Lecture 12

Interaction Devices

9.2 Keyboards

9.3 Pointing Devices

Keyboard Layouts

Where should the keys go?

- **Speed of Performance Issues**
  - **QWERTY layout**
    - Basically a random layout
    - Standard in use and taught extensively
  - **Dvorak layout**
    - Based on frequency of letters in words and minimizing finger travel
    - Faster than QWERTY
    - Reduces finger travel distances by at least one order of magnitude
    - Actual performance varies only a bit from study to study
    - Dvorak layout takes advantage of 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
  - **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-types will find it easier to locate the keys
  - **IBM PC keyboard**
    - Backslash key where most typists expect shift key
    - Placement of several special characters near the enter key

- **Repetitive Strain Injury Issues**
  - Number pad layout
  - Wrist and arm 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, COPY, 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
    - Can reduce number of keystrokes and errors
    - Placement on keyboard can affect efficient use because whole hand moves
    - Frequent movement between keyboard home position and mouse or function keys can be disruptive to use
    - Alternative: use closer 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 for small devices: Fastap

- http://www.digitwireless.com/
- Letter keys raised above number keys
- Note: position of keys varies; 3rd device’s small trackball

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

- Joystick (invented 1940’s)
- Trackball (invented 1940’s)
- Digitizing Tablet (invented 1960’s)
- Mouse (invented 1967)
- Touch Screen (invented 1971)
- 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
**Touch Screen**

- No learning required; good for children
- Walk-up and use situations
- Finger activation requires large space for button
- Can be stylus activated such as PDA

---

**Multi-Touch Interaction**

Research - Jeff Han

- Bi-manual, multi-point, and multi-user interactions on a graphical interaction surface
  - force-sensitive
  - table style implementation measures 36"x27"
  - rear-projected sensing resolution of better than 0.1" at 50Hz
- [http://mrl.nyu.edu/~jhan/ftirtouch](http://mrl.nyu.edu/~jhan/ftirtouch)

---

**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

\[ Time_{\text{position}} = a + b \log_2(Distance + Width + 0.5) \]

Limbs that follow Fitts Law

- Eyes
  - Abrams et al., 1999
  - Warr and Miklofitz, 1987
- Head / Neck
  - Andres & Hartung, 1989; Jagacinski & Monk, 1989
- Arm
  - Fitts, 1954
  - Fitts & Peterson, 1964
  - Langolf, 1974
- Wrist
  - Meyer et al., 1988
  - Crossman & Goodeve, 1983/1963
- Fingers
  - Langolf, 1974
- Feet
  - Drury, 1975
  - Hoffman, 1991

Fitts Pointing Task on the Computer

Score = 1106
Number of error free attempts = 12
You took 1109 milliseconds
Pointing Time: Skilled Users

(Douglas & Mithal, 1997)

<table>
<thead>
<tr>
<th>Device</th>
<th>Task</th>
<th>Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>Dragging Mode Switching</td>
<td>800</td>
</tr>
<tr>
<td>Key</td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>Joystick</td>
<td></td>
<td>1200</td>
</tr>
<tr>
<td>Touchpad</td>
<td></td>
<td>1400</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>1600</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>1800</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>2200</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>2400</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>2600</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>2800</td>
</tr>
<tr>
<td>Trackball</td>
<td></td>
<td>3000</td>
</tr>
</tbody>
</table>

Comparing Device Pointing Times

- Fitts Law applies to computer pointing devices and prediction:
  Pointing time = a + b log2 (D/W + .5)
  - Mouse
    - a = 1.03; b = 0.66
    - Average pointing time approximately 1.1 sec (NOTE: This is about 5 times slower than typing)
    - Fastest 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

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 hand/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