INTERACTION DEVICES

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Interaction Devices

- Interaction devices is a term used to cover the various devices used to interact with a computer.

- The feature of computing is likely to include gestural input, two-handed input, three-dimensional pointing, more voice input-output, wearable devices, and whole-body involvement for some input and output tasks.

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Keyboards layouts

QWERTY layout

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put frequently used letter pairs far apart, thereby increasing finger travel distances

Dvorak layout

-1920

-reduces finger travel distances by at least one order of magnitude

-it takes about 1 week of regular typing to make the switch, but most users have been unwilling to invest the effort

ABCD style

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

- Studies show no improvement vs. QWERTY

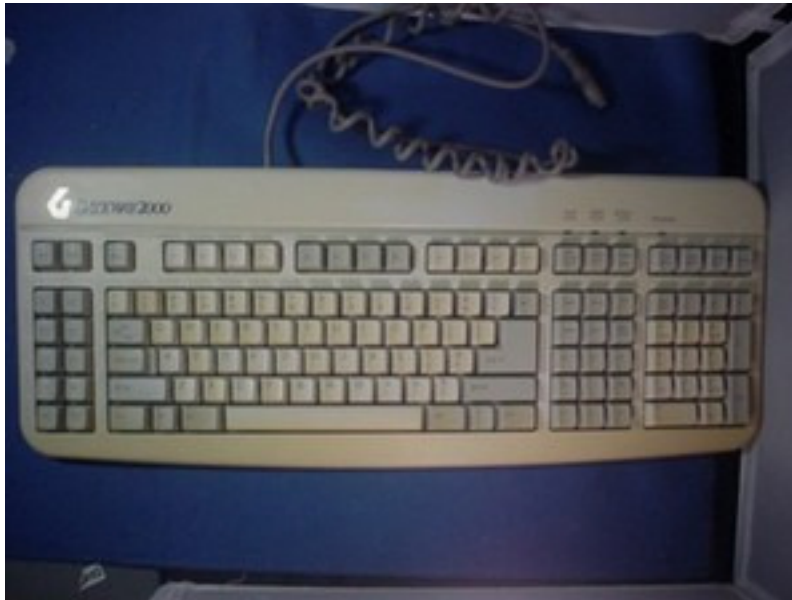# Additional keys

IBM PC Keyboard

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– 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

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Full-size keyboard

- ## Number pads
  -telephone layout (1-2-3)   slightly advantage

  -calculator layout (7-8-9)

Keyboard Layouts (Contd...)

- **Function keys**
  - 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
  - can reduce number of keystrokes and errors
  - meaning of each key can change with each application
  - placement on keyboard can affect efficient use
  - special-purpose displays often embed function keys in monitor bezel
  - lights next to keys used to indicate availability of the function, or on/off status
  - typically simply labeled F1, F2, etc, though some may also have meaningful labels, such as CUT, COPY, etc.
  - frequent movement between keyboard home position and mouse or function keys can be disruptive to use
  - alternative is to use closer keys (e.g. ALT or CTRL) and one letter to indicate special function

Keyboard Layouts (Contd...)

- **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.

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Inverted –T Arrangement

Pointing Devices

**Pointing devices are applicable in six types of interaction tasks:**

- **1. Select:**
  - user chooses from a set of items.
  - used for traditional menu selection, identification of a file in a directory, or marking of a part in an automobile design.

- **2. Position:**
  - user chooses a point in a one-, two-, three-, or higher-dimensional space
  - used to create a drawing, to place a new window, or to drag a block of text in a figure.

- **3. Orient:**
  - user chooses a direction in a two-, three-, or higher-dimensional space.
  - direction may simply rotate a symbol on the screen, indicate a direction of motion for a space ship, or control the operation of a robot arm.

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- **4. Path:**
  - user rapidly performs a series of position and orient operations.
  - may be realized as a curving line in a drawing program, the instructions for a cloth cutting machine, or the route on a map.

- **5. Quantify:**
  - user specifies a numeric value.
  - usually a one-dimensional selection of integer or real values to set parameters, such as the page number in a document, the velocity of a ship, or the amplitude of a sound.

- **6. Text:**
  - user enters, moves, and edits text in a two-dimensional space. The
  - pointing device indicates the location of an insertion, deletion, or change.
  - more elaborate tasks, such as centering; margin setting; font sizes; highlighting, such as boldface or underscore; and page layout.

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

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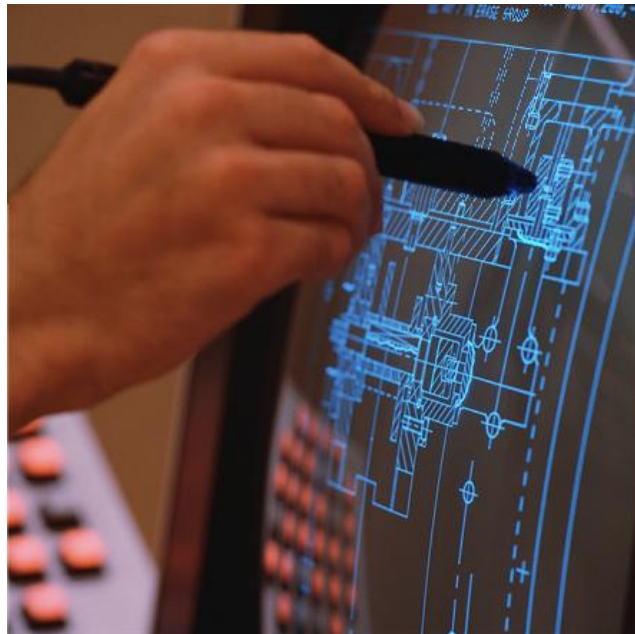
Direct-control
pointing devices (Contd...)

- **Touchscreen**
  - allows direct control touches on the screen using a finger
  - 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

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Indirect-Control Pointing

- **Pros:**
  - Reduces hand-fatigue
  - Reduces obscuration problems

- **Cons:**
  - Increases cognitive load
  - Spatial ability comes more into play

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- Mouse
  - **Pros:**
    - Familiarity
    - Wide availability
    - Low cost
    - Easy to use
    - Accurate

  - **Cons:**
    - Time to grab mouse
    - Desk space
    - Encumbrance (wire), dirt
    - Long motions aren't easy or obvious (pick up and replace)

Contd…

- **Trackball**
  - usually implemented as a rotating ball 1 to 15 centimeters in diameter that moves a cursor on the screen as it moved.

Contd…

- **Joystick**
  - begin in aircraft-control device
  - are appealing for tracking purposes

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Contd…

- **Graphics Tablet**
  - a touch-sensitive surface separate from the screen
  - enables a user to hand-draw images and graphics, similar to the way a person draws images with a pencil and paper

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- **Touchpad**
  - featuring a tactile sensor, a specialized surface that can translate the motion and position of a user's fingers to a relative position on screen
  - common feature of laptop computers, and are also used as a substitute for a mouse where desk space is scarce

Comparing pointing devices

- Direct pointing
  - Study: Faster but less accurate than indirect (Haller '84)

- Lots of studies confirm mouse is best for most tasks for speed and accuracy

- Trackpoint < Trackballs & Touchpads < Mouse

- Short distances – cursor keys are better

- Disabled prefer joysticks and trackballs
  - If force application is a problem, then touch sensitive is preferred

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Fitts's Law

- Paul Fitts (1954) developed a model of human hand movement
- Used to predict time to point at an object
- What are the factors to determine the time to point to an object?
    - D – distance to target
    - W – size of target
- Just from your own experience, is this function linear?
    - No, since if Target A is *D* distance and Target B is *2D* distance, it doesn't take twice as long
    - What about target size? Not linear there either

- **T = a + b $\log_2$(D/W + 1)**
    - a = time to start/stop in seconds (empirically measured per device)
    - b = inherent speed of the device (empirically measured per device)
    - Ex. a = 300 ms, b = 200 ms/bit, D = 14 cm, W = 2 cm
        - Ans: 300 + 200 $\log_2$(14/2 + 1) = 900 ms

Target Width

6 Inches

Target Amplitude

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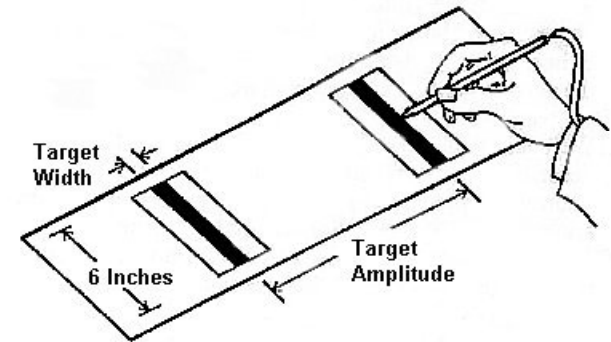
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– **Index of difficulty = log2 (2D / W)**

– **Time to point = C1 + C2 (index of difficulty)**

– **C1 and C2 and constants that depend on the device**

– **Index of difficulty is log2 (2*8/1) = log2(16) = 4 bits**

– **A three-component equation was thus more suited for the high-precision pointing task:**

– **Time for precision pointing = C1 + C2 (index of difficulty) + C3 log2 (C4 / W)**

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Novel Devices

- Themes:
  - Make device more diverse
    - Users
    - Task
  - Improve match between task and device
  - Improve affordance
  - Refine input
  - Feedback strategies
- Foot controls
  - Already used in music where hands might be busy
  - Cars
  - Foot mouse was twice as slow as hand mouse
  - Could specify 'modes'

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Speech Recognition, Digitization, and Generation

- 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

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Discrete-Word Recognition

- Recognize individual words spoken by a specific person

- 90-98% for 100-10000 word vocabularies

- Training
  - Speaker speaks the vocabulary
  - Speaker-independent
- Still requires
  - Low noise operating environment
  - Microphones
  - Vocabulary choice

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- Helps:
  - Disabled
  - Elderly
  - Cognitive challenged
  - User is visually distracted
  - Mobility or space restrictions

- Apps:
  - Telephone-based info

Continuous Speech Recognition

- Not generally available:
  - difficulty in recognizing boundaries between spoken words

  - normal speech patterns blur boundaries

  - many potentially useful applications if perfected

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Speech store and forward

– Voice mail users can
  - receive messages
  - replay messages
  - reply to caller
  - forward messages to other users, delete messages
  - archive messages

– Stored speech commonly used to provide information about tourist sites, government services, after-hours messages for organizations

– Low cost

– Voice prompts

Speech generation

- is an example of a successful technology
- have been used in
  - Cameras ("too dark- use flash")
  - Automobiles ("your door is ajar")
  - Children's game
  - Utility-control rooms ("danger")
- Applications for the blind are an important sucsess story

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— Michaelis and Wiggins (1982) suggest that speech generation is "frequently preferable" under these circumstances:

- The message is simple.
- The message is short.
- The message will not be referred to later.
- The message deals with events in time.
- The message requires an immediate response.
- The visual channels of communication are overloaded.
- The environment is too brightly lit, too poorly lit, subject to severe vibration, or otherwise unsuitable for transmission of visual information.
- The user must be free to move around.
- The user is subjected to high G forces or anoxia

Audio tones, audiolization, and music

- – Sound feedback can be important:
  - to confirm actions

  - offer warning

  - for visually-impaired users

  - music used to provide mood context, e.g. in games

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Display Devices

- Monochrome displays (single color)
  - Low cost
  - Greater intensity range (medical)

- Color
  - Raster Scan CRT
  - LCD – thin, bright
  - Plasma – very bright, thin
  - LED – large public displays

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Heads-up and helmet mounted displays

– is any transparent display that presents data without requiring users to look away from their usual viewpoints

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- A helmet/head mounted display (HMD) moves the image with the user

Printers

- Important criteria for printers:
  - Speed
  - Print quality
  - Cost
  - Compactness
  - Quiet operation
  - Use of ordinary paper (fanfolded or single sheet)
  - Character set
  - Variety of typefaces, fonts, and sizes
  - Highlighting techniques (boldface, underscore, and so on)
  - Support for special forms (printed forms, different lengths, and so on)
  - Reliability

Contd…

- ## Dot-matrix printers

- print more than 200 characters per second, have multiple fonts, can print boldface, use variable width and size, and have graphics capabilities

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Contd…

- Inkjet printers
  - offer quiet operation and high-quality output

Contd…

- Thermal printers or fax machines
  - offer quiet, compact, and inexpensive output on specially coated papers

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Contd…

- Laser printers
  - operate at 30,000 lines per minute
  - support graphic and produce high quality images
  - resolution ranges from 200 to 1200 points per inch

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- ## Color printers
  - allow users to produce hardcopy output of color graphics, usually by an inkjet approach with three colored and black inks

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- Photographic printers
  - allow the creation of 35-millimeter or larger slides (transparencies) and photographic prints

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THANK YOU!!!

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