CS 315 – Intro to Human Computer Interaction (HCI)

Interaction Devices

Input / Output

- What forms of input and output currently exist?

- http://www.youtube.com/watch?v=v9kTVZiJ3Uc

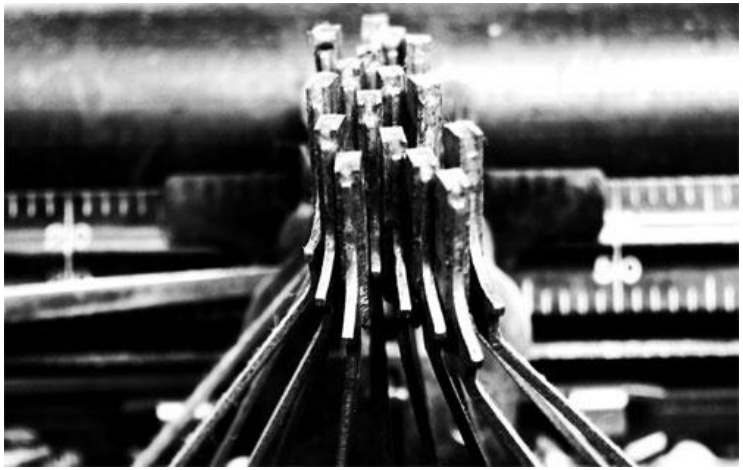
QWERTY Keyboard

- What are the origins of the QWERTY keyboard?

Keyboards

- QWERTY layout
  - 1870 Christopher Latham Sholes
  - Good mechanical design and a clever placement of the letters that slowed down the users enough that key jamming was infrequent
  - Put frequently used letter pairs far apart, thereby increasing finger travel distances

QWERTY Typewriter



Dvorak Layout

- Dvorak layout
  - 1920
  - Reduces finger travel distances by at least one order of magnitude
  - Acceptance has been slow despite the dedicated efforts of some devotees
  - It takes about 1 week of regular typing to make the switch, but most users have been unwilling to invest the effort

Dvorak Layout

ABCDE Layout

- 26 letters of the alphabet laid out in alphabetical order non-typists will find it easier to locate the keys

Keyboard Issues

- IBM PC keyboard was widely criticized because of the placement of a few keys
  - Backslash key where most typists expect SHIFT key
  - Placement of several special characters near the ENTER key
- Number pad layout
- Wrist and hand placement

Keyboard Layouts

- **Keys**
  - 1/2 inch square keys
  - 1/4 inch spacing between keys
  - slight concave surface
  - matte finish to reduce glare finger slippage
  - 40- to 125-gram force to activate
  - 3 to 5 millimeters displacement
  - tactile and audible feedback important
  - certain keys should be larger (e.g. ENTER, SHIFT, CTRL)
  - some keys require state indicator, such as lowered position or light indicator (e.g. CAPS LOCK)
  - key labels should be large, meaningful, permanent
  - some "home" keys may have additional features, such as deeper cavity or small raised dot, to help user locate their fingers properly (caution - no standard for this)

Keyboard Layouts

- **Cursor movement keys**
  - up, down, left, right
  - some keyboards also provide diagonals
  - best layout is natural positions
  - inverted-T positioning allows users to place their middle three fingers in a way that reduces hand and finger movement
  - cross arrangement better for novices than linear or box
  - typically include typamatic (auto-repeat) feature
  - important for form-fillin and direct manipulation
  - other movements may be performed with other keys, such as TAB, ENTER, HOME, etc.

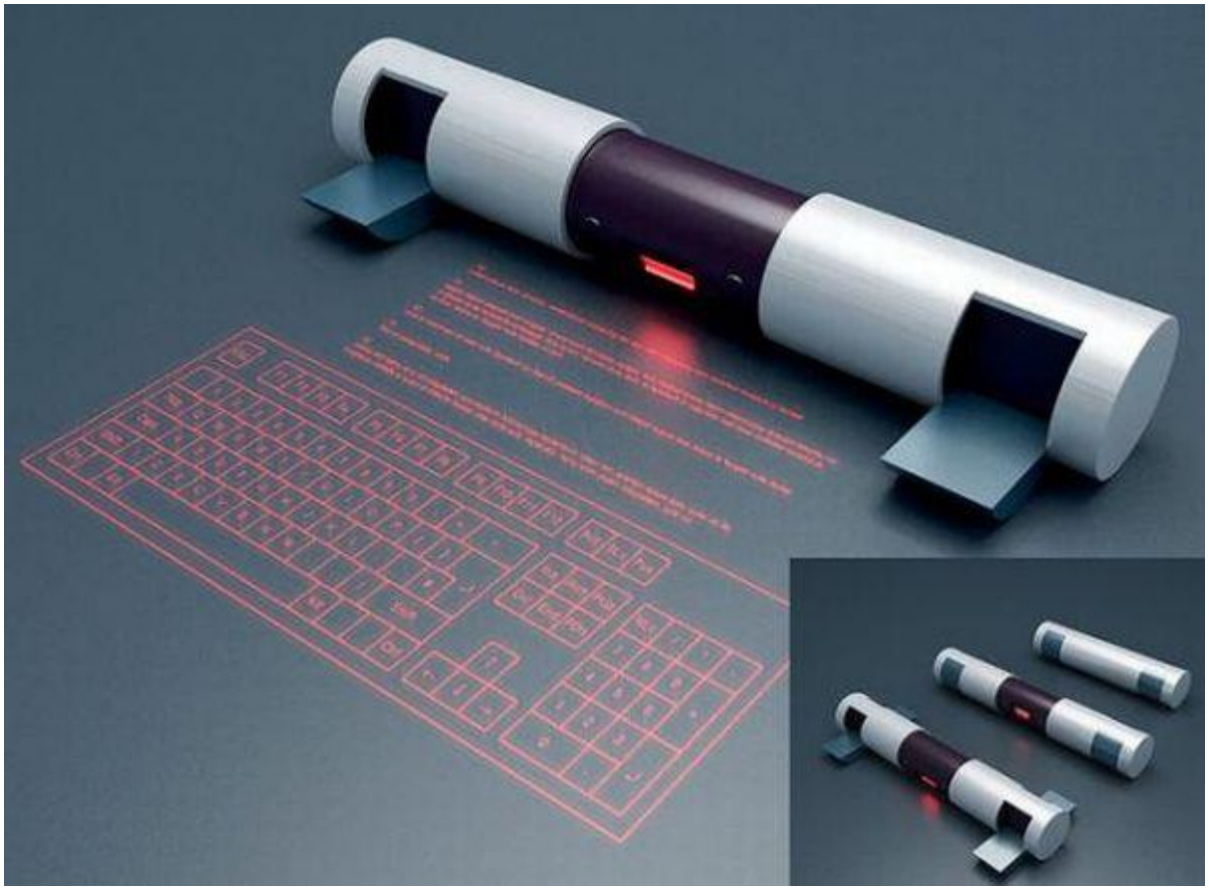
Keyboard & Keypads for Small Devices

- Wireless or foldable keyboards
- Virtual keyboards
- Cloth keyboards
- Pens and touchscreens

Foldable Keyboard

Virtual Keyboard

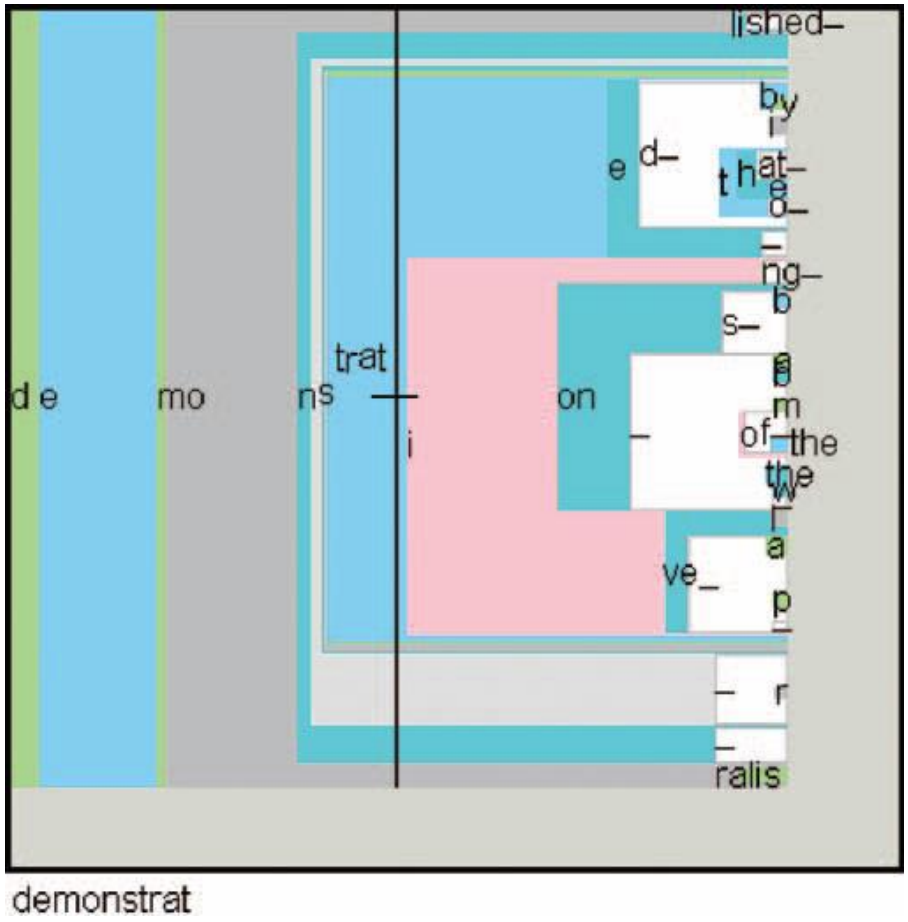
Virtual Keyboard



Cloth Keyboard

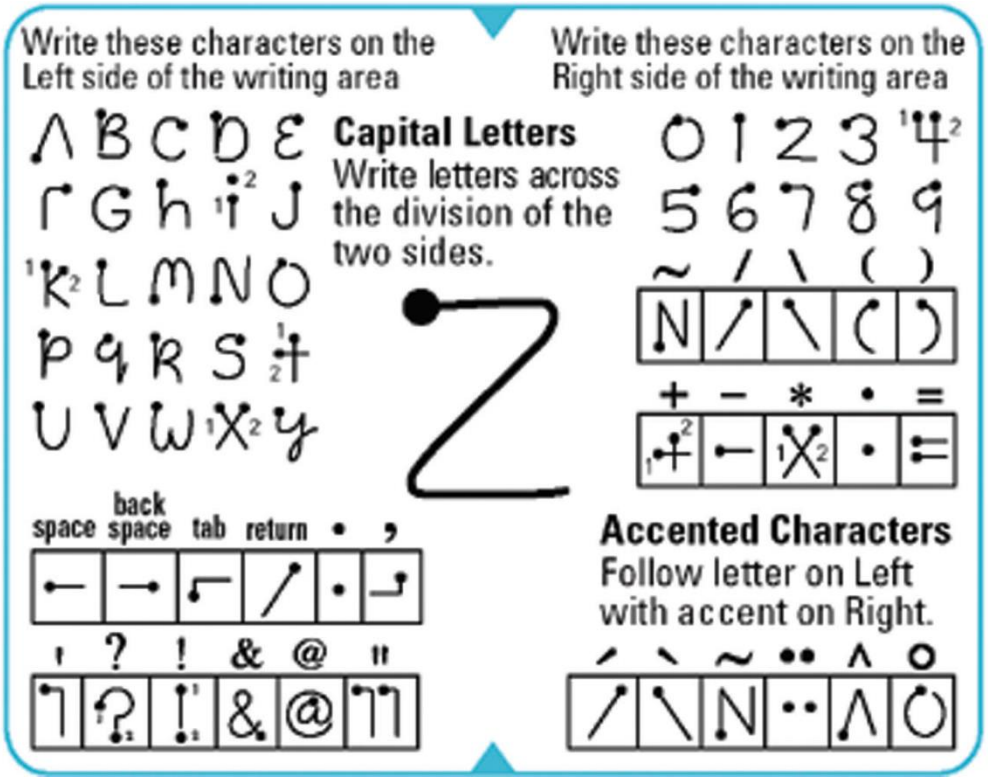
Keyboard Layouts

Text Entry Methods



Text Entry Methods

Text Entry Methods



Pointing Devices

- Pointing devices are useful for several types of interaction tasks. What are some examples?

1. Select
2. Position
3. Orient
4. Path
5. Quantify
6. Gesture
7. Text

Pointing Devices

Direct control devices (easy to learn and use, but hand may obscure display)

- Lightpen
- Touchscreen
- Stylus

Indirect control devices (take time to learn)

- Mouse
- Trackball
- Joystick
- Trackpoint
- Touchpad
- Graphics tablet

Non-standard devices and strategies (for special purposes)

- Multitouch tablets and displays
- Bimanual input
- Eye-trackers
- Sensors
- 3D trackers
- DataGloves
- Boom Chameleon
- Haptic feedback
- Foot controls
- Tangible user interfaces
- Digital paper

Criteria for success

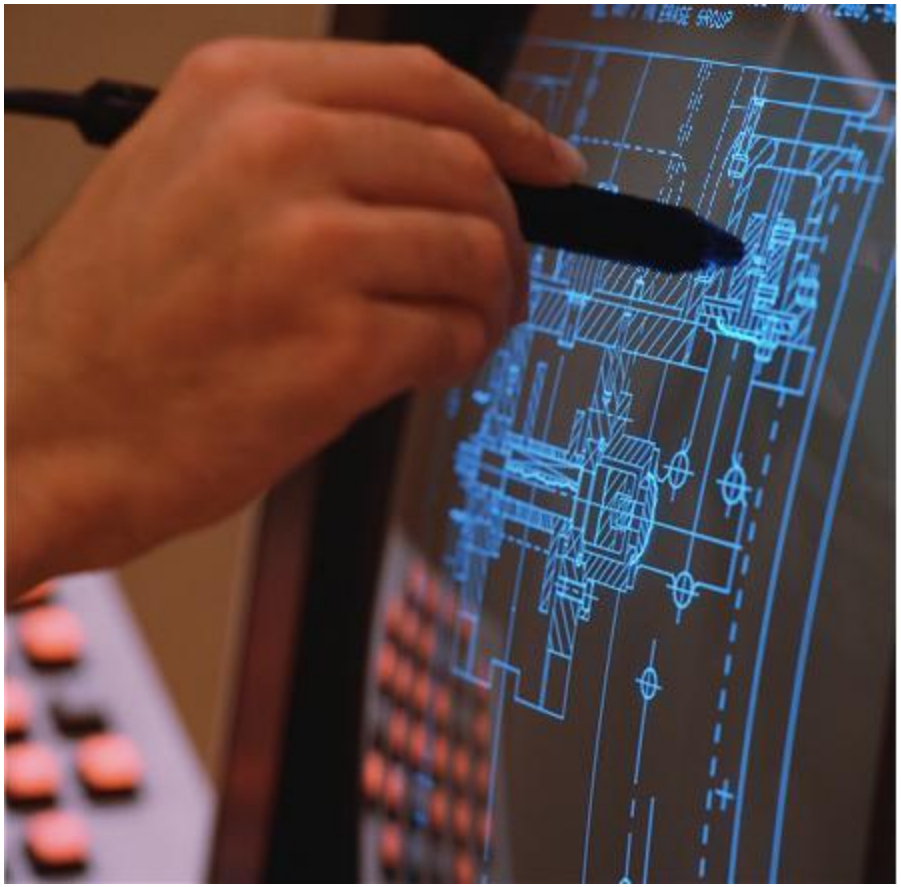
- Speed and accuracy
- Efficacy for task
- Learning time
- Cost and reliability
- Size and weight

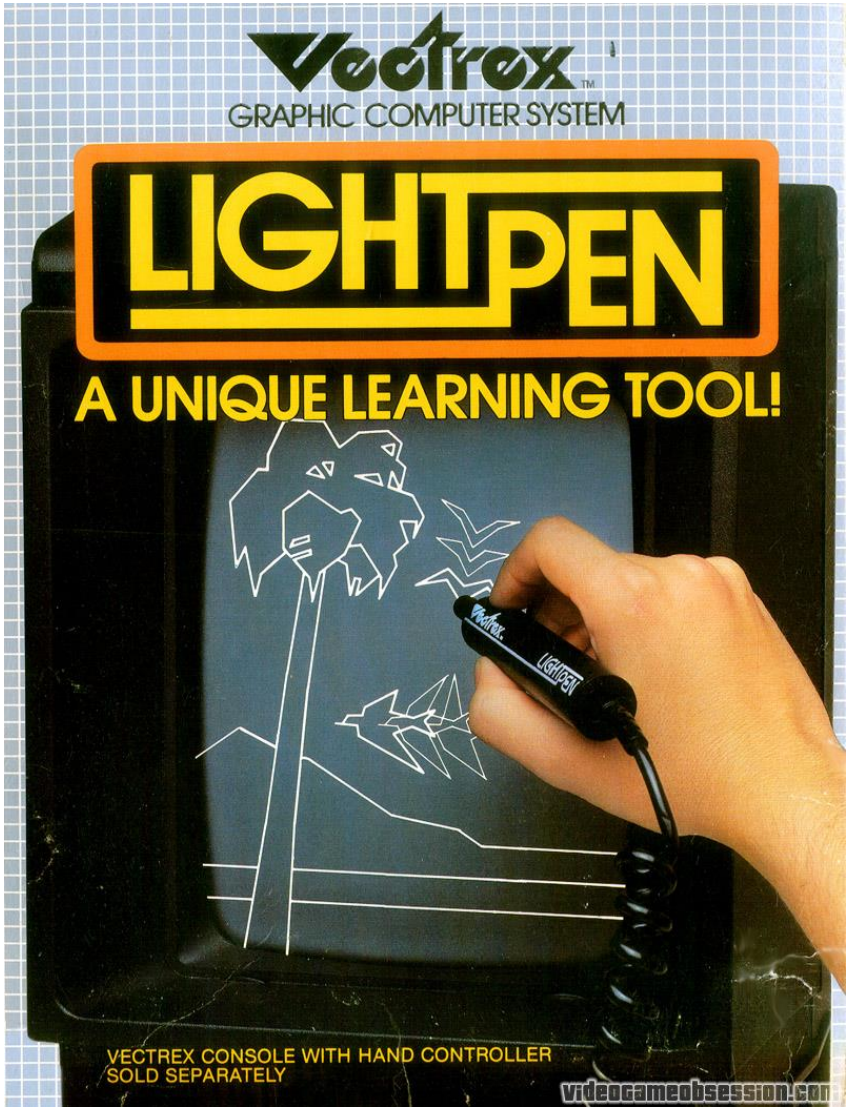
Direct-Control Pointing Devices

Direct-Control Pointing Devices

- Lightpen
  - Enabled users to point to a spot on a screen and to perform a select, position, or other task
  - It allows direct control by pointing to a spot on the display
  - Incorporates a button for the user to press when the cursor is resting on the desired spot on the screen
  - Lightpen has three disadvantages: users' hands obscured part of the screen, users had to remove their hands from the keyboard, and users had to pick up the lightpen

Lightpen




Vectrex
GRAPHIC COMPUTER SYSTEM
LIGHTPEN
A UNIQUE LEARNING TOOL!
VECTREX CONSOLE WITH HAND CONTROLLER
SOLD SEPARATELY
videogameobsession.com

Touchscreen

- Allows direct control touches on the screen using a finger
- Early designs were rightly criticized for causing fatigue, hand-obscuring-the-screen, hand-off-keyboard, imprecise pointing, and the eventual smudging of the display
- Lift-off strategy enables users to point at a single pixel
- The users touch the surface
- Then see a cursor that they can drag around on the display
- When the users are satisfied with the position, they lift their fingers off the display to activate
- Can produce varied displays to suit the task
- Are fabricated integrally with display surfaces

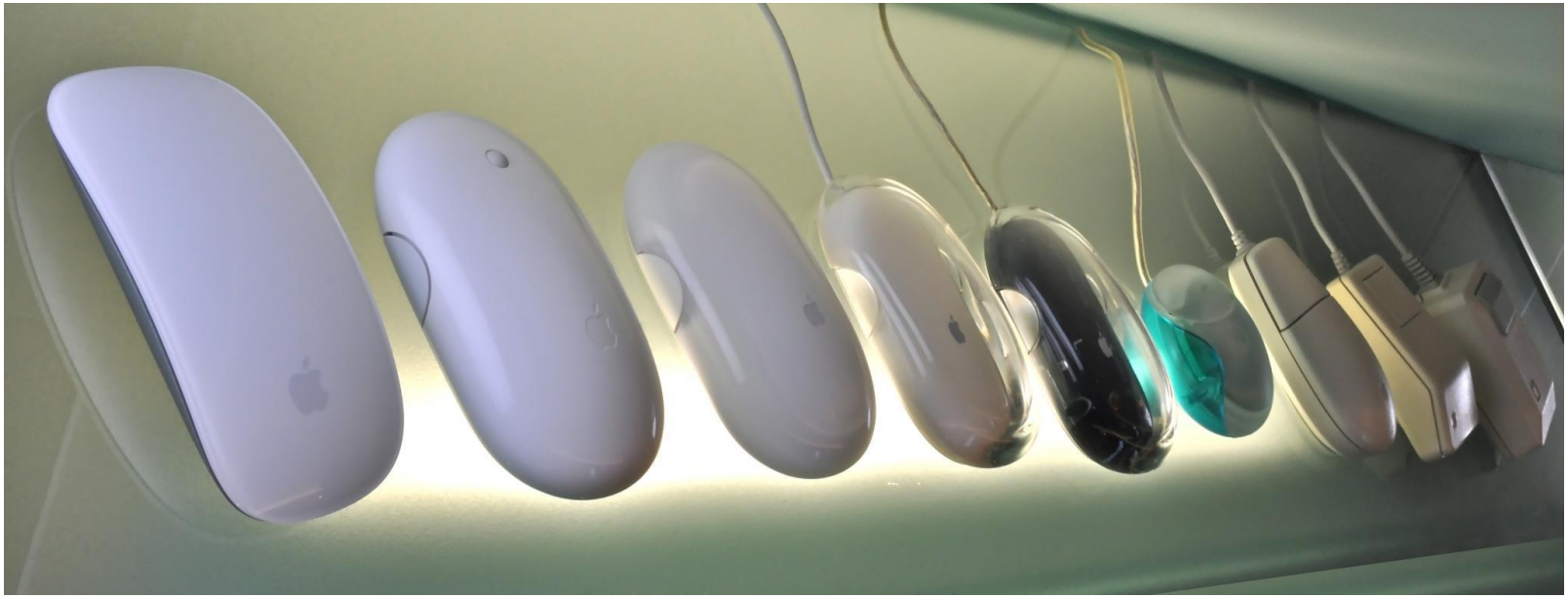
Tablet PCs and Mobile Devices

- Natural to point on the LCD surface
- Stylus
- Keep context in view
- Pick up & put down stylus
- Gestures and handwriting recognition

Indirect Pointing Devices

Mouse

- The hand rests in a comfortable position, buttons on the mouse are easily pressed, even long motions can be rapid, and positioning can be precise



Trackball

- Usually implemented as a rotating ball 1 to 6 inches in diameter that moves a cursor

Joystick

- Are appealing for tracking purposes

Directional Pad (D-pad)

Graphics Tablet

- A touch-sensitive surface separate from the screen

Trackpoint

Touchpad

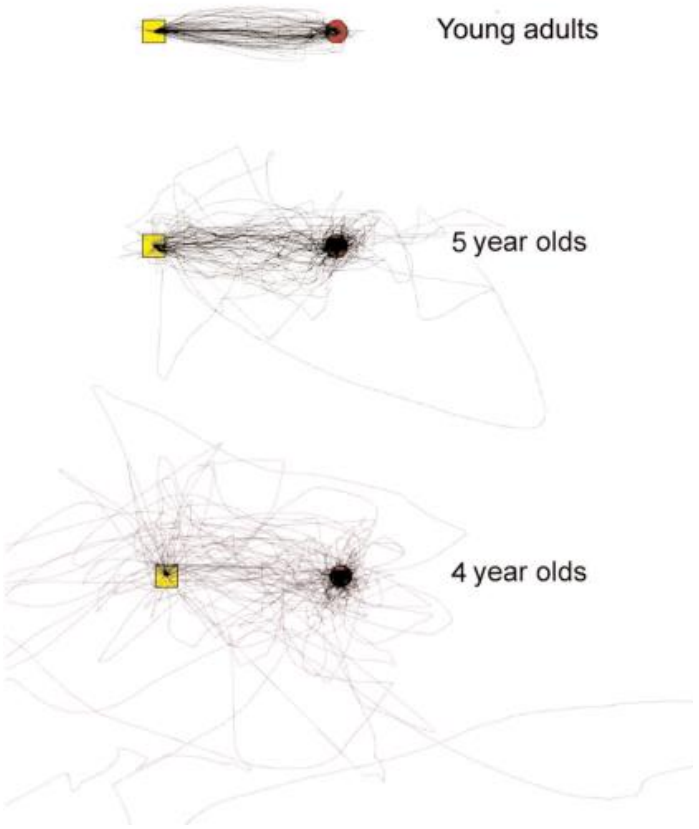
- Built-in near the keyboard offers the convenience and precision of a touchscreen while keeping the user's hand off the display surface

Comparison

- Human-factors variables
  - speed of motion for short and long distances
  - accuracy of positioning
  - error rates
  - learning time
  - user satisfaction
- Other variables
  - cost
  - durability
  - space requirements
  - weight
  - left- versus right-hand use
  - likelihood to cause repetitive-strain injury
  - compatibility with other systems

Comparison

- Some results
  - Direct pointing devices faster, but less accurate
  - Graphics tablets are appealing when user can remain with device for long periods without switching to keyboard
  - Mouse is faster than isometric joystick
  - For tasks that mix typing and pointing, cursor keys a faster and are preferred by users to a mouse
  - Muscular strain is low for cursor keys



Novel Devices

1. Foot controls
2. Eye-tracking
3. Multiple-degrees-of-freedom devices
4. DataGlove
5. Haptic feedback
6. Bimanual input
7. Ubiquitous computing and tangible user interfaces
8. Handheld devices
9. Smart pens
10. Table top touch screens

Speech and Auditory Interfaces

Speech

- Speech recognition still does not match the fantasy of science fiction:
  - Demands of user's working memory
  - Background noise problematic
  - Variations in user speech performance impacts effectiveness
  - Most useful in specific applications, such as to benefit handicapped users

Speech

- http://www.youtube.com/watch?v=MA1hD3XRlh0

Speech and auditory interfaces (cont.)

Opportunities

- When users have vision impairments
- When the speaker's hands are busy
- When mobility is required
- When the speaker's eyes are occupied
- When harsh or cramped conditions preclude use of a keyboard

Technologies

- Speech store and forward
- Discrete-word recognition
- Continuous-speech recognition
- Voice information systems
- Speech generation

Obstacles to speech recognition

- Increased cognitive load compared to pointing
- Interference from noisy environments
- Unstable recognition across changing users, environments, and time

Obstacles to speech output

- Slow pace of speech output when compared to visual displays
- Ephemeral nature of speech
- Difficulty in scanning/searching

Speech and auditory interfaces (cont.)

- Discrete word recognition
  - Recognize individual words spoken by a specific person; can work with 90- to 98-percent reliability for 20 to 200 word vocabularies
  - Speaker-dependent training, in which the user repeats the full vocabulary once or twice
  - Speaker-independent systems are beginning to be reliable enough for certain commercial applications
  - Been successful in enabling bedridden, paralyzed, or otherwise disabled people

Speech and auditory interfaces (cont.)

- Also useful in applications with at least one of the following conditions:
  - speaker's hands are occupied
  - mobility is required
  - speaker's eyes are occupied
  - harsh or cramped conditions preclude use of keyboard
- Voice-controlled editor versus keyboard editor
  - lower task-completion rate
  - lower error rate
- Use can disrupt problem solving

Speech and auditory interfaces (cont.)

- Continuous-speech recognition
  - Not generally available:
    - difficulty in recognizing boundaries between spoken words
    - normal speech patterns blur boundaries
    - many potentially useful applications if perfected

Speech and auditory interfaces (cont.)

- Voice information systems
  - Stored speech commonly used to provide information about tourist sites, government services, after-hours messages for organizations
  - Low cost
  - Voice prompts
  - Deep and complex menus frustrating
  - Slow pace of voice output, ephemeral nature of speech, scanning and searching problems
  - Voice mail
  - Handheld voice recorders
  - Audio books
  - Instructional systems