Accessibility

Temporary and Situation Disabilities

Chronic and Long-term Disabilities

Curb Cut Effect

Accessible Interface Design and Implementation

Abilities

People vary in physical and mental capabilities

- How are your abilities different from other people?
- How will your abilities change in the future?
- How do your abilities change in different environments?

We have a range of **ability dimensions:**
(characteristics and factors that influence our capabilities)

Age
Gender
Cognitive
Physical

Culture
Language
Lived Experience
Emotional
Spiritual

Abilities

Individual performance and capabilities vary significantly

- The “average person” is just a statistical construct
- The people who will use your interface are different than you

The challenge: usable *and accessible* interfaces for everyone

People have **temporary** disabilities and situational impairments

- Due to nature of environment, health, usage context, …
- What forms of “temporary” disabilities are there?

Temporary and Situational Disabilities

- examples
- impacts on interaction with computers
- interface and interaction techniques to compensate

Temporary Disabilities

Sick or injured

- Temporarily impaired cognitive capabilities
- Temporary loss of motor capabilities

Driving a car

- Limited attentional bandwidth

Underwater diving

- Impaired sight, hearing, mobility

Using an ATM late at night in an unfamiliar surrounding

- Likely paying attention to multiple things at the same time

London street has record cell phone texting injuries

https://youtu.be/807vebt-mmQ

Daily Mail .com

Brick Lane made Britain's first 'Safe Text' street with padded lampposts to prevent mobile phone injuries

Last updated at 17:00 04 March 2008

Collision course: Padding around a lamppost in Brick Lane, London. The move is part of the 'safe text' drive to cut the number of phone users injured in street accidents

In actually, it was a clever Guerrilla marketing campaign

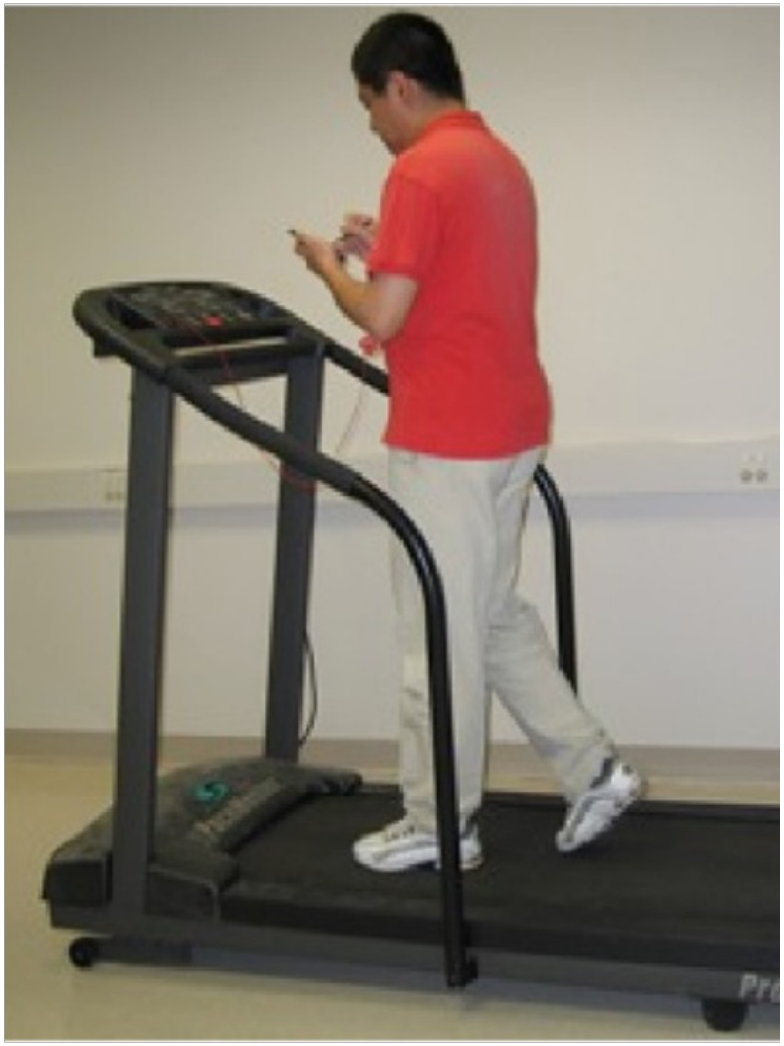
... but it illustrates a point

https://www.dailymail.co.uk/news/article-525785

Input while Walking

Controlled experiment to understand the impact of using a mobile device while walking

- Fitts' law target tapping task (using a stylus)
- Conditions
  - Sitting
  - Treadmill (slow/fast)
  - Obstacle course (self-paced)
- Measures
  - **Time** to complete task
  - **Errors** when selecting targets

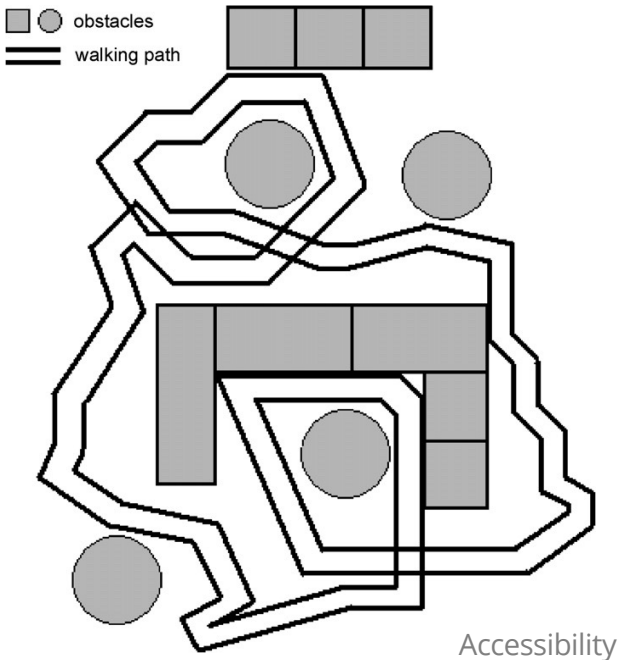


Lin et al. How do people tap when walking? An empirical investigation of nomadic data entry (2007)

Input while Walking

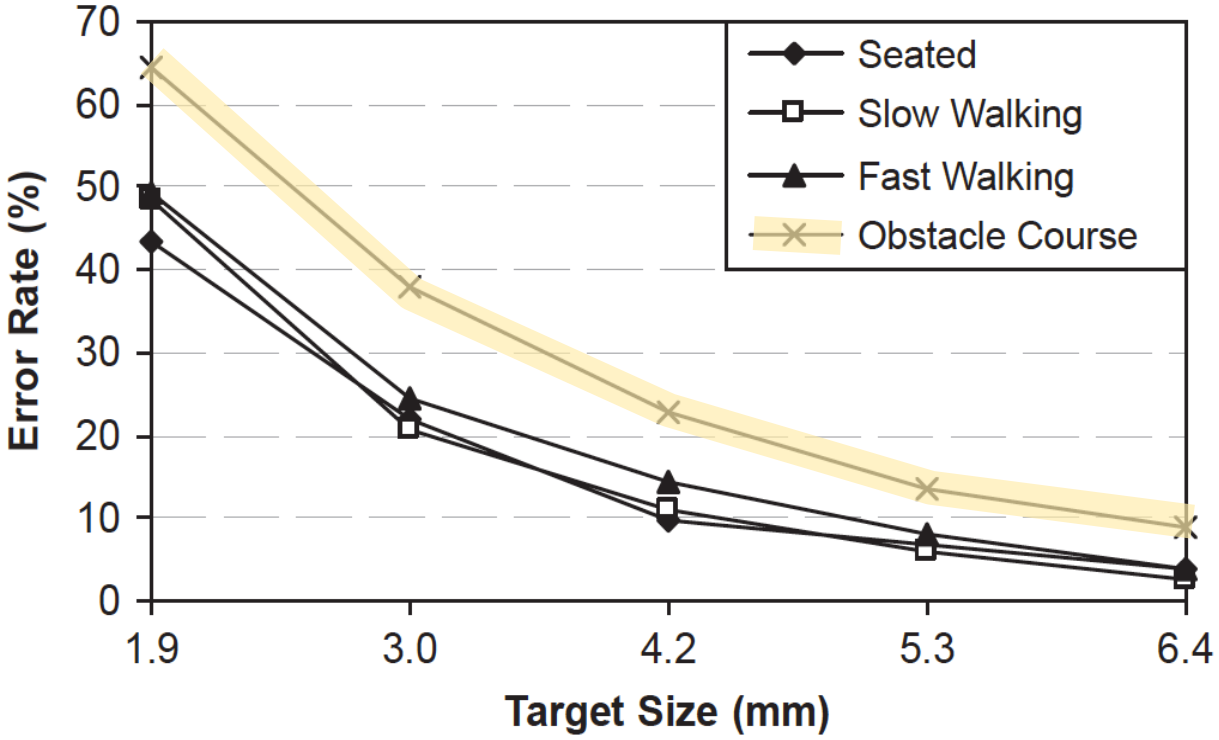
Overall task completion time with standard deviations in parentheses

	Mobility condition			
	Seated	Slow walking	Fast walking	Obstacle course
Task completion time (s)	457.2 (74.2)	448.1 (94.8)	468.3 (82.1)	526.9 (73.7)



Lin et al. How do people tap when walking? An empirical investigation of nomadic data entry (2007)

Input while Walking



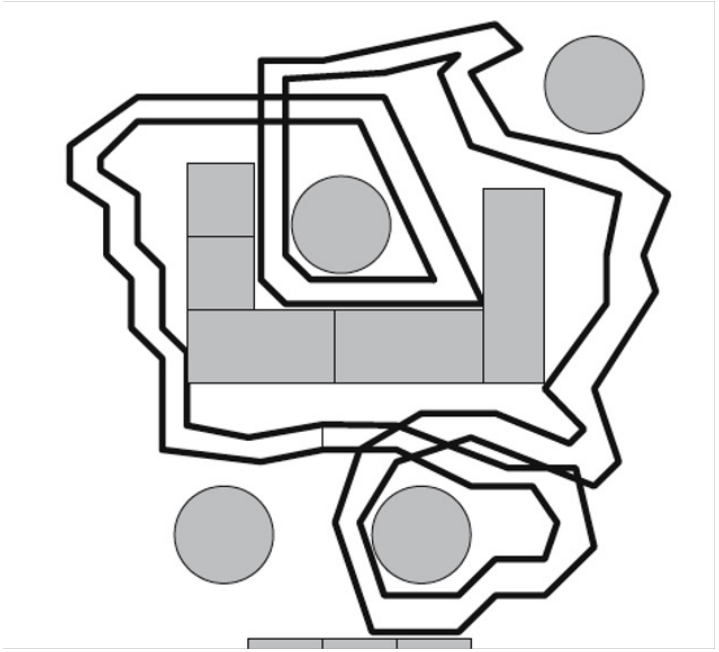
Lin et al. How do people tap when walking? An empirical investigation of nomadic data entry (2007)

Reading and Thinking while Walking

Conditions

- Sitting
- Obstacle course (self-paced)

- Tasks
  - read short descriptions
  - answer questions



Barnard et al. Capturing the effects of context on human performance in mobile computing systems. (2007)

Reading and Thinking while Walking

Reading time

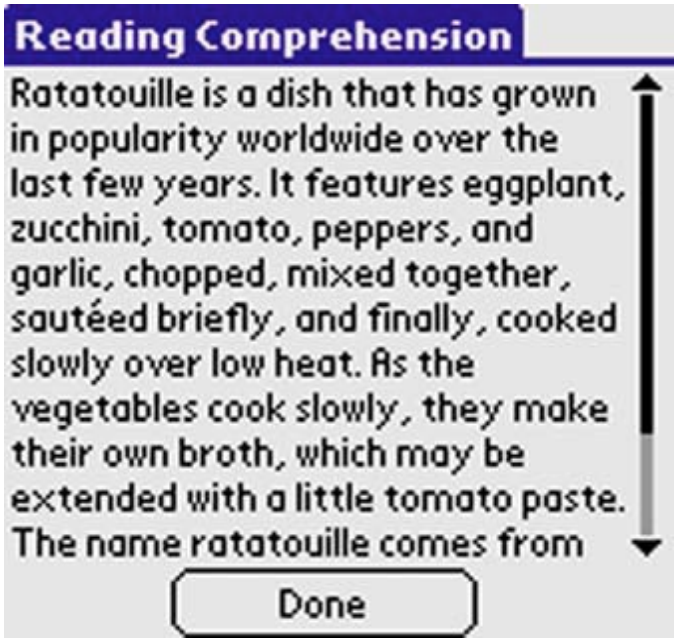
- people were *slower* when walking compared to sitting

Response time

- *no difference* in how quickly people responded to the reading comprehension questions between the two conditions

Correctness of Responses

- *significantly worse* in the walking condition



Barnard et al. Capturing the effects of context on human performance in mobile computing systems. (2007)

Reading and Thinking while Walking

Time

- people took *longer to tap* on the line containing the highlighted word in the walking condition

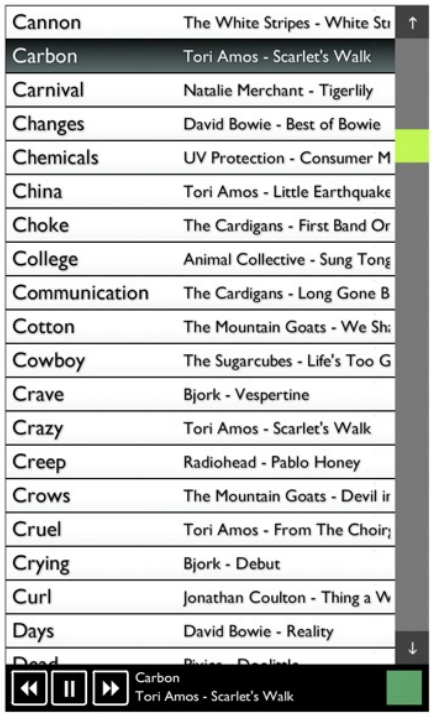
Errors

- people made *twice as many* errors in the walking condition

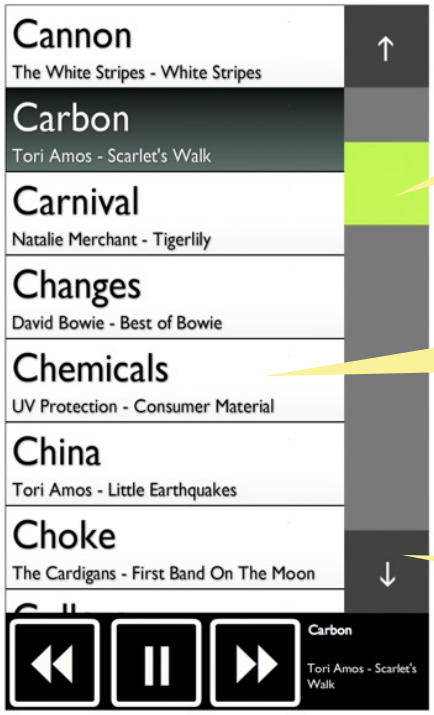
Barnard et al. Capturing the effects of context on human performance in mobile computing systems. (2007)

Interface Adaptation when Walking

- To address walking impairments
  - Reduced dexterity and motor control
  - Reduced cognitive ability



sitting interface



walking interface

Varied saliency of visual elements helps address limited attention

Larger visual cues address reduced reading ability

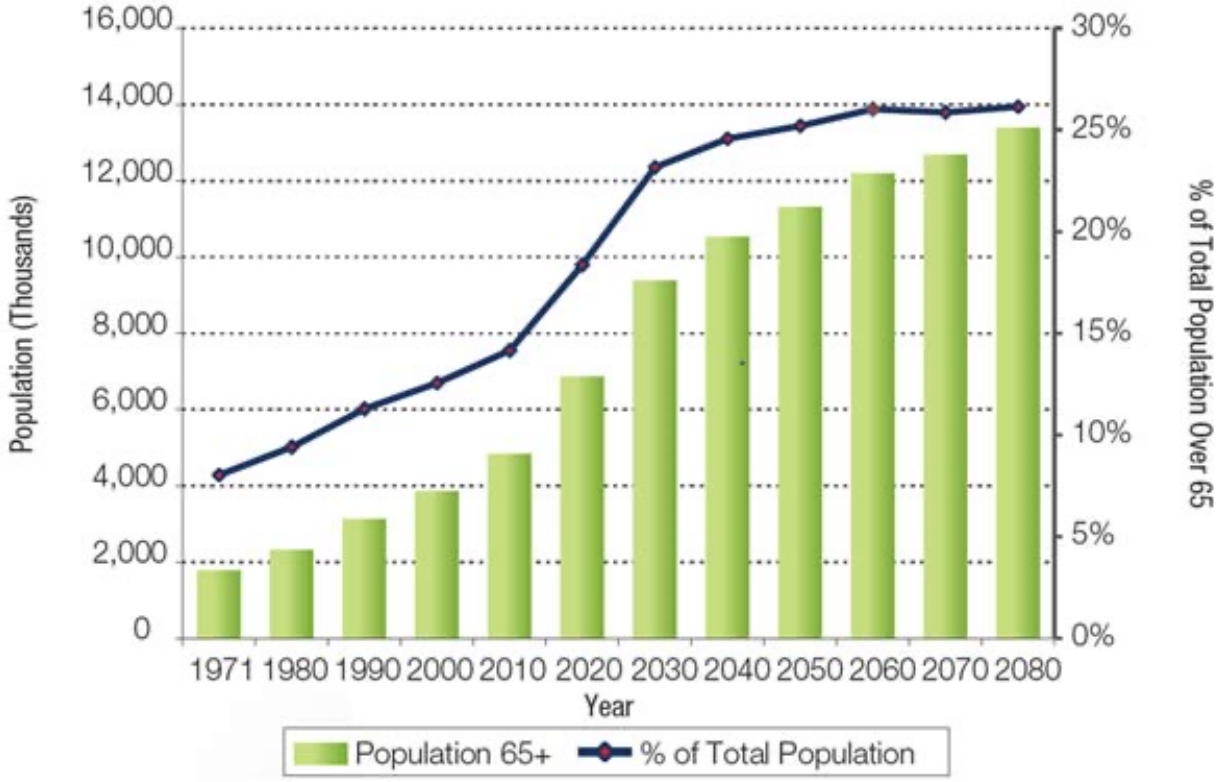
Larger widget targets address impaired dexterity

Kane et al. Getting off the treadmill: evaluating walking user interfaces for mobile devices in public spaces. (2008)

Age-Related Impairments

- Reduced motor coordination (fine/gross motor skills)
- Visual and hearing impairments
- Cognitive effects like loss of memory

~25% of Canadians will be over 65 by 2030 (only ~10% in 1991)

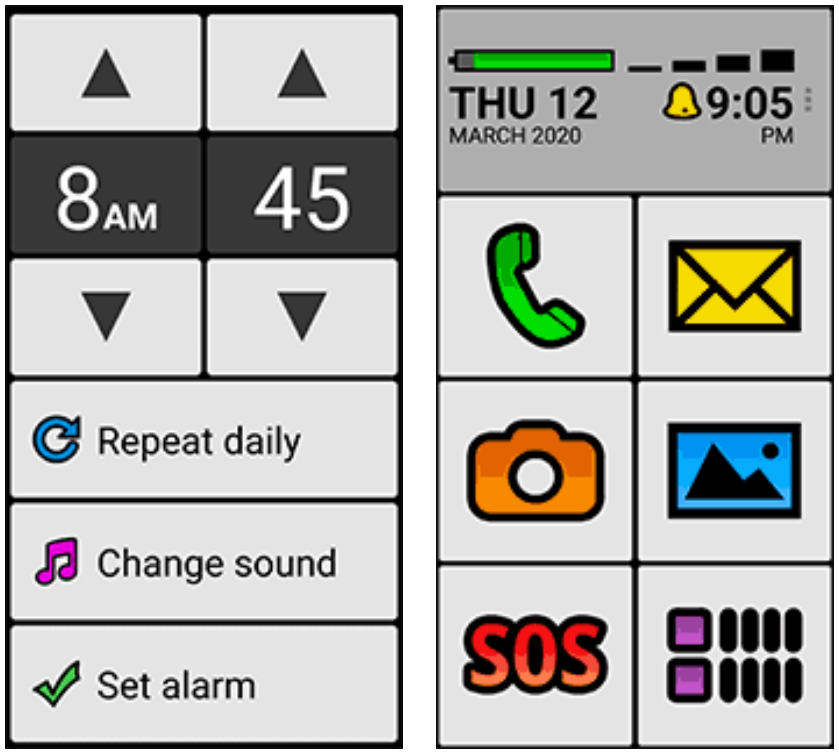


https://www.canada.ca/en/employment-social-development/programs/seniors-action-report.html

Meet MIT AgeLab's AGNES
https://youtu.be/czuww9rp5f4

Interfaces for Age-Related Impairments

- Keep information simple (cognitive)
- High contrast colours, large text and icons (vision)
- Large widget and button sizes (motor)



http://biglauncher.com

https://www.ablenetinc.com/bigtrack-2/

https://www.popsci.com/smartphone-settings-accessibility/

Chronic and Long-term Disabilities

- impairment types
- interface and toolkit support

Many People are Affected

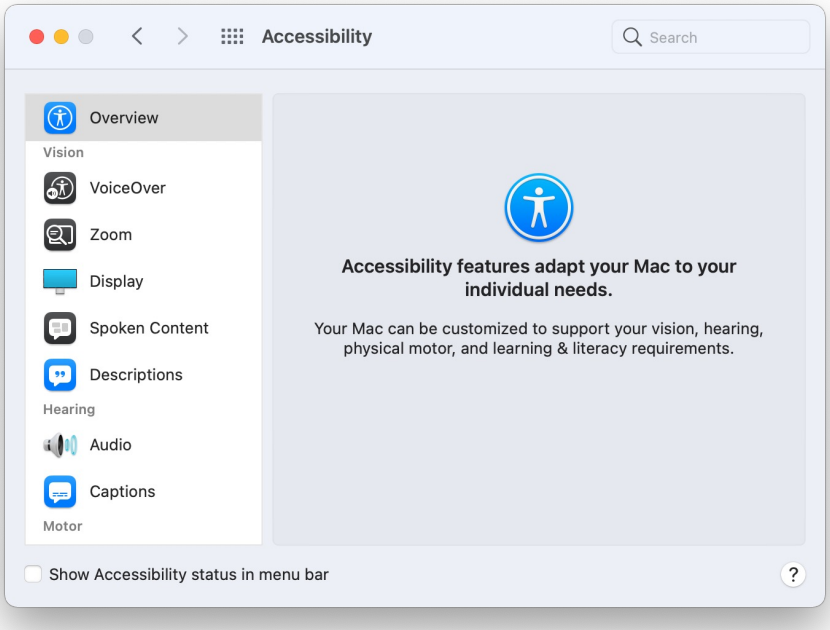
- Visual
  - 1 in 100 people have a significant visual disability
  - 1 in 475 people are legally blind
  - 1 in 2000 people are totally blind
- Hearing
  - 1 in 10 people have a significant hearing impairment
  - 1 in 125 people are deaf
- Motor
  - 1 in 250 people use a wheelchair
- Cognitive
  - 3 in 100* people have a significant cognitive disability

10 to 20% of population estimated to have a long-term disability
(3 to 6 million people in Canada)

Handbook of Human-Computer Interaction, chapter by Newell & Greg, 1997
*Bielska et al. 2012

Modern OS Level Interface Support

- Significant support for accessibility issues such as
  - Control cursor from keyboard (motor)
  - Adjust acceleration, tracking, precision (motor)
  - Speech dictation (visual/motor)
  - Magnify portions of the screen, adjust element sizes or font-size, provide full voice dictation (visual)
  - Captions / subtitles (audial)



Interface Enhancements for Visual Impairments

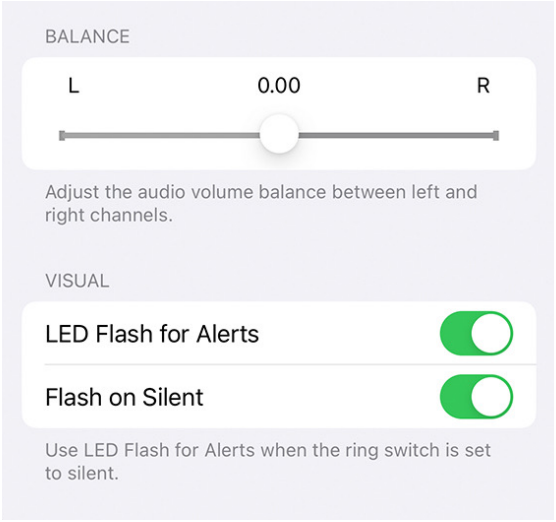
- zoom screen or specific area, increase font size
- high contrast colours, dark mode, remove animations
- screen reader, voice input
- real world magnifier

How A Blind Person Uses A Computer
https://youtu.be/UzffnbBex6c

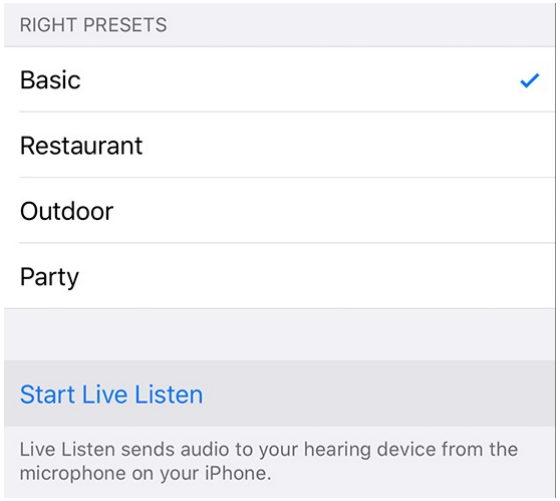
Seeing AI: Making the visual world more accessible
https://youtu.be/DybczED-GKE

Enhancements for Hearing Impairments

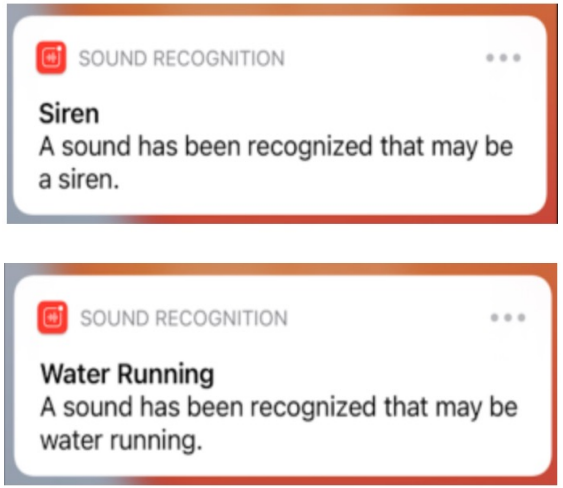
- Show audio alerts visually (e.g. vibrate, flashlight alarm)
- Realtime audio processing to filter background noise and amplify the voice of another person
- Monitor audio for certain sounds and send alert (e.g. baby crying)



IOS **Sensory Alerts**



IOS **Live Listen**

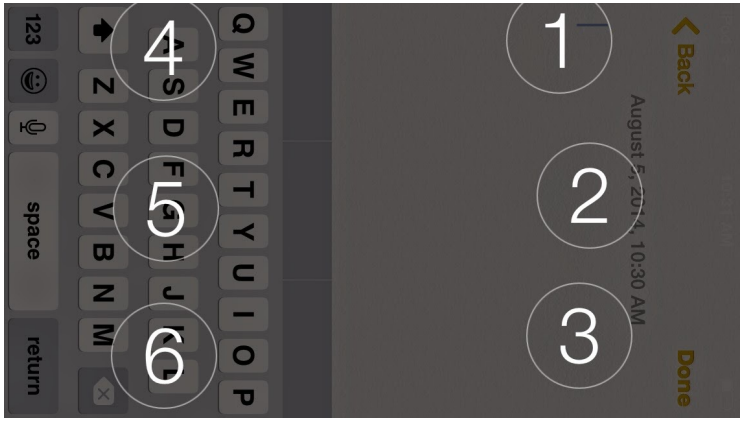


IOS **Sound Recognition**

https://www.apple.com/ca/accessibility/hearing/

Input Enhancements for Audio and Visual Impairments

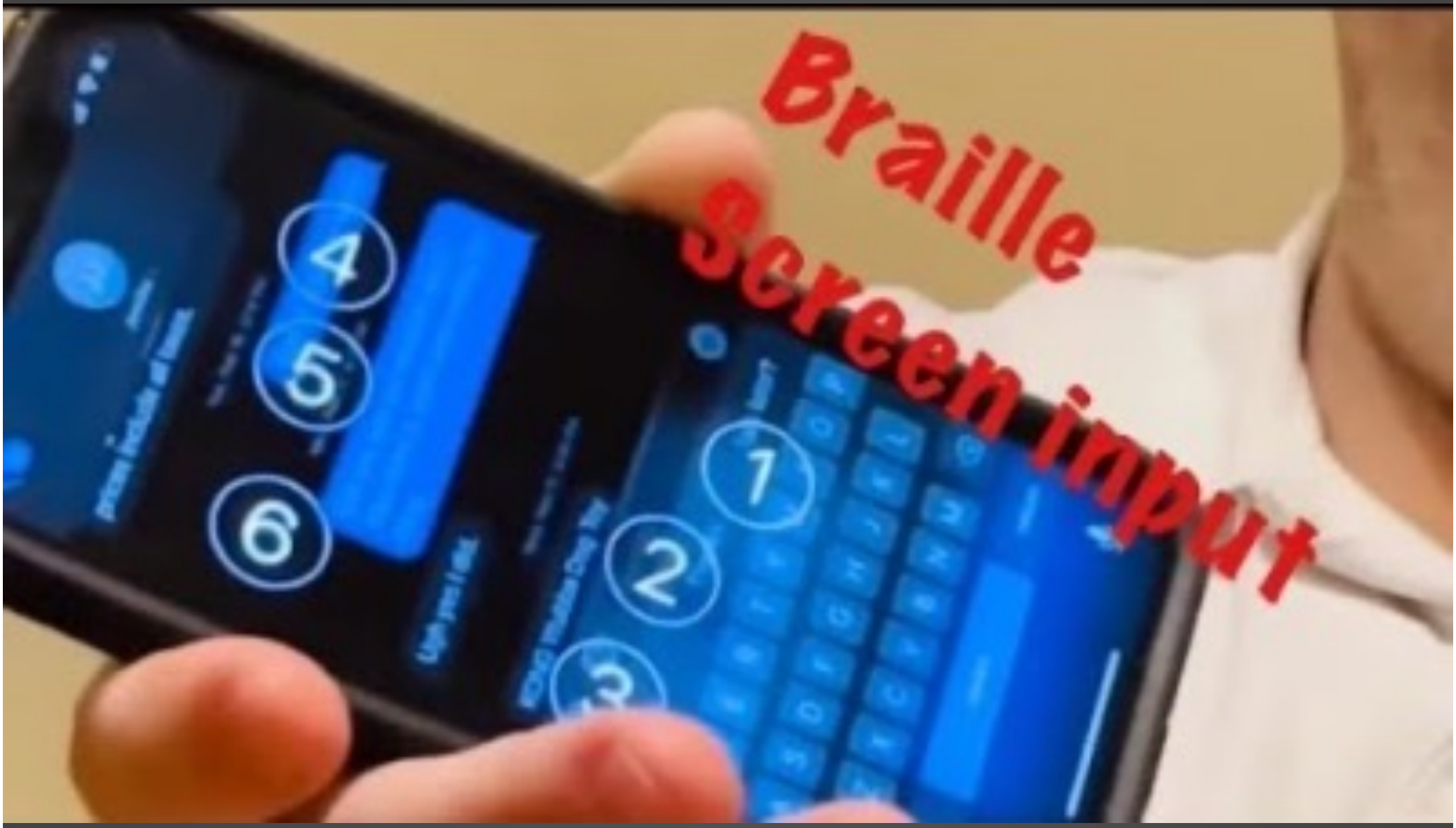
- external braille keyboard and display
- touchscreen braille input



IOS Braille keyboard

https://www.freedomscientific.com/products/blindness/

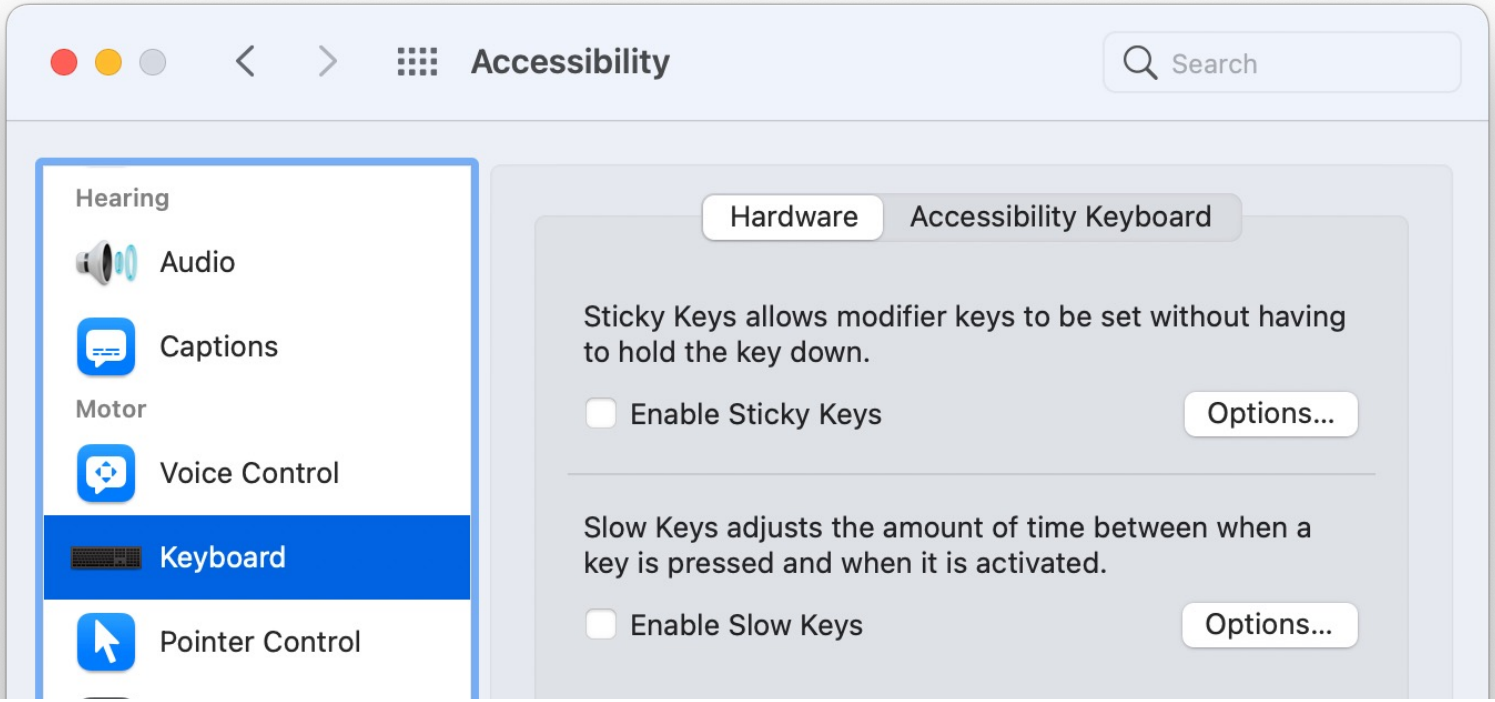
Using the Focus 14 Blue Refreshable Braille Display with iOS Devices
https://youtu.be/oK0XTDwwXaU

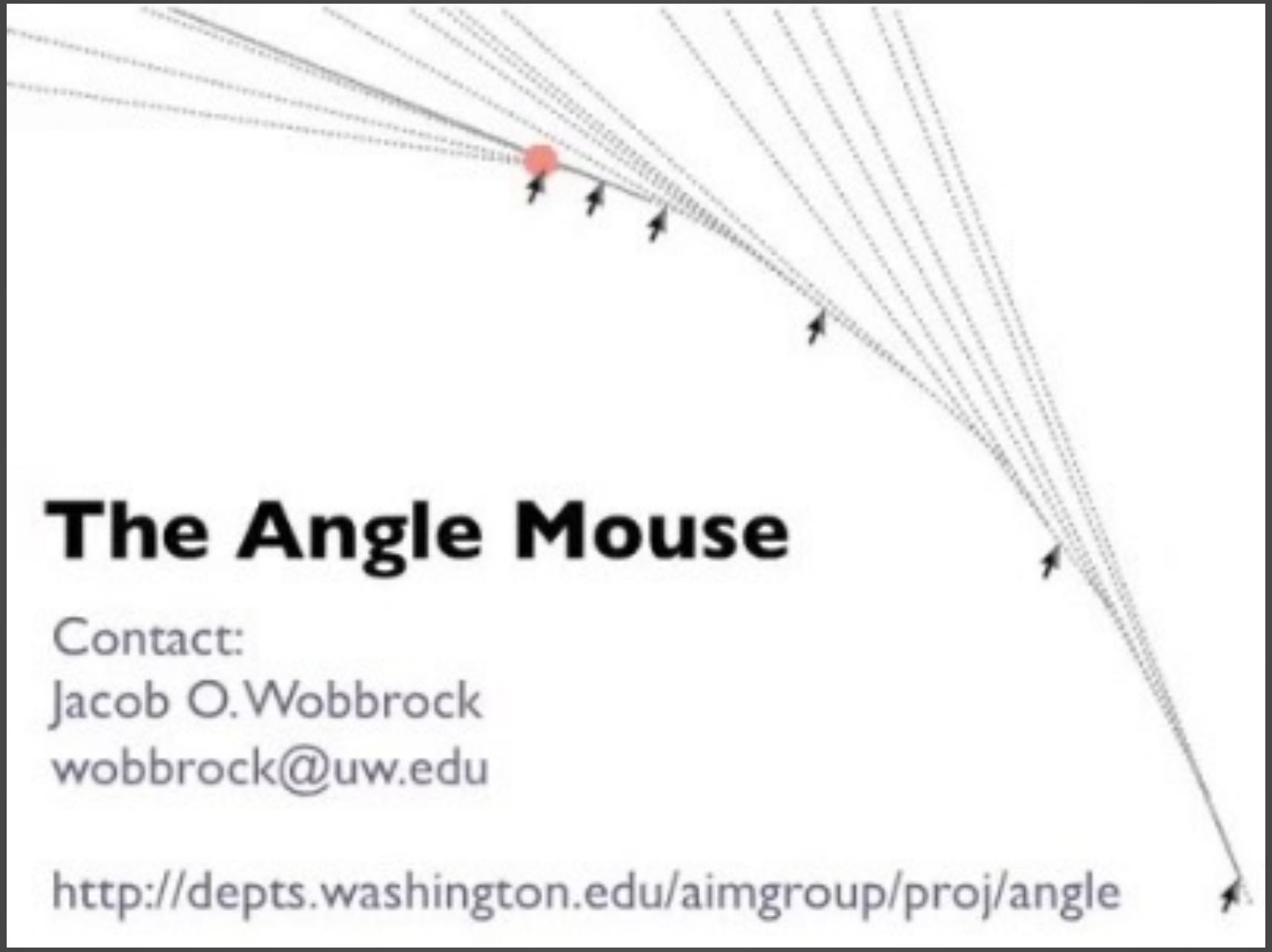


Entering braille on my iPhone as a blind person
https://youtu.be/46NHRVXBh-4

Enhancements for Motor Impairments

- sticky keys, slow keys, and filter keys
- reduce key repeat rate
- eye tracking
- voice input
- physical switches and "puffers"
- brain-computer interfaces (BCI)





Wobbrock et al. Angle Mouse (2009)
https://youtu.be/O4ahGmHenps

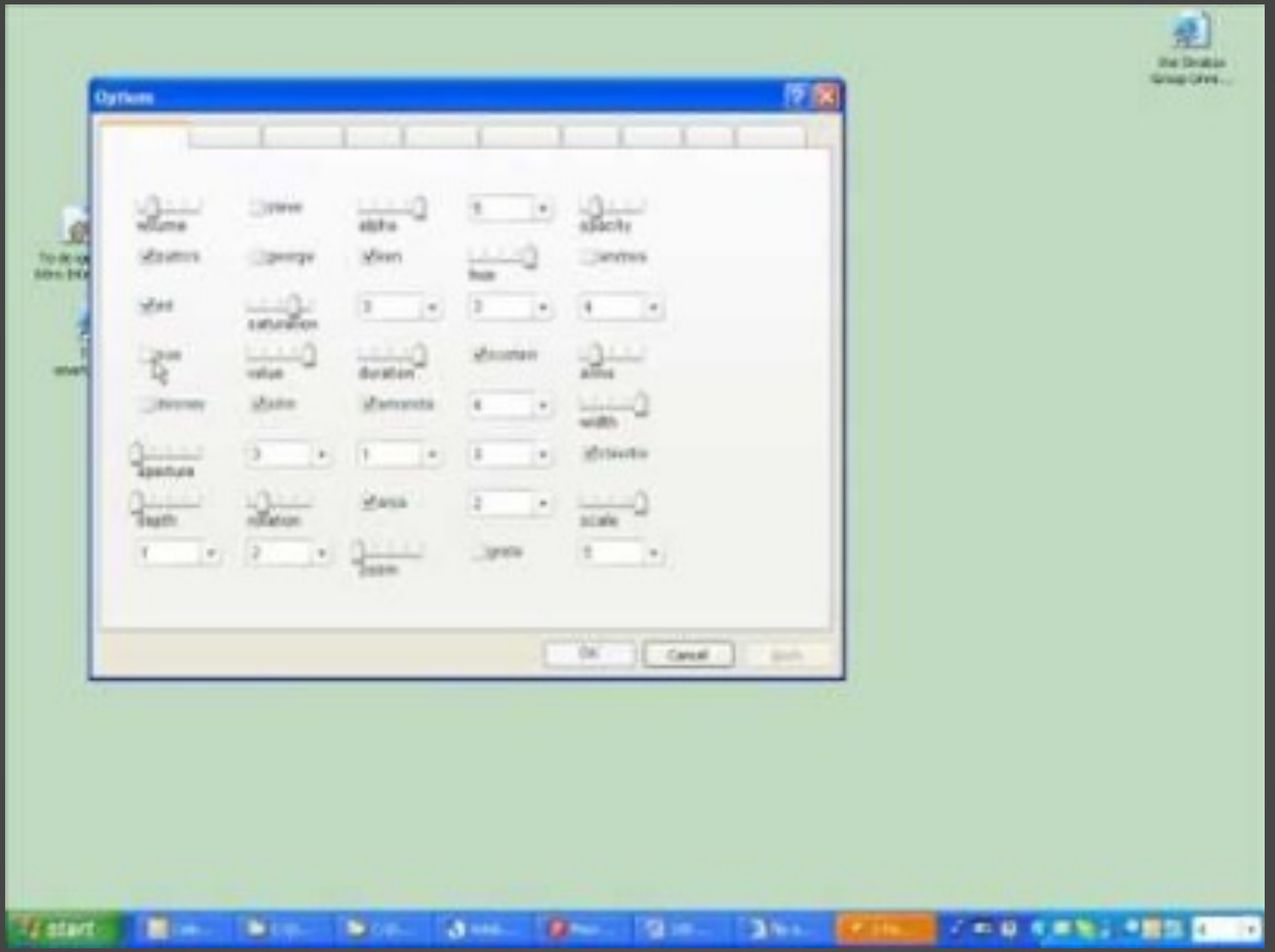
RockyNoHands: The Gamer Who Can Beat You With His Mouth
https://youtu.be/ZMvikz2cA-8

Stephen Hawking's Voice and the Machine That Powers It
https://youtu.be/OTmPw4iy0hk

Graz-BCI Game Controller - World of Warcraft Mindcontrolled
https://youtu.be/jXpjRwPQC5Q

Enhancements for Cognitive Impairments

- word prediction, grammar and spelling check
- text-to-speech
- augmenting text with icons and pictures
- "slow down interface"
  - avoid sudden state changes
  - reduce or remove unnecessary animations (esp. flickering)
  - eliminate time sensitive actions



Phosphor: Explaining Transitions in the User Interface Using Afterglow Effects
https://youtu.be/oQPTiqMGd60

The “Curb Cut” Effect

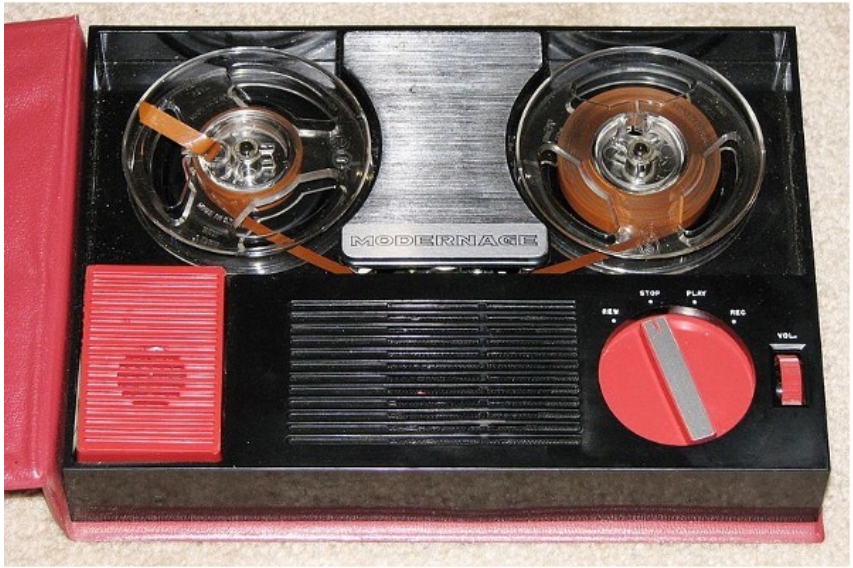
- Laws and programs designed to benefit vulnerable groups, such as people with a disability, often end up benefiting all of society

99 PI podcast highly recommended

https://99percentinvisible.org/episode/curb-cuts/

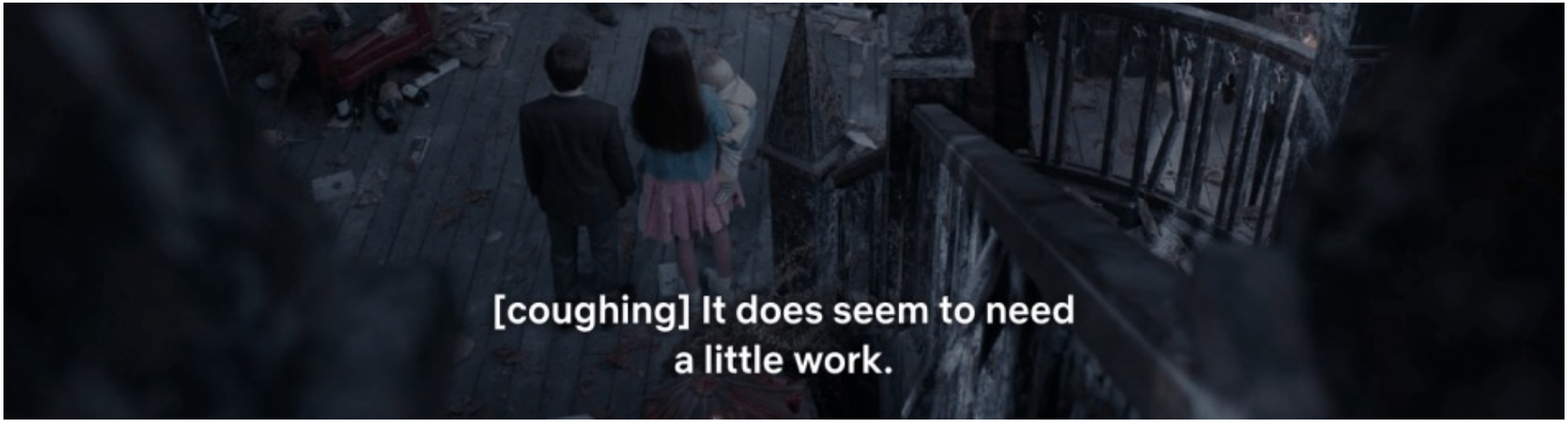
Cassette Tape

- Developed as an alternative to reel-to-reel tape so visually impaired individuals could use books on tape more easily
- Engineers didn't think average user would buy it because of inferior audio quality
- Became widely adopted because of its portability



Video Closed-Captioning

- Captions benefit more than people with hearing impairments
  - enables watching TV in silence (while someone else is sleeping) or in noisy environments (like sports bar)
  - helps children learn to read or adults to learn a second language
  - native language captions enable viewers to enjoy foreign language films and television (i.e. "sub-titles")
  - source for searching and data mining video content



Source: http://www.icdri.org/technology/ecceff.htm

Text-to-Speech Synthesis

Early development focused on people with vision impairments

- TSI Speech+ calculator (1976)
- Kurzweil Reading Machine (1976)
- Led to education toys like Speak & Spell (1978), and technologies used in automated phone systems and digital voice assistants

(TSI) Speech+ Calculator
http://www.vintagecalculators.com/html/speech-.html

Kurzweil Reading Machine
https://www.historyofinformation.com/detail.php?entryid=1170

Speak & Spell

Implementing Accessible Interfaces

Legal Obligations in Canada

- The Accessible Canada Act (since 2019)
  - government and federally regulated organizations (e.g. transportation, broadcasting, telecommunications, financial)
  - expected to use Web Content Accessibility Guidelines (WCAG)
  - fines up to $250K
- Accessibility for Ontarians with Disabilities Act (since 2005)
  - applies to all Ontario government websites
  - applies to Ontario public and private entities (50+ employees)
  - must adhere to Web Content Accessibility Guidelines (WCAG) 2.0
  - fines up to $100K

https://siteimprove.com/en-ca/blog/a-complete-overview-of-canada-s-accessibility-laws

Legal Obligations Elsewhere

- United States Disabilities and Rehabilitation Act "Section 508"
  - any organization doing business with federal agency or receives federal funding
- Americans with Disabilities Act (ADA)
  - non-profits, business, local and state governments
- European Union Web Accessibility Directive
  - all government websites
  - any organizations financed through public contracts

POLICY —

Lawsuit over web site accessibility for the blind becomes class action

A federal judge has certified a class action lawsuit against Target after ...

NATE ANDERSON - 10/3/2007, 1:34 PM

A lawsuit brought in 2006 by a blind student at the University of California-Berkeley has now morphed into a class action case against US retailer Target. A federal judge has just certified a nationwide class in the case, which alleges that Target's web site is not fully accessible to the blind. It's a case that could help establish the ways in which the Americans With Disabilities Act applies to the Internet, and it has already generated a ruling that, in California at least, commercial web sites must be accessible.

The case focuses on the alleged lack of descriptive "alt" tags in Target's HTML, making the site difficult to navigate with screen reading software. The use of image maps is also claimed to make the site inaccessible.

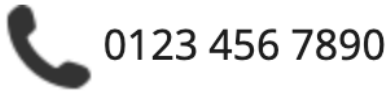
Public locations in the real world have long been required to abide by the ADA, but the law was written in the days before the Web, and it remains unclear how it should be applied to web sites. One of the lawyers from Disability Rights Advocates, which is handling the case, sees inaccessibility as a simple issue of discrimination, online or off.

"Target Corporation has led a battle against blind consumers in a key area of modern life: the Internet economy," said Larry Paradis in a statement after the ruling. "The court's decision today makes clear that

Implementing for Web Accessibility

- Include alt text for information images

```
<p><img src="phone.png" alt="Telephone:"/>0123 456 7890</p>
```



- Use headings, and use them correctly
- Give links unique and descriptive names
- Use colour with care
- Use tables for tabular data, not for layout
- User ARIA roles and landmarks (but only when necessary)
- Make dynamic content accessible
- Make all content accessible using keyboard too
- Design forms for accessibility (examples next slide)

https://webaccess.berkeley.edu/resources/tips/web-accessibility
https://www.w3.org/WAI/tutorials/images/informative/

Design HTML forms for accessibility

Name:

```
<label for="name">Name:</label>
<input id="name" type="text" autocomplete="name"
aria-required="true" >
```

Choose a shipping method:

- Overnight
- Two day
- Ground

```
<fieldset>
<legend>Choose a shipping method:</legend>
<input id="overnight" type="radio" name="shipping" value="overnight">
<label for="overnight">Overnight</label>
<input id="twoday" type="radio" name="shipping" value="twoday">
<label for="twoday">Two day</label>
<input id="ground" type="radio" name="shipping" value="ground">
<label for="ground">Ground</label>
</fieldset>
```

https://webaim.org/techniques/forms/controls

Making Desktop and Mobile Interfaces Accessible

- GUI toolkits like Java, Cocoa, and those for MS Windows provide hooks to integrate with accessibility functions
- include features to provide additional information about interface
  - individual component names, functions they serve, etc.
  - built-in tools or software uses this to make interface accessible
- interaction must be possible using different or altered modalities
  - output (e.g. screen readers, enlarged text, high contrast colour)
  - input (e.g. voice commands, sticky buttons, alternative devices)

JavaFX Accessibility Implementation

- Primary goal is to add meta information to Nodes (Widgets)
  - for assistive technologies like screen reader
  - to make traversable and usable with keyboard only
  - supporting special high contrast mode
- Each Node has accessibility-related properties:

  `accessibleRole`
  - identifies kind of control for screen reader like BUTTON or MENU

  `accessibleRoleDescription`
  - string for screen reader to speak that describes role

  `accessibleText`
  - string for screen reader to speak for this node

  `accessibleHelp`
  - a string with more detailed description of node

https://www.infoworld.com/article/2991463/javafx-improvements-in-java-se-8u40.html

Android Accessibility Implementation

- Use "sd" units for text
- Choose colours that maintain enough contrast
  - text smaller than 18pt, contrast should be 4.5:1 or greater
  - other text, contrast should be 3:1 or greater
- Use large simple controls

  `(paddingLeft + minWidth + paddingRight)` >= 48dp

  `(paddingTop + minHeight + paddingBottom)` >= 48dp
- Describe information elements for screen reader

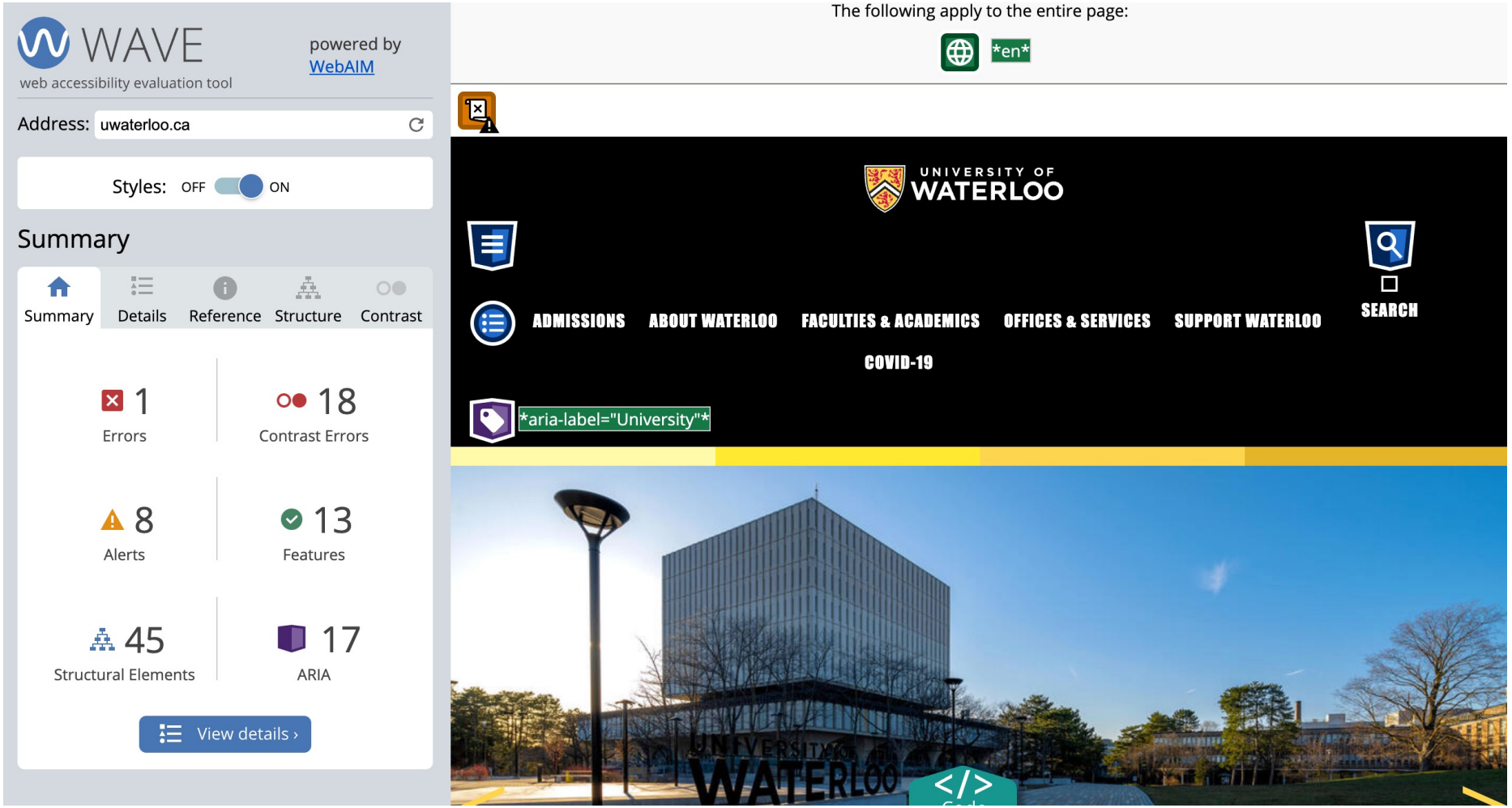
  `android:contentDescription="@string/inspect"`
- For decorative elements, set

  `android:importantForAccessibility="no"`

https://developer.android.com/guide/topics/ui/accessibility/apps

Accessibility Testing Tools

http://wave.webaim.org/report#/uwaterloo.ca



Summary

- Impairments can be situational and chronic/long term
- Enhancements for visual, hearing, motor, cognitive impairments need the developer to implement the interface in a certain way
- In many countries, interfaces must be accessible by law
- Accessibility is an important part of user interface development