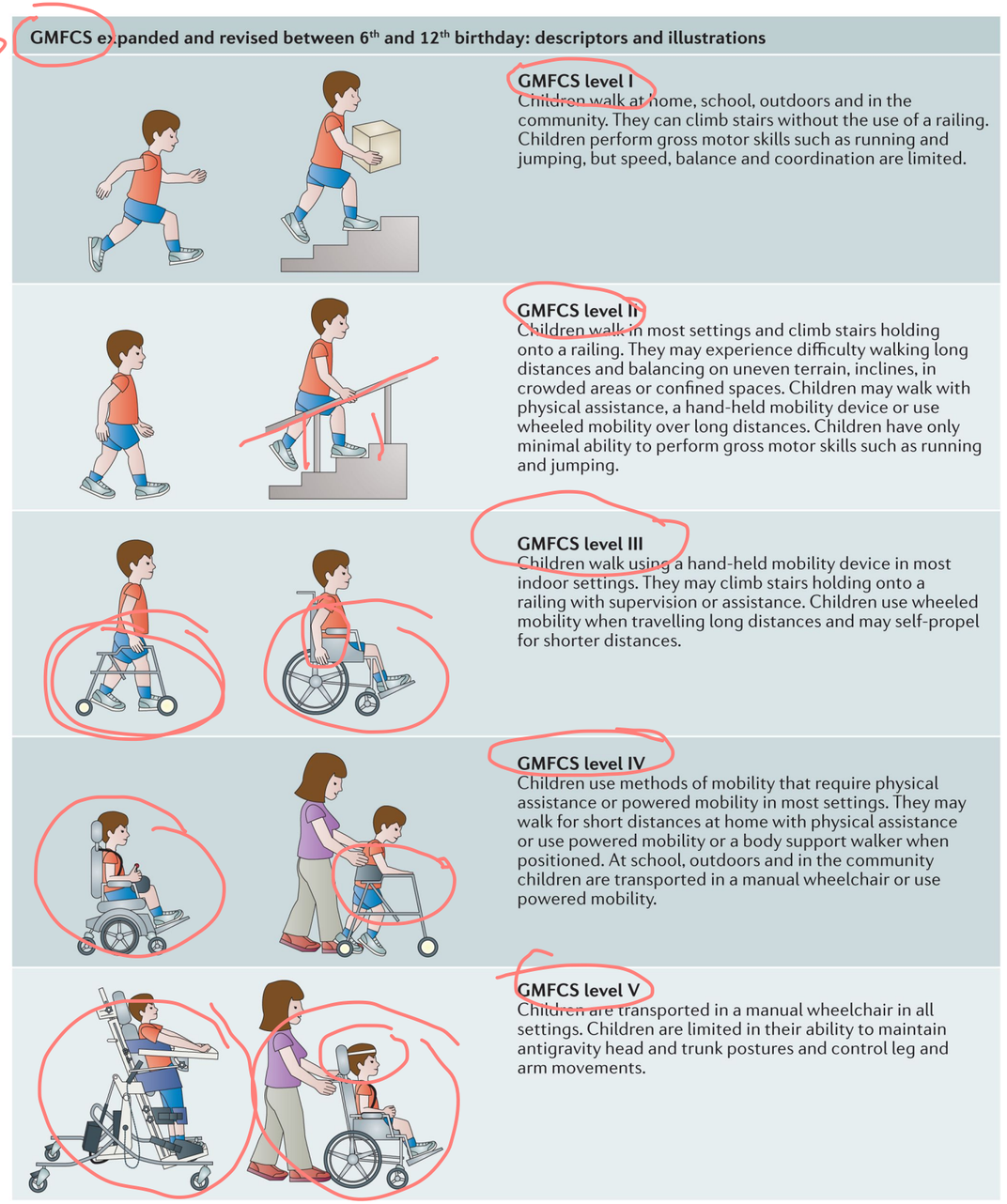
Definition: Congenital, developmental, and traumatic (e.g., traumatic brain injury) conditions that result in cognitive or learning challenges.

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 perception



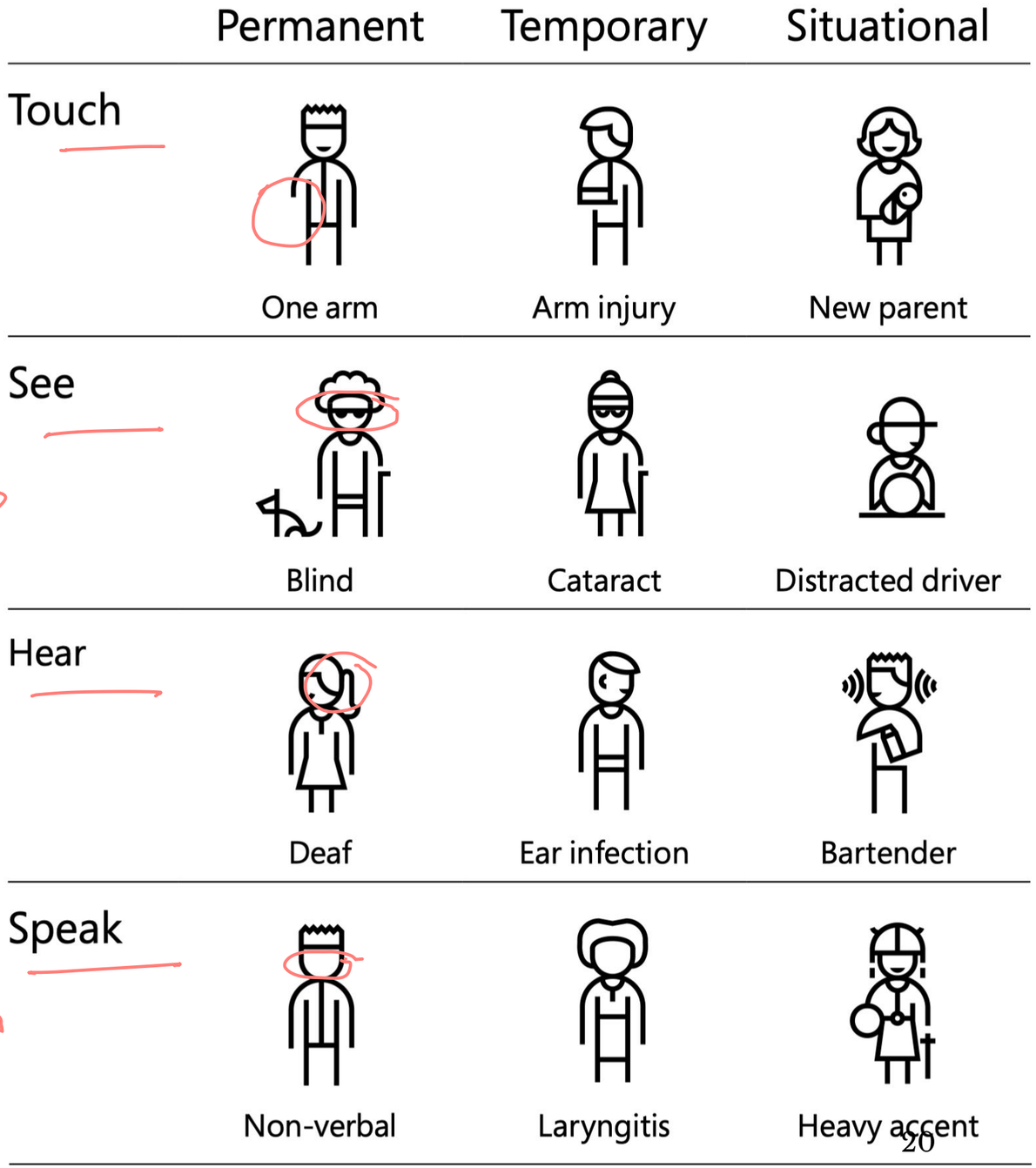
[4] Image source

Types of Impairment: Temporal

1. *Permanent* impairment
2. *Temporary* impairment
3. *Situational* impairment

Permanent Impairment[5]

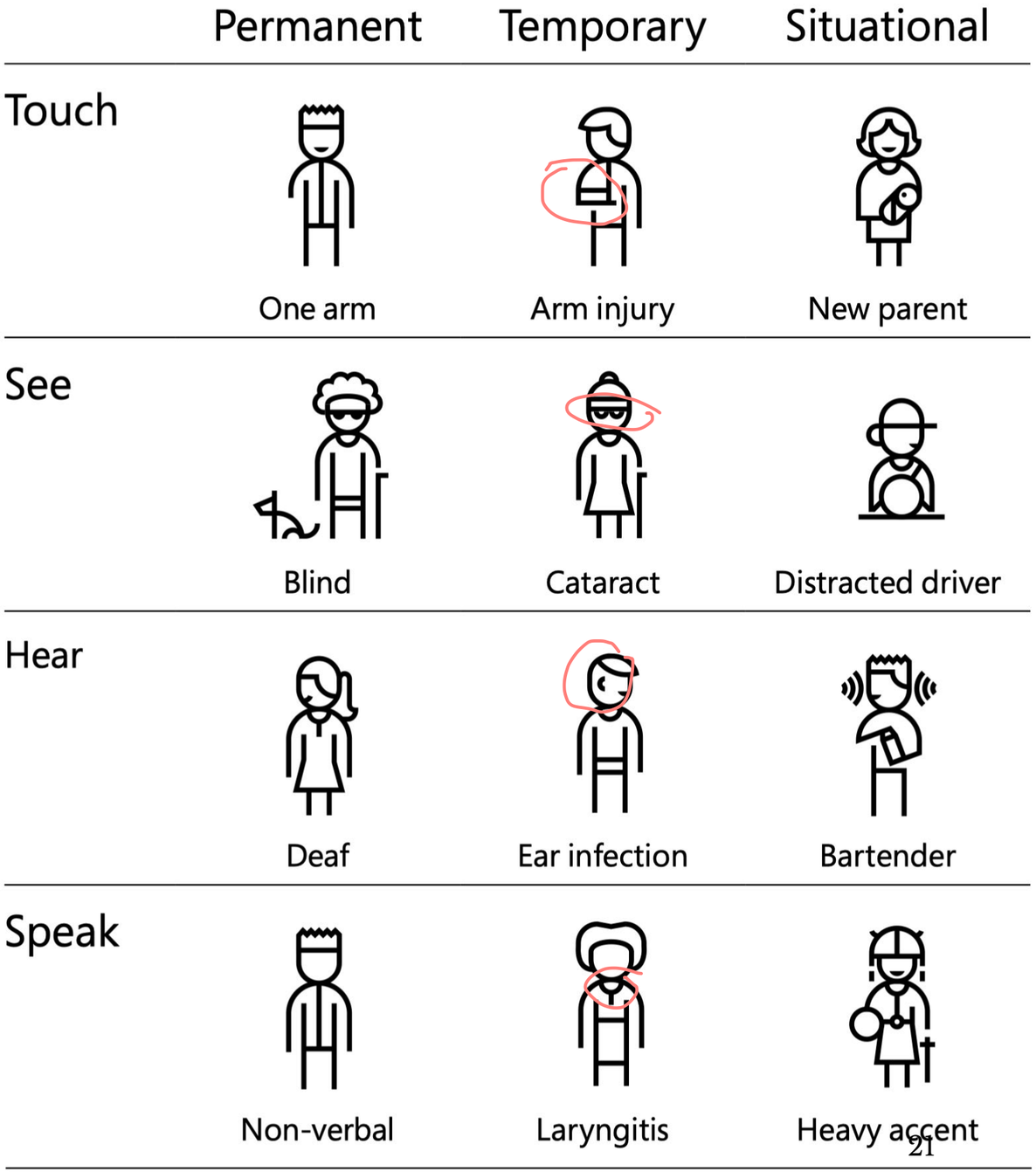
Congenital or long-term conditions, such as color blindness, missing body parts, etc.



[5] Image source: Microsoft Inclusive Design Toolkit

Temporary Impairment[6]

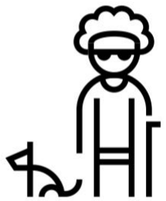
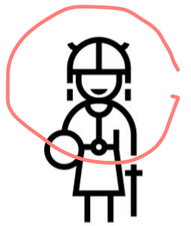
Impairments that improve over time, such as recovery after illness or accidents, e.g., a broken arm.



[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

Quiz 1

Complete the Canvas quiz.

How do we achieve accessibility?

Two ways to address accessibility problems:

1. Accessible design
2. Assistive technologies

Accessible Design

Context-dependent Model 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:

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Ability + Context = Disability
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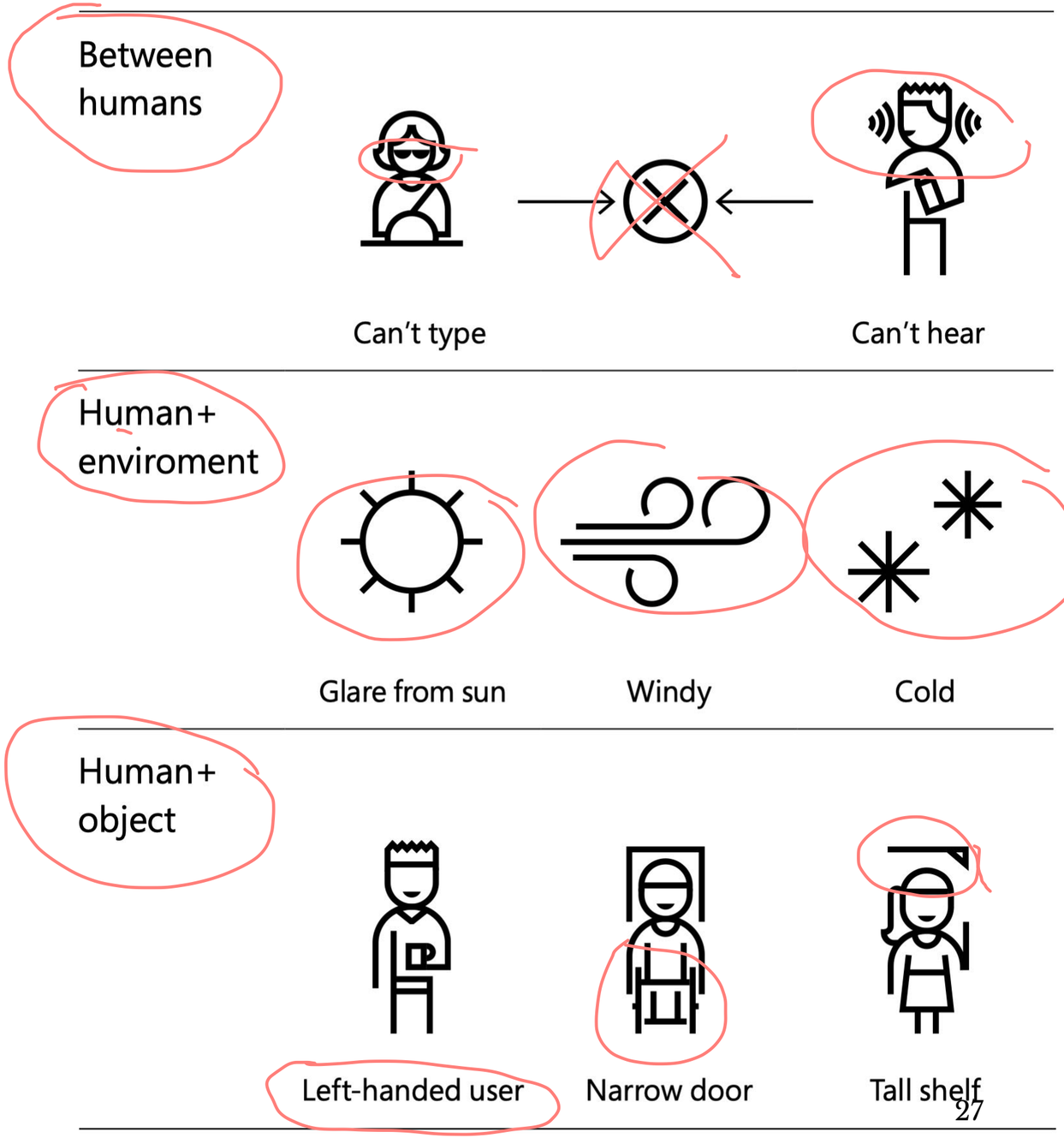
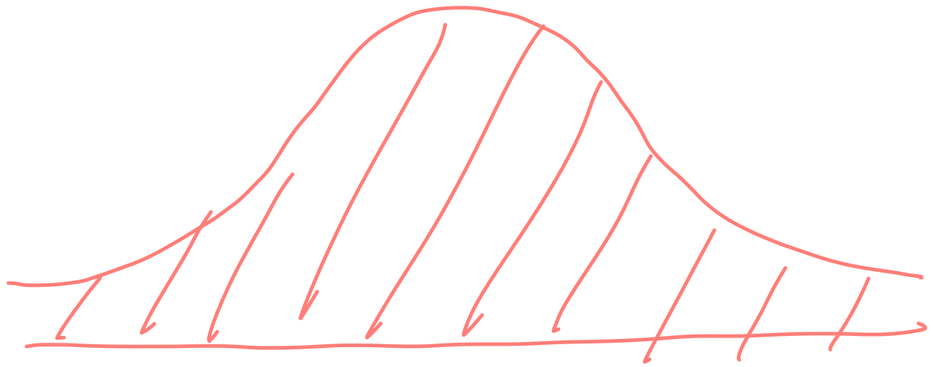


[8] Image source: Microsoft Inclusive Design Toolkit

Universal Design[9]

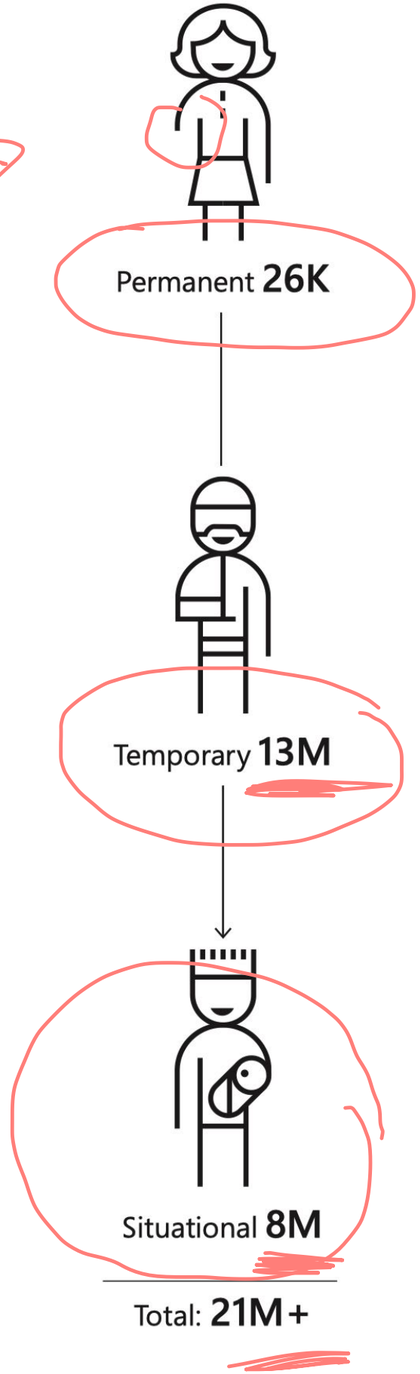
Definition: The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.



[9] Ron Mace, 1996

The Main Premise of Universal Design[10]

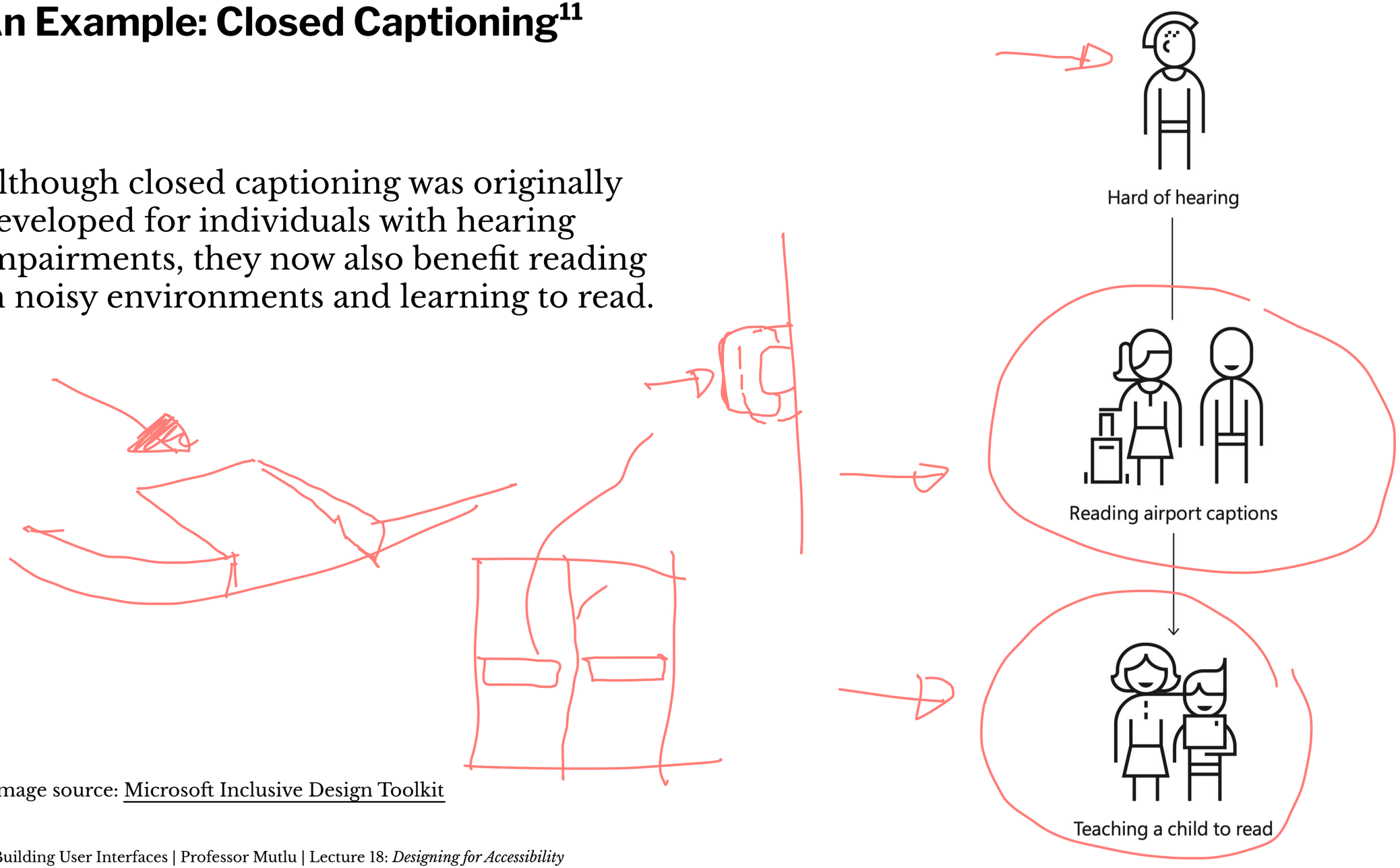
Design solutions that benefit some individuals may benefit the whole society. E.g., in the US, only 26K people are suffer loss of upper extremities. Designs that would benefit these 26K would also benefit another 21M people with temporary or situational disabilities.



[10] Image source: Microsoft Inclusive Design Toolkit

An Example: Closed Captioning[11]

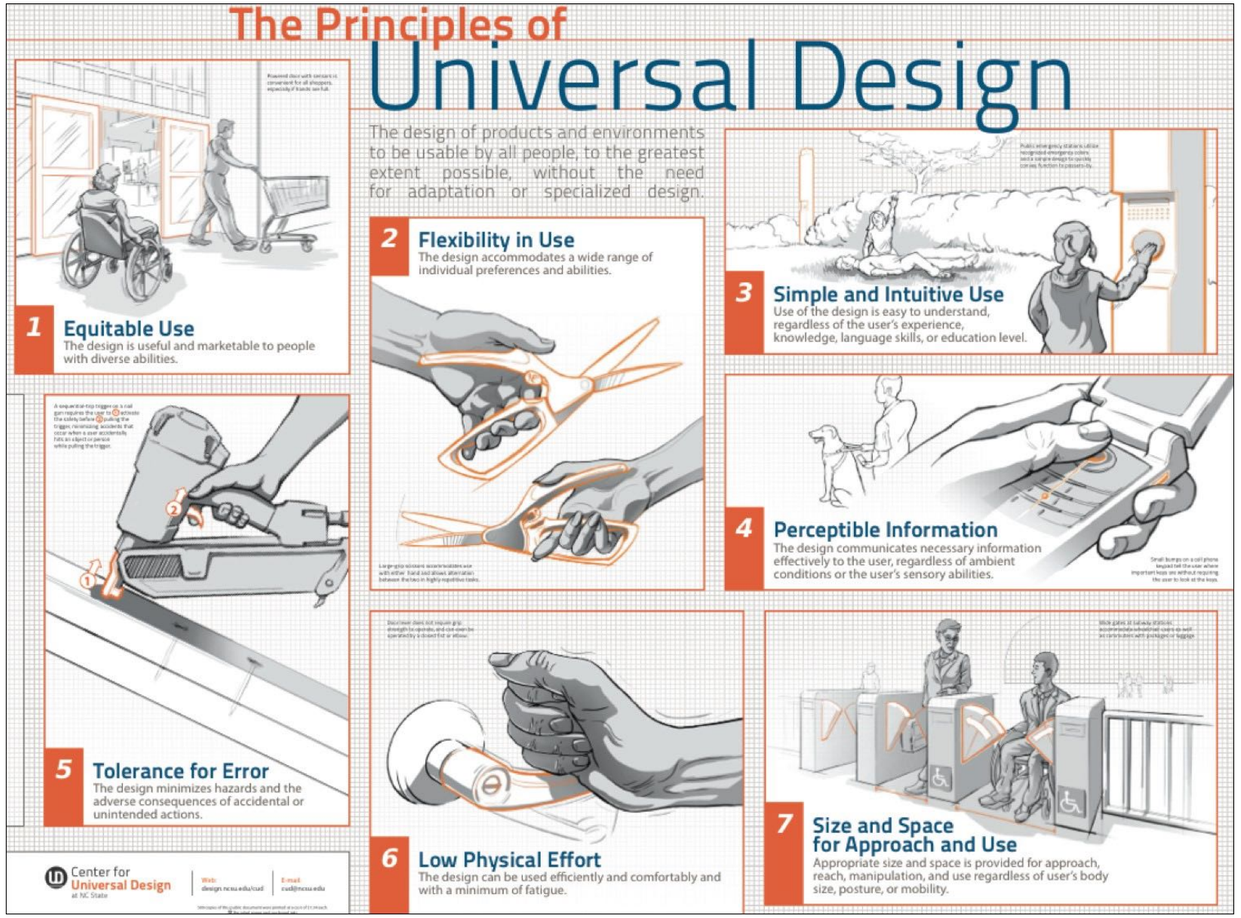
Although closed captioning was originally developed for individuals with hearing impairments, they now also benefit reading in noisy environments and learning to read.



[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



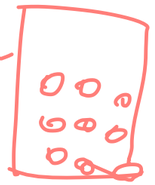
[12] Image source: Interaction Design Foundation

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.

smooth / invisible



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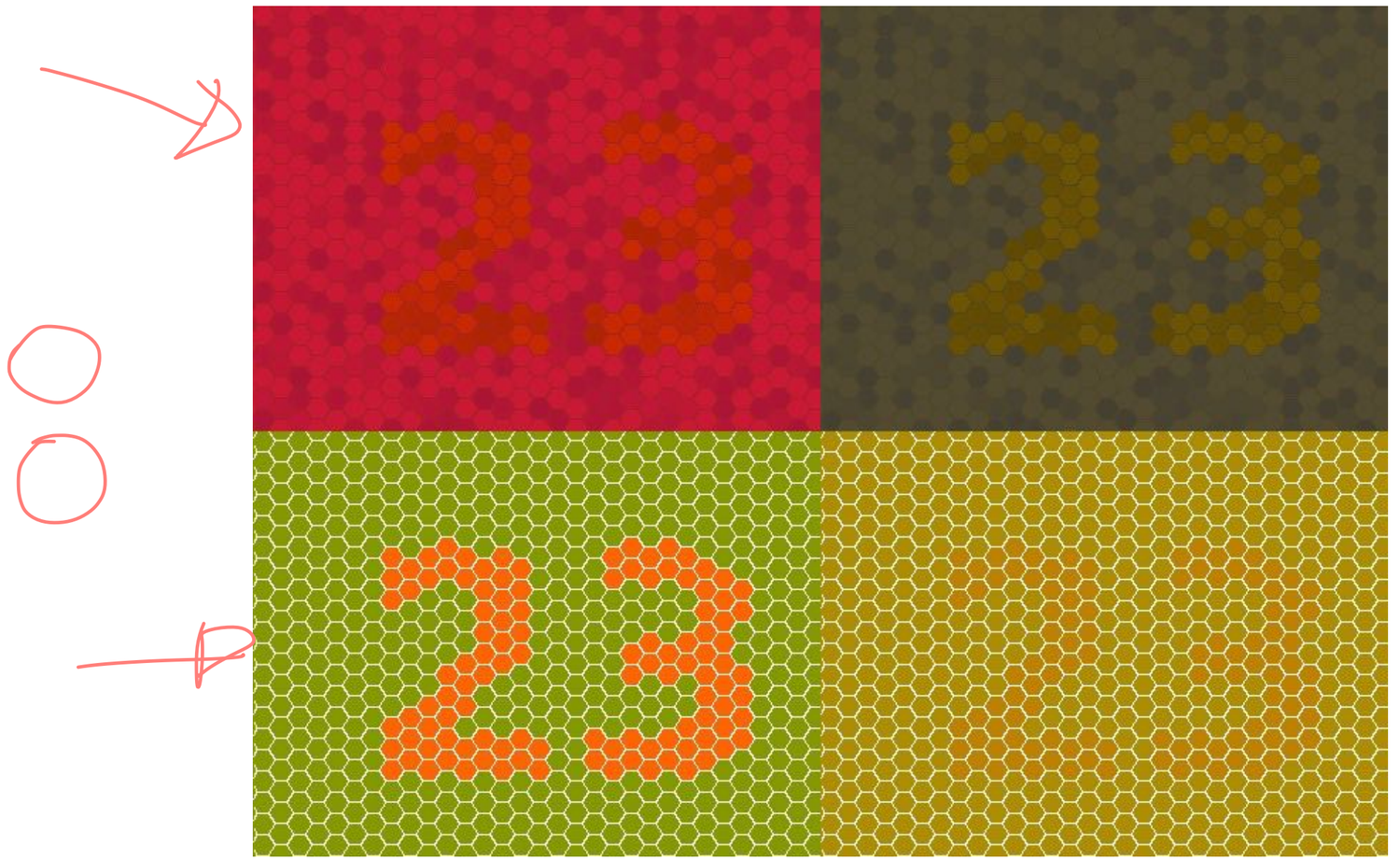

[13] Example source: Interaction Design Foundation; Image source: Johannes Ahlmann

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.

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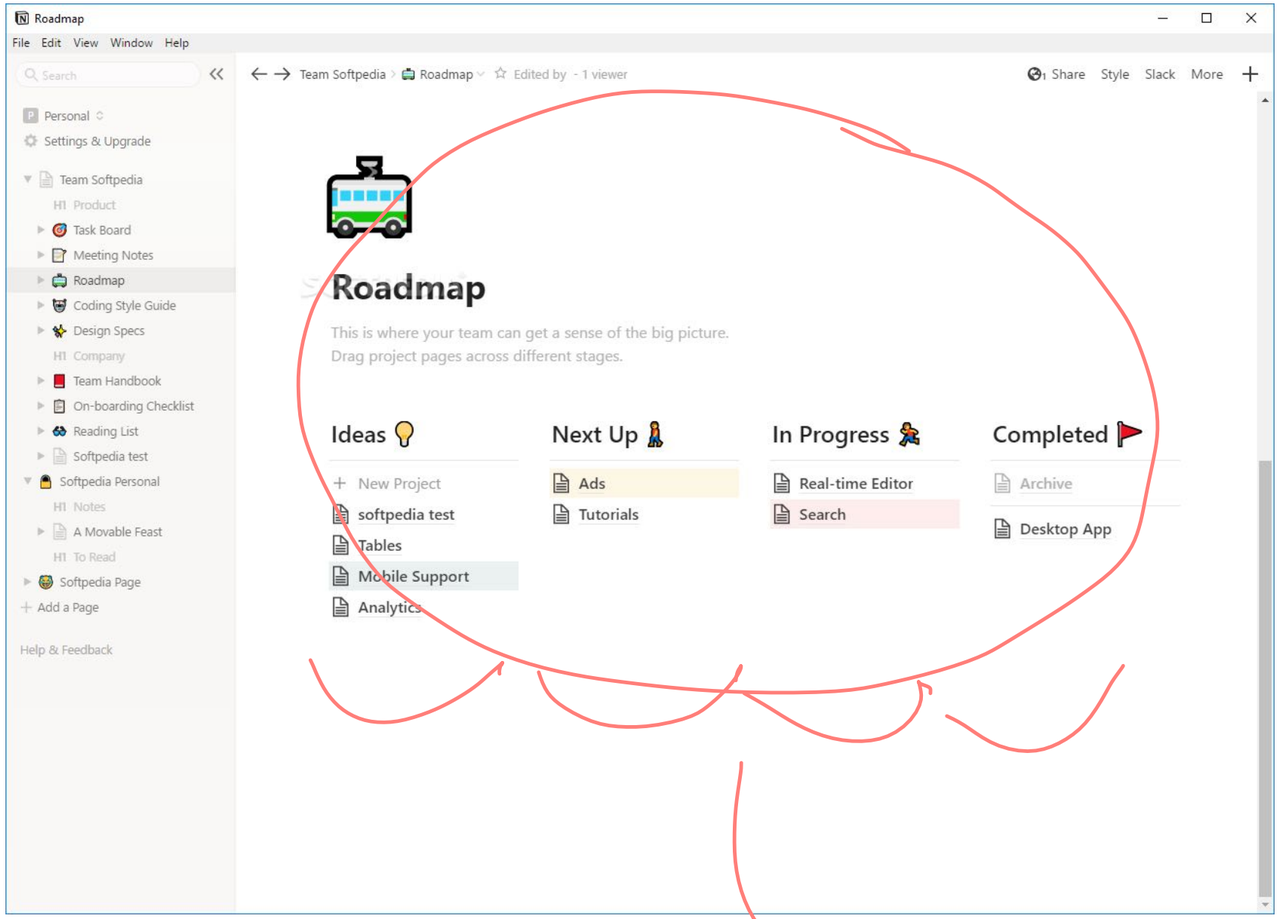
Notion



kanban board

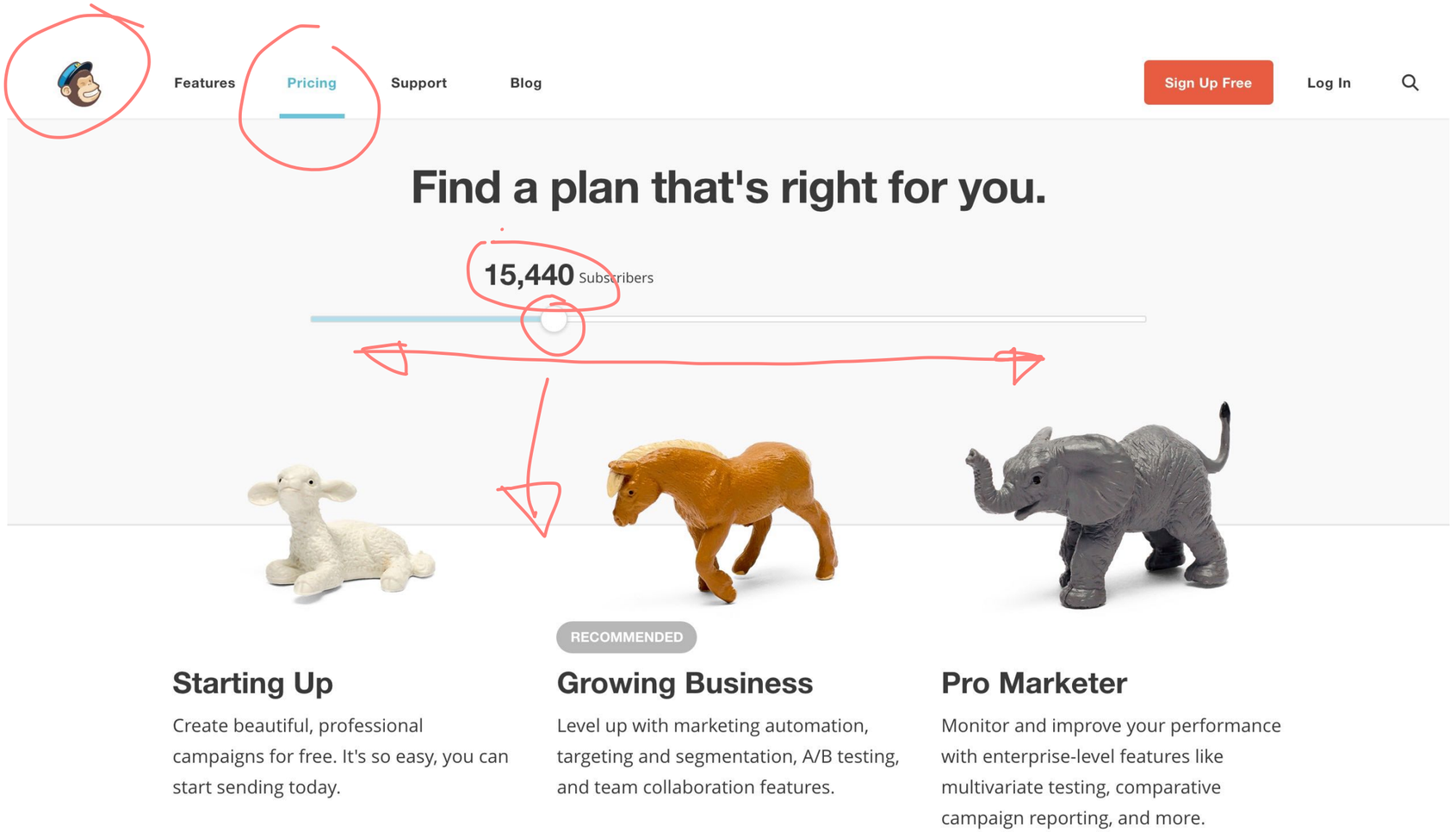
[14] Image source

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.

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



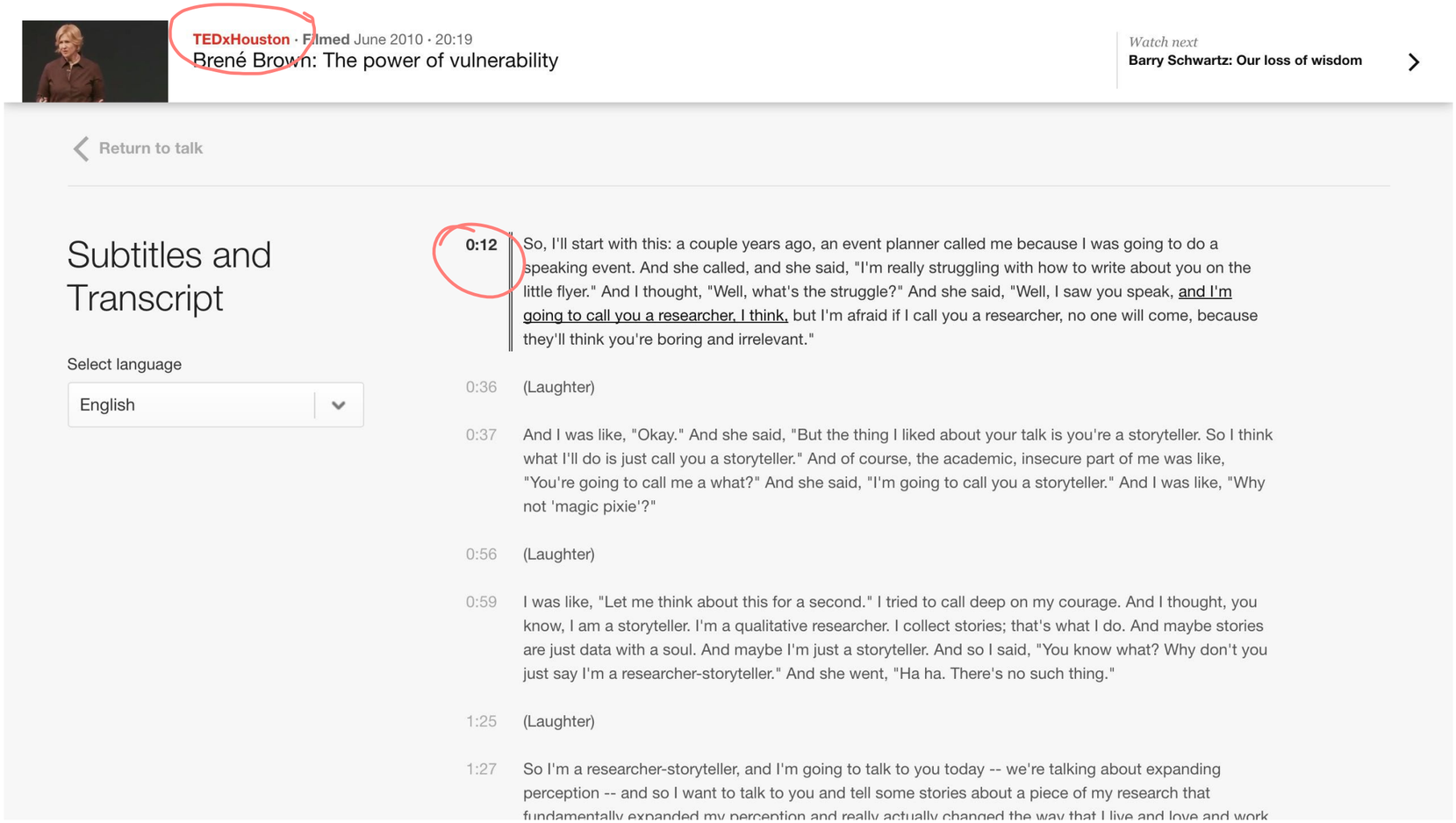
[15] Example source: Interaction Design Foundation

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 & surroundings.
3. Maximize "legibility" of essential information
4. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
5. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

ARIA



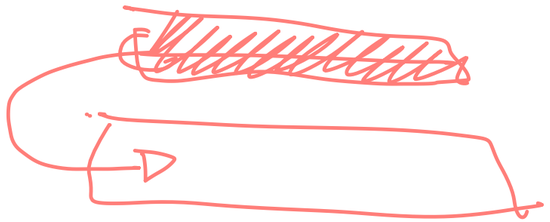
[16] Image source: Interaction Design Foundation

Principle 5: Tolerance for Error

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.

Delete



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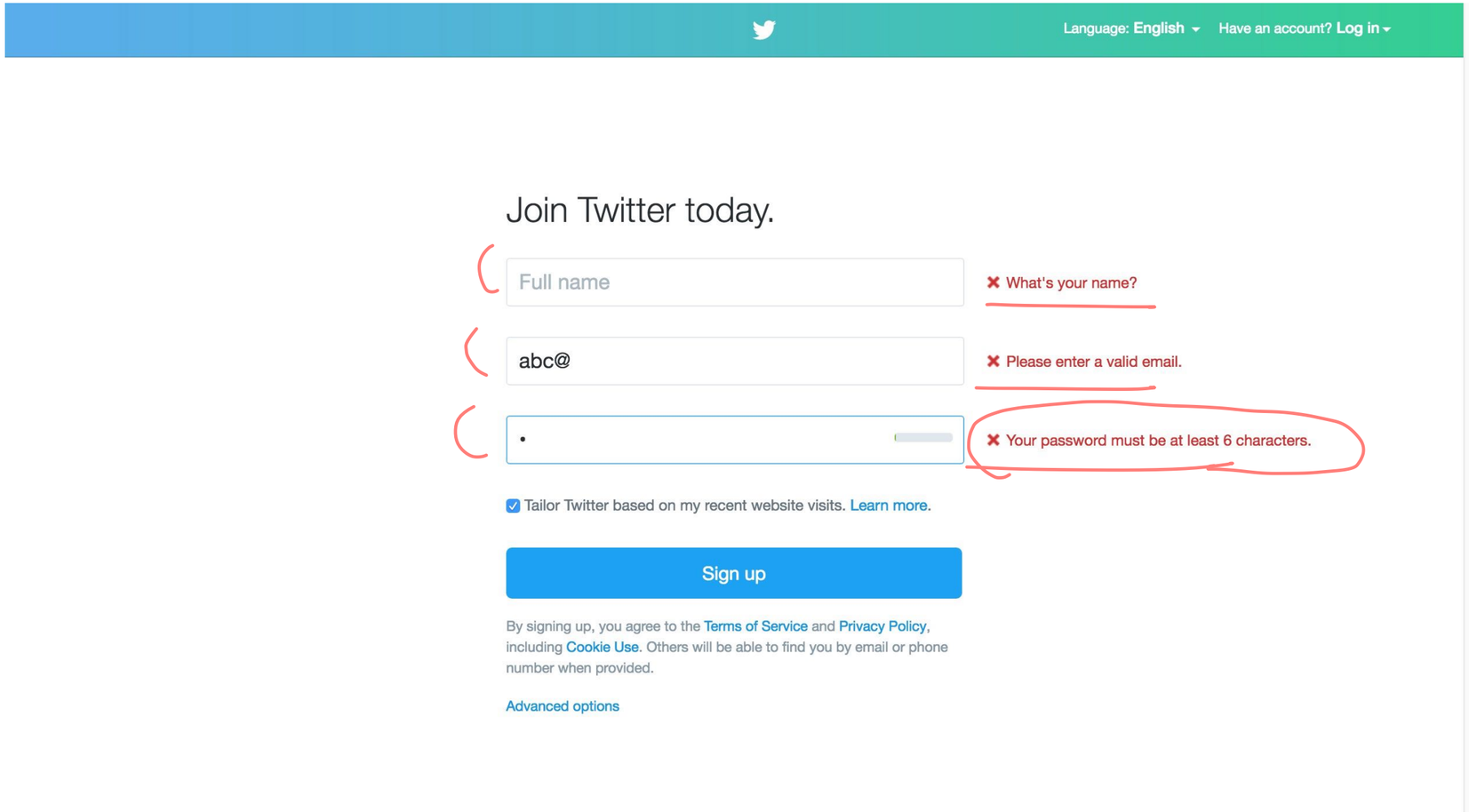
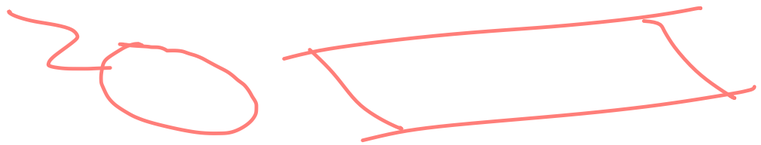


[17] Image source: Interaction Design Foundation

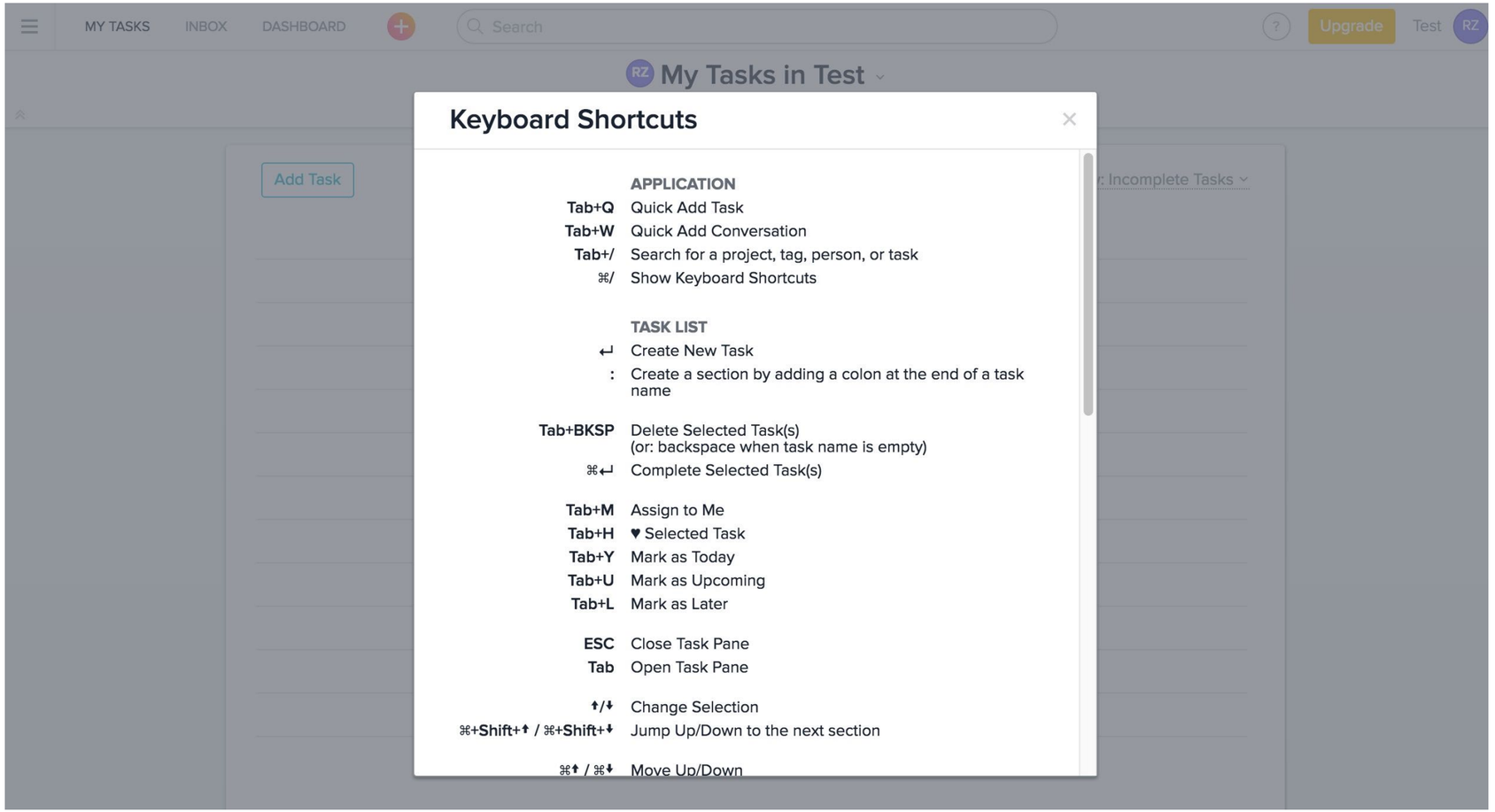
Principle 6: Low Physical Effort

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

1. Allow user to maintain a neutral body position.
2. Use reasonable operating forces.
3. Minimize repetitive actions.
4. Minimize sustained physical effort.



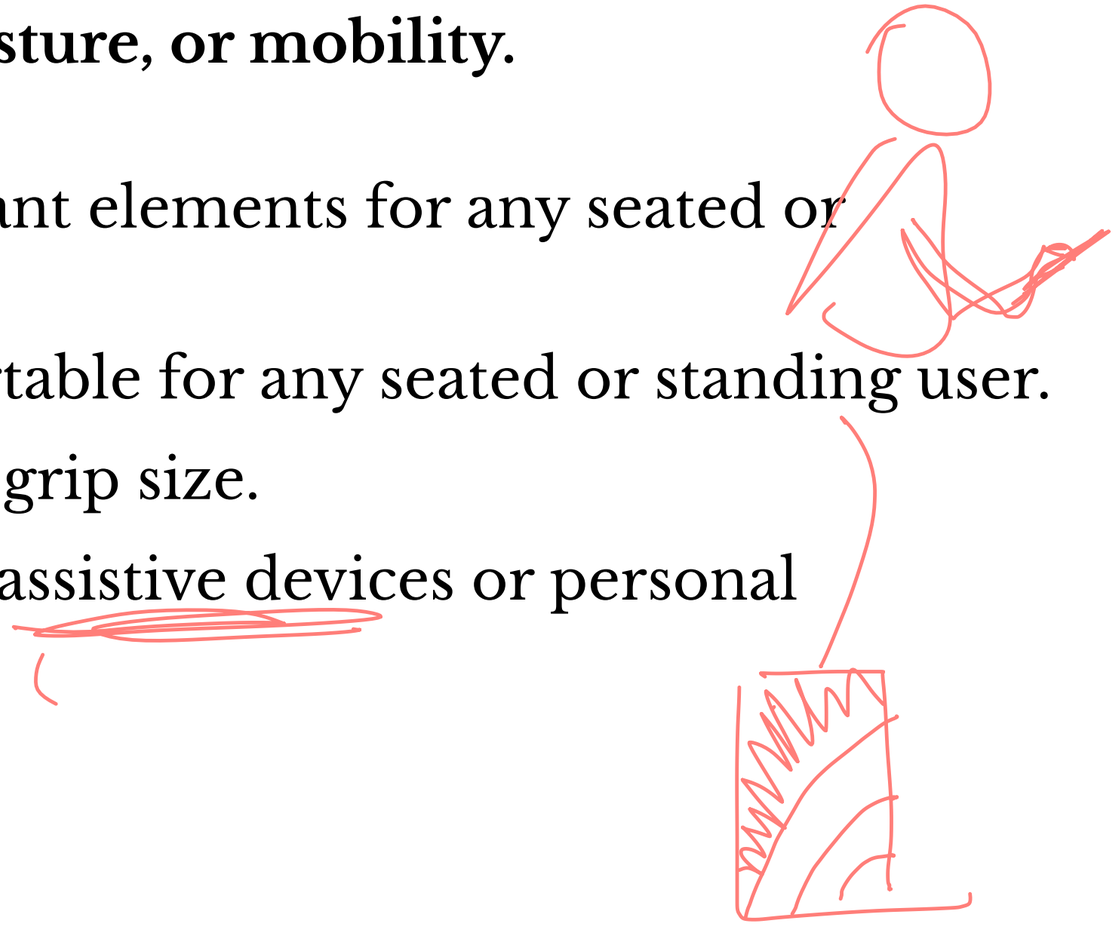
accelerators



[18] Image source: Interaction Design Foundation

Principle 7: Size and Space for Approach and Use

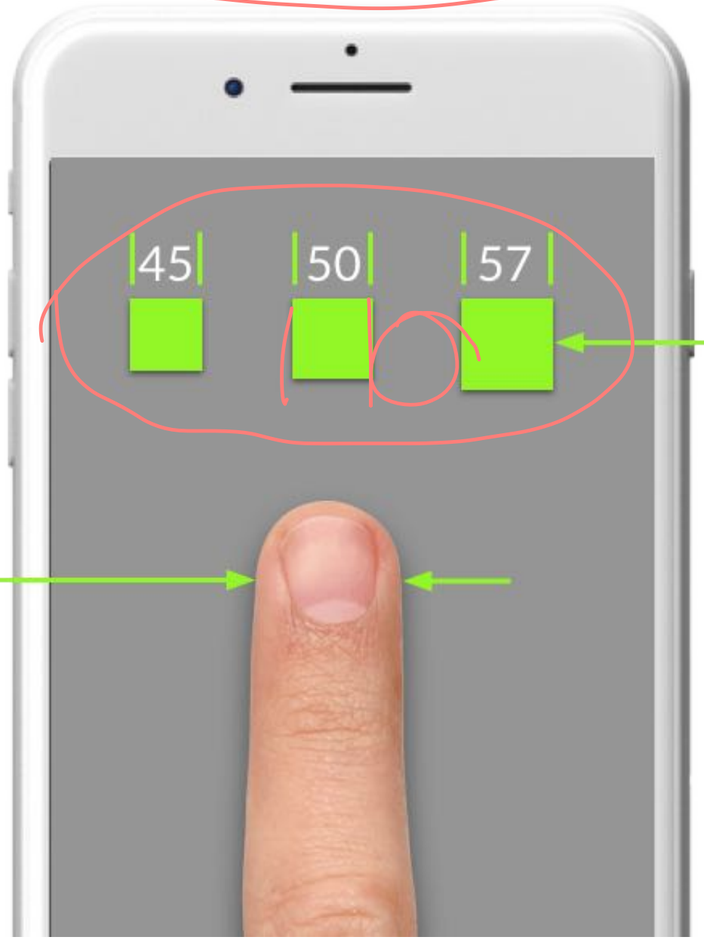
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.



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

[19] Image source on next slide

iPhone 8
375 x 667 pixel screen size



touch target size range
.63 - .79”
(16 - 20 mm)

In Sketch pixels: 45 - 57

Average finger
width about
0.67” (17mm)

Quiz 2

Complete the Canvas quiz.

Assistive Technologies

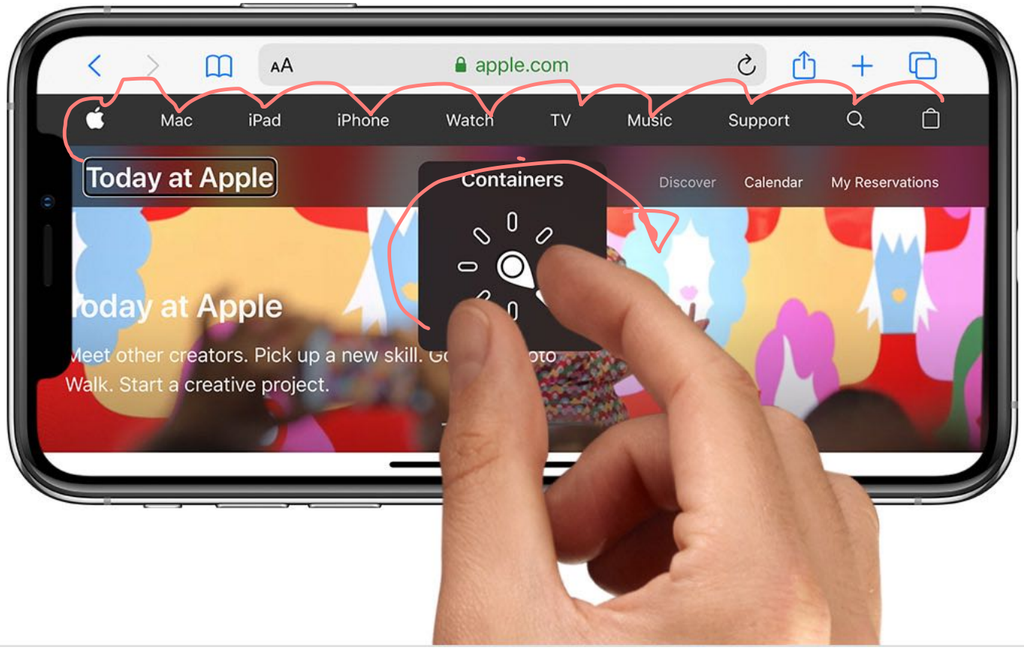
What are assistive technologies?

Definition: Specialized tools that close accessibility gaps.

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.

[22] Image source

Braille for the Web[23]

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

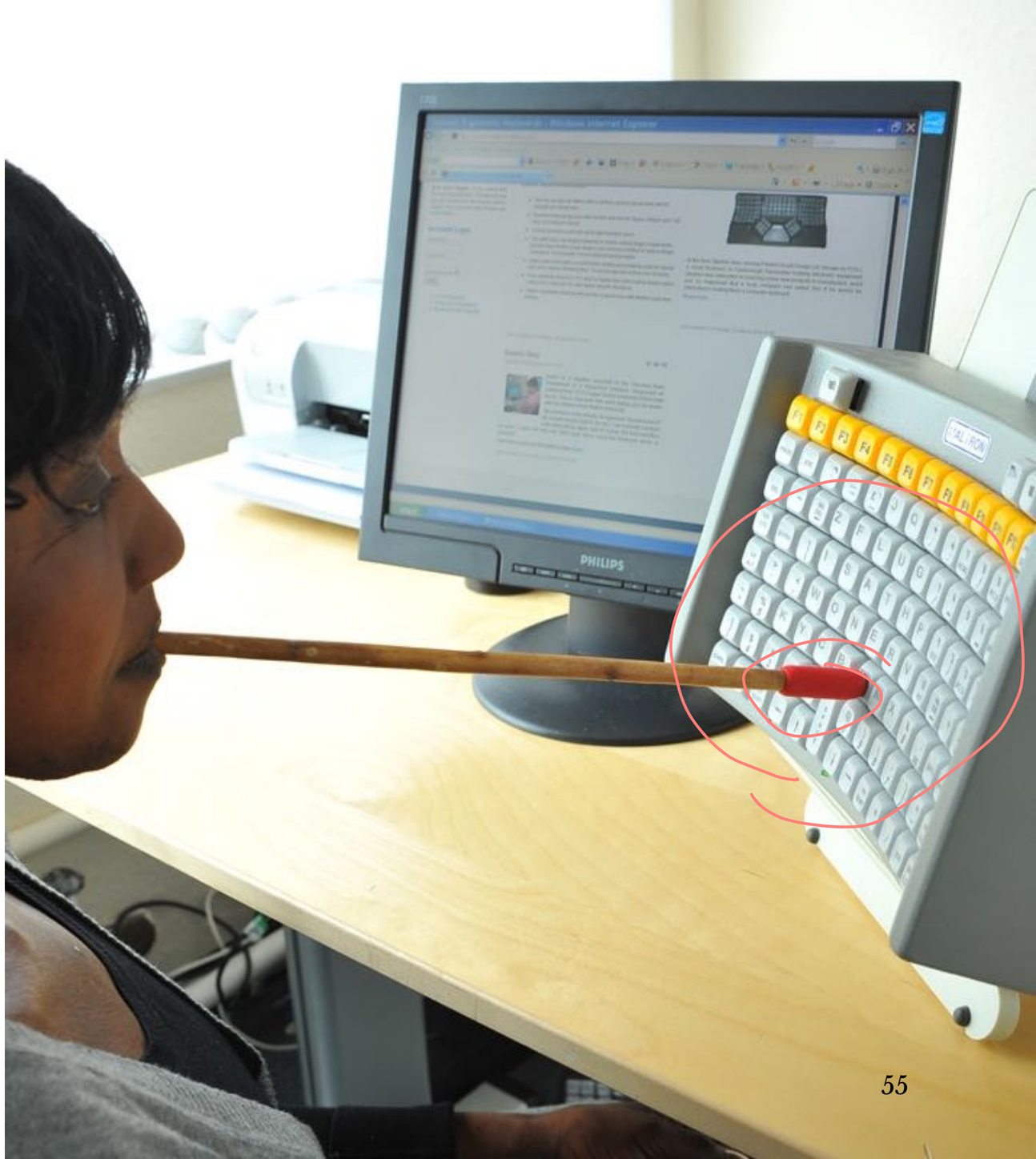
[23] Image source

Alternative Input Devices

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

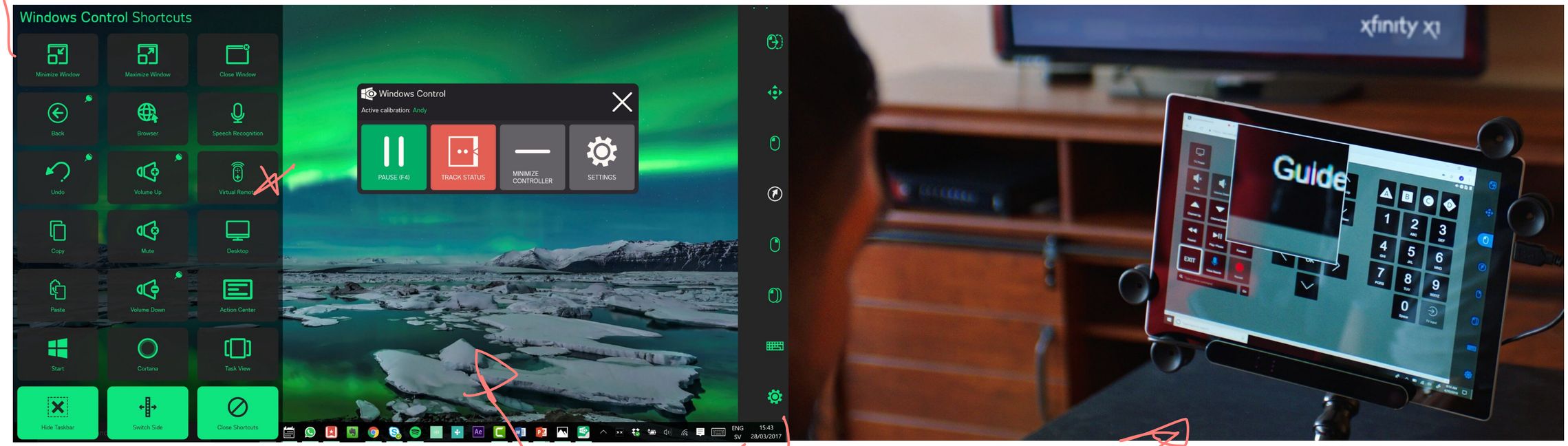
- Head/mouth wands/pointers
- Motion/eye tracking
- Single-switch (e.g., sip-and-puff)
- Speech input

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]

[26] Image source

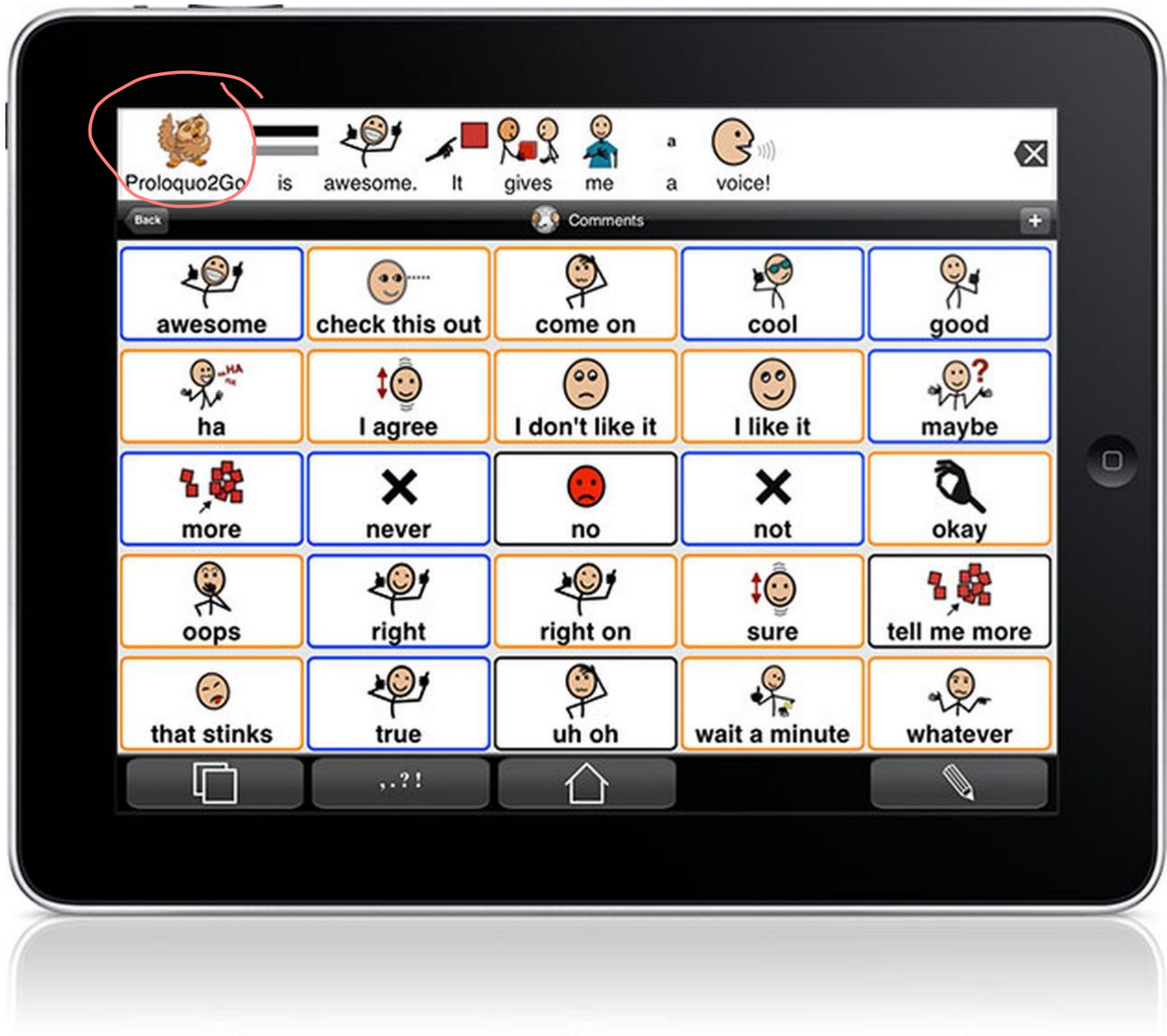
Speech input[27]

[27] Image source

Alternative & Augmentative Communication[28]

AAC

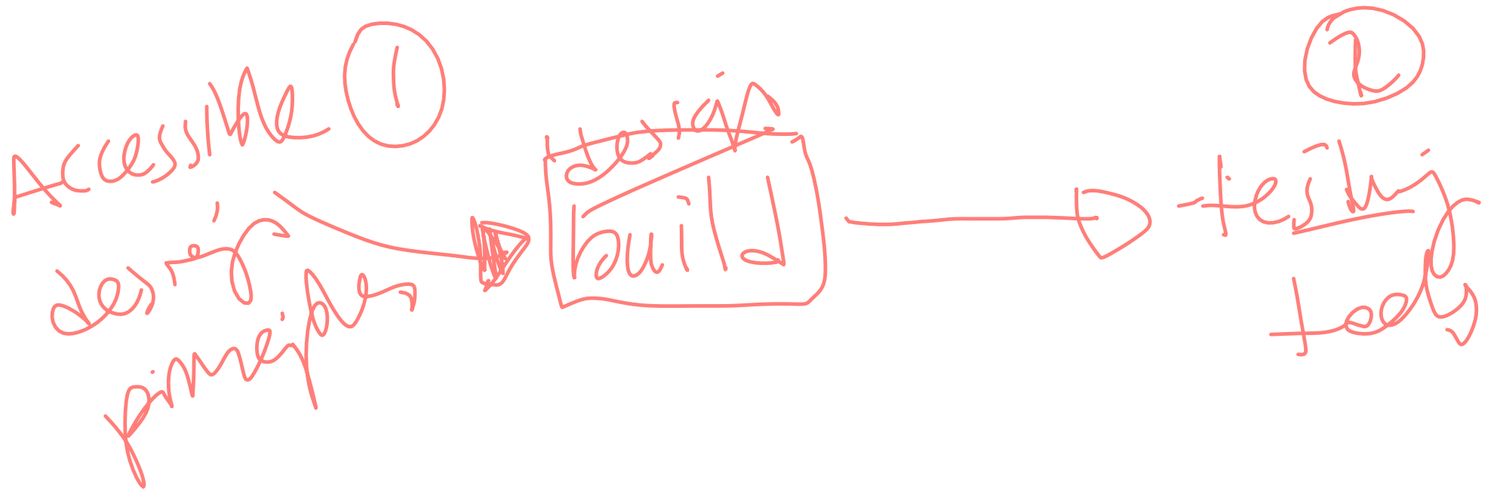
Definition: Tools that help individuals who are unable to use verbal speech to communicate.



[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.



Quiz 3

Complete the Canvas quiz.

Quiz 4

Complete the Canvas quiz.

Try out an assistive technology:

VoiceOver

TalkBack

1. **Task 1:** Purchase a new iPhone on the Apple site.
2. **Task 2:** Send a new email to Apple support.

Report on an observation.

canvas

How to

Navigate with VoiceOver

[29] Video source

What did we learn today?

- What is accessibility?
- Accessible design
- Assistive technologies