Chapter 9

Interaction Devices

9.2 Keyboards
9.3 Pointing Devices

Keyboard Layouts

Where should the keys go?

- **Speed of Performance Issues**
  - QWERTY layout
    - Standard in use and taught extensively
  - Dvorak layout
    - Based on frequency of letters in words and minimizing finger travel
    - Faster than QWERTY
    - Reduced finger travel distances by at least one order of magnitude
  - Ordinal layout
    - Consistently places the dedicated function keys above the numbers
    - Takes about 1 week of regular typing to make the switch, but most users have been switching to avoid the effort
  - Chorded layouts (More than one key pressed at a time)
    - Very fast
    - Hard to learn

Keyboard Layouts (cont.)

- **Learning Issues**
  - ABCDE style
    - 26 letters of the alphabet laid out in alphabetical order non-optimal will find it easier to locate the keys
  - IBM PC keyboard
    - Dedicated key where most types expect SHIFT key
    - Placement of several special characters near the ENTER key

- **Repetitive Strain Injury Issues**
  - Number pad layout
  - Wrist and hand placement
  - Minimizing movement actually causes RSI
  - Semi-circular designs for keyboard
Keyboard 2003

- Adesso Tru Form USB Touchpad & Keyboard
- Note contoured “ergonomic” shape

Keyboard Layouts (cont.)

- Function keys
  - Learning issues
    - Typically simply labeled F1, F2, etc., though some may also have meaningful
      labels, such as CUT, CROP, etc.
    - Users must either remember each key’s function, identify them from the screen’s
      display, or use a template over the keys in order to identify them properly.
    - Meaning of each key can change with each application.
  - Speed of performance issues
    - Placement of keys on keyboard can affect efficient use because whole hand
      movement between keyboard home position and mouse or function keys can be
      disruptive to use.
    - Alternate use causes keys (e.g., ALT or CTRL) and one letter to indicate special
      function.
  - Feedback (Error Rate)
    - Lights next to keys used to indicate availability of the function, or on/off status.

Keyboard Layouts (cont.)

- Keyboard and keypads for small devices
  - Wireless or foldable keyboards
  - Virtual keyboards
  - Cloth keyboards
  - Soft keys
  - Pens and touchscreens
Keying Speeds

- Seconds/stroke
  - Best: 0.060
  - Average touch typist typing text: 0.158 - 0.231
  - Typing random letter: 0.462 - 0.500
  - Unskilled typing of text: 1.154
  - For UI modeling, for a single key press: 0.200

Pointing Devices

- Pointing Devices
  - Joystick (invented 1940's)
  - Trackball (invented 1940's)
  - Digitizing Tablet (invented 1960's)
  - Mouse (invented 1987)
  - Eye Tracker (invented 1980's)
  - Brain Activity Sensors (invented 1990's)
  - Haptic (touch) sensing 3D device (invented mid-1990's)
Mouse 2003

- Microsoft
- Wireless, optical
- Note ergonomic shape, integrated scrollbar

Tablet

- Wacom Intuos2
- Drawing surface as well as control

Finger Touchpad

- Portable computer: Apple Powerbook G3
- Button below touchpad
Joystick 2003

- Logitech WingMan Joystick
- Note multiple controls and ergonomic shape

Finger Joystick

- Portable computer: IBM Trackpoint II on IBM laptop computers
- Isometric joystick

Joystick - Mouth

- Special accessibility: Infogrip Quadjoy
- Isometric joystick controlled by mouth, selection by sip and puff switch
**Head Mouse**

- Special accessibility: Infogrip Headmaster plus
- Move head to move cursor, puff on tube to select

**Footmouse**

- Special accessibility: Hunter Digital "No Hands" Mouse
- Left pedal for mouse clicks, right for cursor movement

**Eye Tracker**

- Special accessibility: Eye aRe glasses
- Detects simple eye movement
Brain Tracker

- Special accessibility: EEG system
- 22.0 seconds on average to select a letter

SpaceBall

- Spaceball
- Move or rotate 3D by gently pushing, pulling or twisting the ball. Cursor then moves in the direction of the force or twist applied.
3D Haptics Device

- 3D control + touch display: SensAble PHANToM
- Commercially available

Telesurgery with Haptics

How do we know which device is best?

- Tasks
  - Pointing
  - Dragging
  - Typing/Pointing (Mode Switching)
  - Drawing
- Performance Measures (ISO 9241, Part 9)
  - Learning time
  - Practiced performance time
  - Accuracy (error rate)
  - Satisfaction of use
  - Fatigue and strain
Fitts Law

Time_{position} = a + b \log_2(Distance/Width + 0.5)

Limbs that follow Fitts Law

Eyes
(Abrams et al., 1999;
Ware and Mikulitz, 1987)

Head / Neck
(Andres & Hartung, 1989;
Jagaciński & Most, 1989)

Arm
(Fitts, 1954;
Fitts & Peterson, 1964;
Langolf, 1974)

Wrist
(Meyer et al., 1986;
Crossman & Goodwin, 1986/1983)

Fingers
(Langolf, 1974)

Feet
(Deary, 1976;
Hoffman, 1991)

Fitts Pointing Task on the Computer
Pointing Time: Skilled Users (Douglas & Mithal, 1997)

Mouse...durability, space requirements, weight—likelihood to cause repetitive-strain injury—compatibility with other systems

Fitts

Pointing time = \( a + b \log_2 (D/W + .5) \)

Menu functions: pull-down, pop-up, hierarchical

one, two, three button mouse

dragging

Learning is the most rapid

Error rate significantly lower

Positioning time is faster overall, at every size/distance

Menu functions: pull-down, pop-up, hierarchical

What is the best pointing device?

Mouse is the superior device for pointing

Positioning time is faster overall, at every size/distance

Error rate significantly lower

Learning is the most rapid

Rate of movement nearly maximal with respect to handle-eye coordination (Fitts Law)

Semantics of mouse actions integrated into OS

one, two, three button mouse

single, double, triple clicking; dragging

Menu functions: pull-down, pop-up, hierarchical

When is the mouse not the superior device?

Other variables

Other tasks: drawing

Cost, durability, space requirements, weight

Likelihood to cause repetitive-strain injury

Compatibility with other systems

Comparing Device Pointing Times

• Fitts Law applies to computer pointing devices and prediction!

  Pointing time = \( a + b \log_2 (D/W + .5) \)

  - Mouse
    - \( a = 1.03 \) to 1.06
    - Average pointing time approximately 1.1 sec (NOTE: This is about 5 times slower than writing)
    - Faster and most accurate pointing device
  - Trackball
    - About 30% slower than mouse
  - Joystick
    - About twice as slow as the mouse
  - Touchpad
    - About 20% slower than the joystick