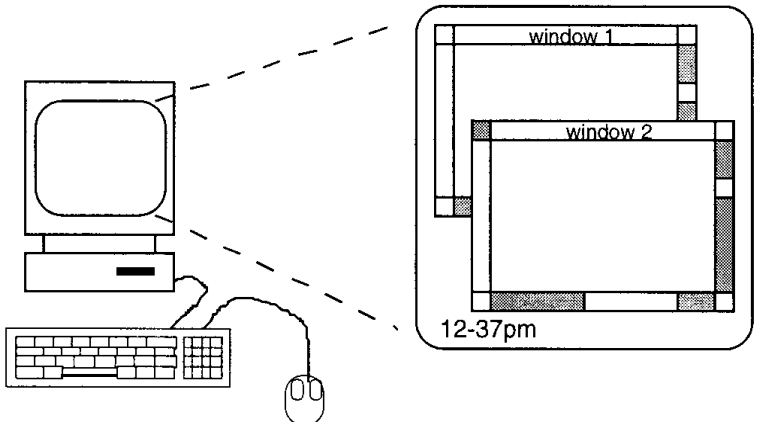
Computer & Interaction

- Computer Input and Output Devices
- Design Implications and Device Usages
- Interaction Models and Styles

Interaction Devices



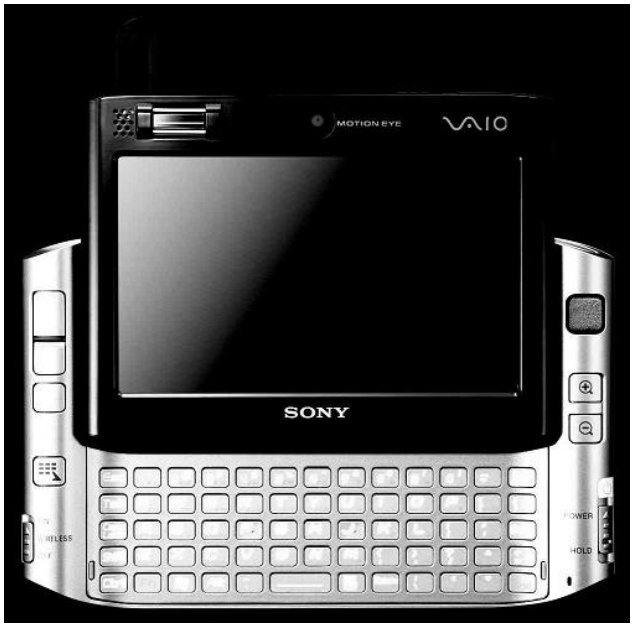
A typical computer system:

- screen, or monitor, on which there are
  - Windows – separate areas that behave independently
- Keyboard
- Mouse

These devices dictate styles of interactions that the system supports

Interaction Devices

Mobile computer system: Tablet PC, Pocket PC, Micro PC

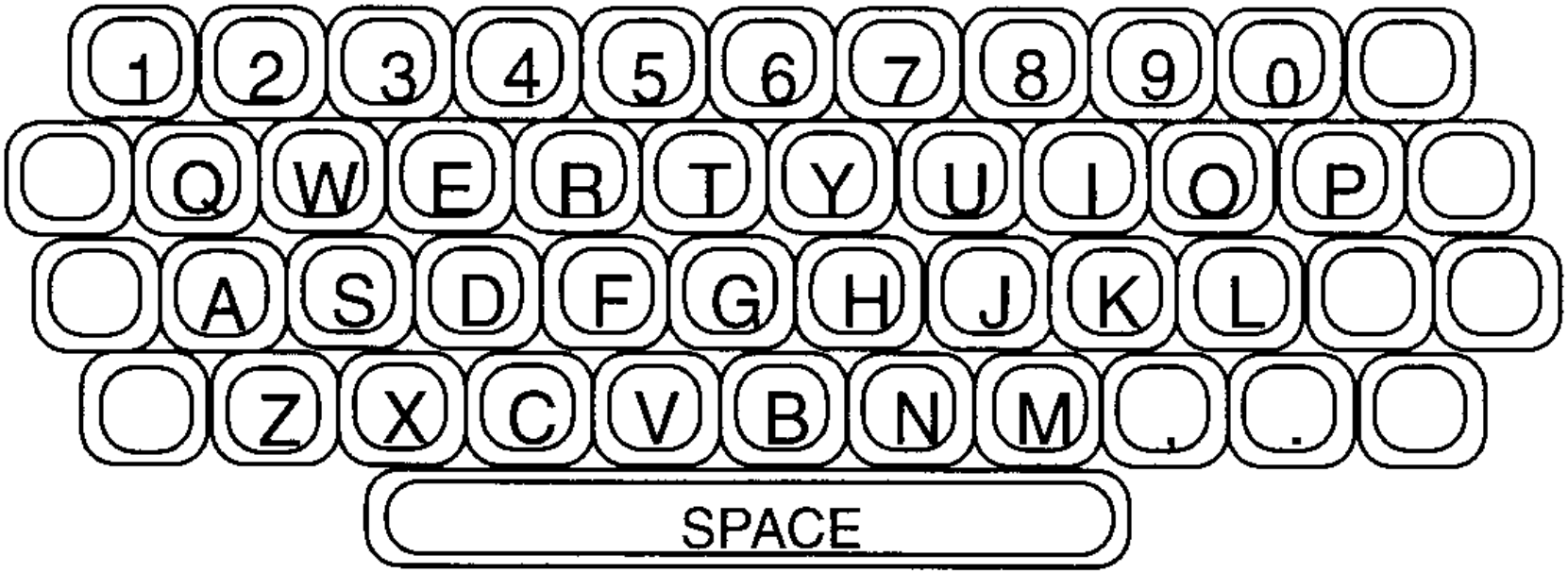


Interaction Devices

Input	Output
Keyboard	Screen
Pointing devices	Printer
Mouse	Plotter
Trackball	Loudspeaker (sound, speech)
Joystick	Braille reader
Pen	
Touch screen	
Speech	
Video/Image	
Camera	
Scanner	
Eyegaze	

Input Devices

- Keyboard
  - Common text input device
  - QWERTY is the standard layout (developed in 1870s)



  - Keypress closes connection, causing a character code to be sent

Input Devices

- Allow rapid entry of text by experienced users, 150 words per minutes is possible
- QWERTY arrangement is not optimal for typing - layout due to typewriters. For typewriters, if we type too fast, the keys (the arms of the typewriters) will jam together.

Input Devices

- Other keyboard designs can allow faster typing but large social base of QWERTY typists produce reluctance to change
- Biased towards left hand
- Other suggested keyboard layouts:
- Alphabetic
  - Keys arranged in alphabetic order, ABCDE...
  - Not faster for trained typists
  - Not faster for beginners

Input Devices

- Dvorakor (developed in 1920s)
  - Common letters under dominant fingers
  - Biased towards right hand (or left hand)
  - Common combinations of letters alternate between hands (e.g., ARE, WERE, GREAT)
  - 10-15% improvement in speed and reduction in fatigue
  - Large social base of QWERTY typists produce market pressures not to change
  - http://www.mwbrooks.com/dvorak/support.html
- User Defined
  - e.g., Janko's keyboard (http://solair.eunet.yu/~janko/engdload.htm)

Input Devices

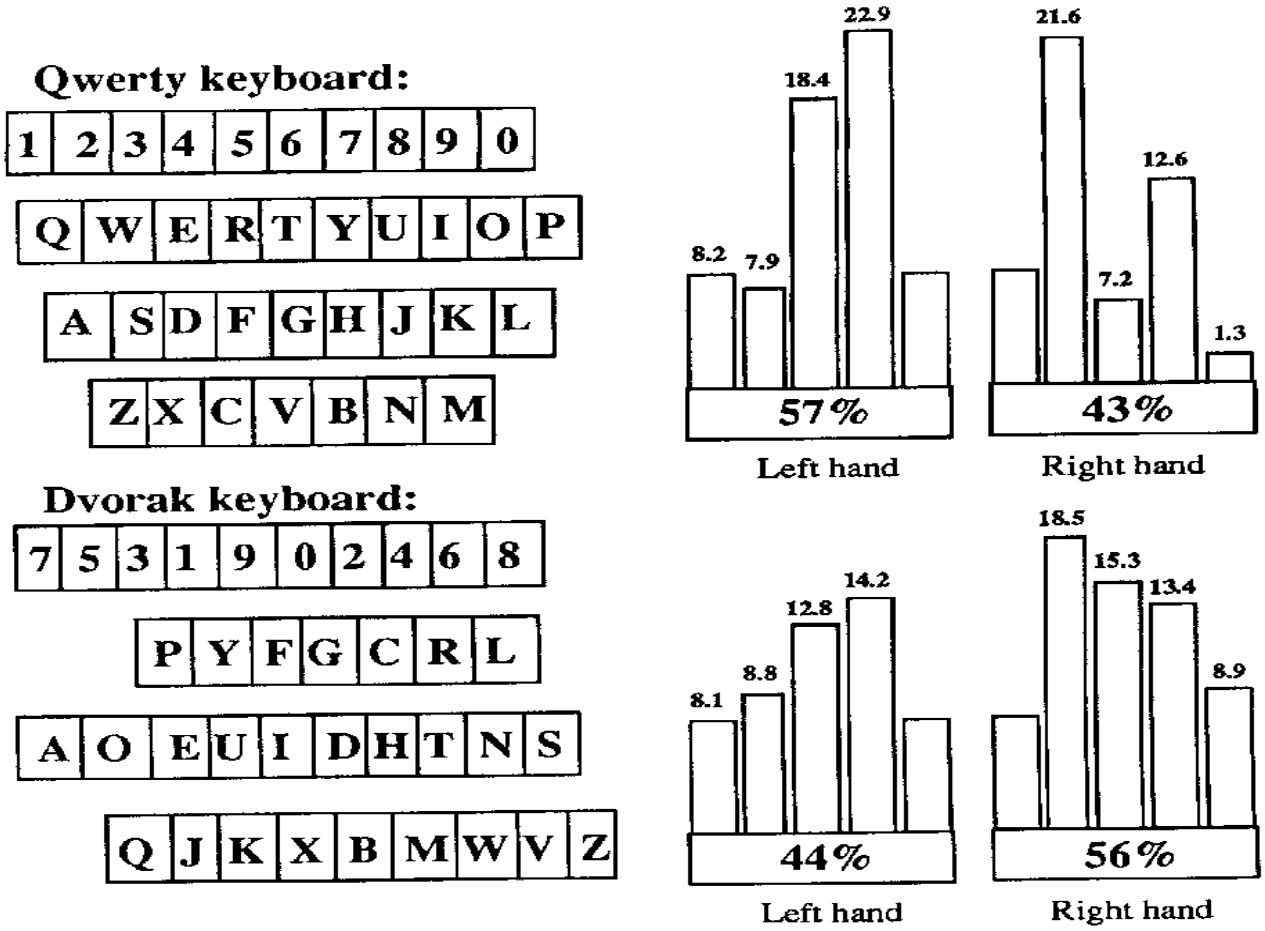


Figure 12–2 Alpha key layouts: QWERTY and Dvorak. From Cakir, Hart, and Stewart, *The VDT Manual* (New York: John Wiley and Sons, 1980). With permission.

Input Devices

- Ergonomically designed (http://www.kinesis-ergo.com)

Input Devices

- For mobile devices
  - Virtual keyboard: can achieve 20-30 words/min.

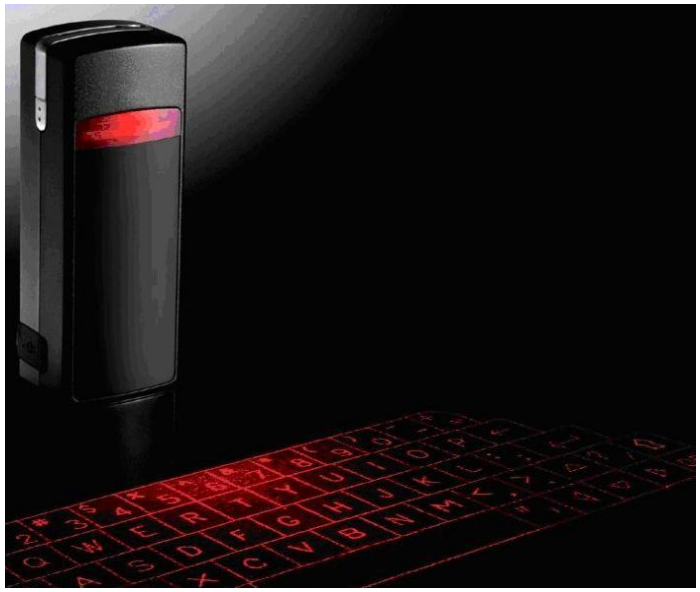
Input Devices

- Foldable keyboard

http://www.palm.com/us/support/accessories/ppk.html

Input Devices

- Virtual projection keyboard



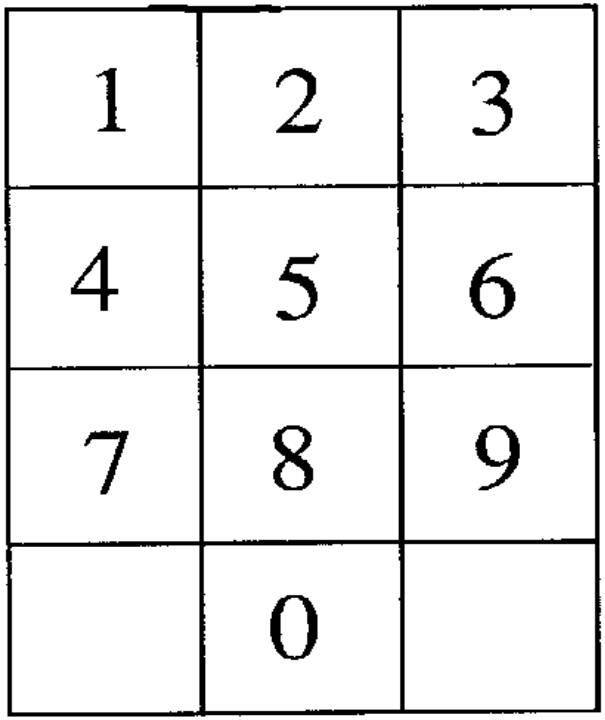
http://www.itechdynamic.com/en/products_spec.asp?cid=7&pid=07010

http://www.alpern.org/weblog/stories/2003/01/09/projectionKeyboards.html

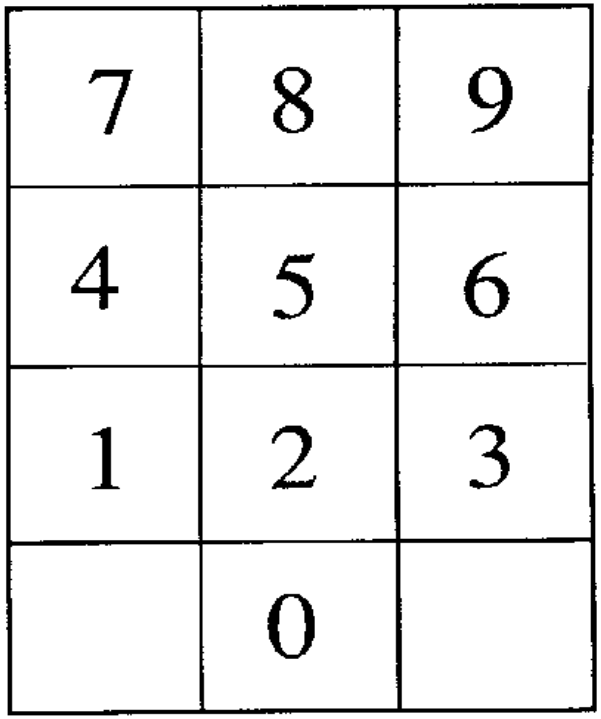
Which one is more preferable? Virtual, Foldable or Projection? Why?

Input Devices

- Numeric keypad
  - Input number
  - Two layouts: telephone & calculator
  - Locate the numeric keypad to the right of the alpha key area



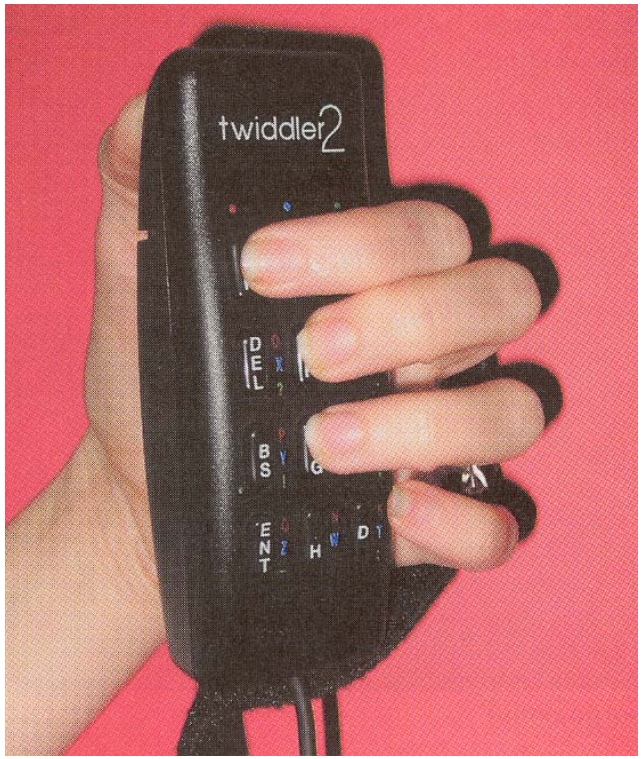
Telephone



Calculator

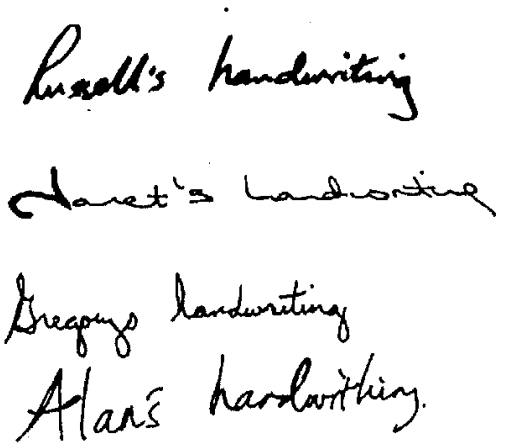
Input Devices

- Chord keyboard
  - Several keys are pressed simultaneously for inputting multiple characters with one hand only
  - 300 words per minutes is possible after training
  - e.g., used in courts



Input Devices

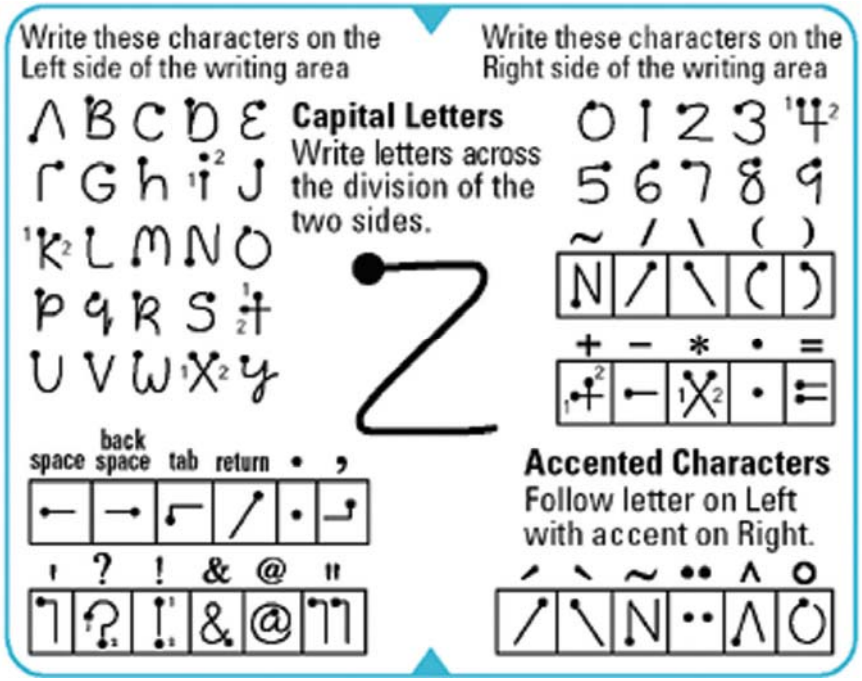
- Stylus
  - Recognize handwritten text input into computer
  - Advantages:
    - No training is needed
    - Compact size (handheld organisers use handwriting recognition technology & do away with a bulky keyboard)



  - Disadvantages :
    - Relatively low recognition accuracy
      - Variation between the handwriting of individuals
      - Handwriting of same person is varying

Input Devices

- Recognition rate can be improved via special data-entry methods, e.g., unistrokes or Graffiti



http://sandbox.xerox.com/parctab/csl9501/node4.html

- Speed is slow: maximum is 25 words/minute but the speed of a typist is 60 words/minute

Input Devices

- Speech input
  - Promising, but only successful in limited situations – specific user, limited vocabulary systems
  - Available at Windows XP and Tablet PC systems (http://www.microsoft.com/downloads)
  - For discrete word recognition, accuracy is around 90-98% for 20 to 200 word vocabularies for the case of speaker-dependent training, in which the user repeats the full vocabulary once or twice
  - Speaker-independent systems are beginning to be reliable enough for some commercial applications, e.g., telephone enquiry system by PCCW
  - Continuous speech recognition is more difficult

Input Devices

- Types of errors
  - Substitution - a word from the vocabulary is mistaken for another
  - Rejection - a word from the vocabulary is detected but rejected
  - Insertion - a word that was not spoken is detected
  - Deletion - a word that was spoken but is missed
  - Background noise
  - Imprecision of pronunciation

Input Devices

- Advantages:
  - Much training is not needed
  - Good for the case when hands/eyes are occupied or disabled

- Disadvantages:
  - Feedback may be limited (Verification procedures slow down speed)
  - Speech is a single channel mode: cannot speak while listening, cannot listen to >1 messages simultaneously
  - Recognition accuracy is not high
  - Speed is slow: maximum is 20-40 words/minute

Input Devices

Some guidelines for speech recognition interface design

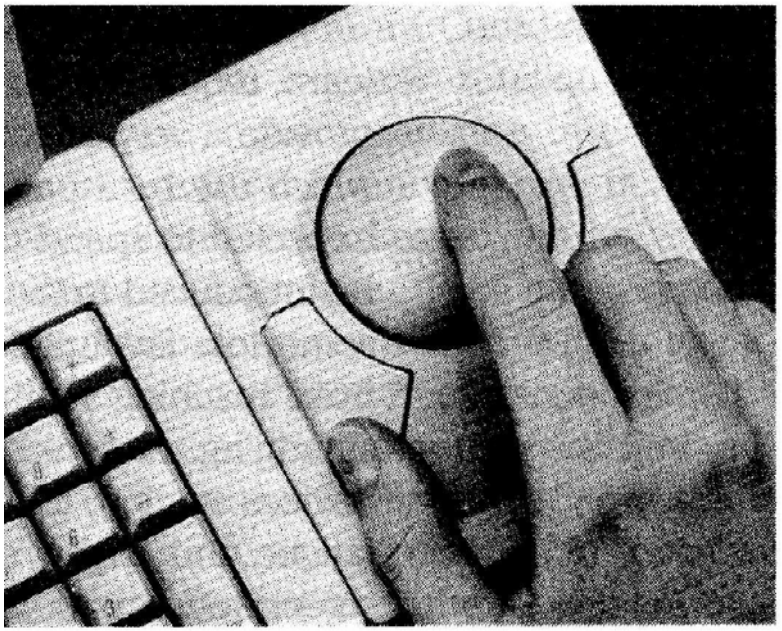
- Consider voice recognition as an input device when user's hands are occupied or user's eyes are busy
- Avoid voice recognition as an input device in open environments (noise & security)
- Provide a familiar vocabulary
  e.g., user is more consistent when pronouncing familiar words
- Words used should be distinctive
  e.g., "pick" & "quit" are very similar; use "select" & "quit" is better

Input Devices

- Mouse
  - A very common handheld pointing device
  - Characteristics - planar movement, buttons
  - Mechanical, optical & acoustic
  - Advantages:
    - Direct relationship between hand & cursor movement on all 3 issues of direction, speed, & distance
    - Allow diagonal & continuous movement
    - Easy to use
  - Disadvantage:
    - Require that the hand be removed from the keyboard

Input Devices

- Trackball
  - Like an upside-down mouse
  - Advantages:
    - Direct relationship between hand & cursor movement on all 2 issues of direction & speed
    - Allow diagonal & continuous movement
    - Comparing with mouse, less physical space is required
  - Disadvantages:
    - Require that the hand be removed from keyboard
    - No direct relationship on distance



Input Devices

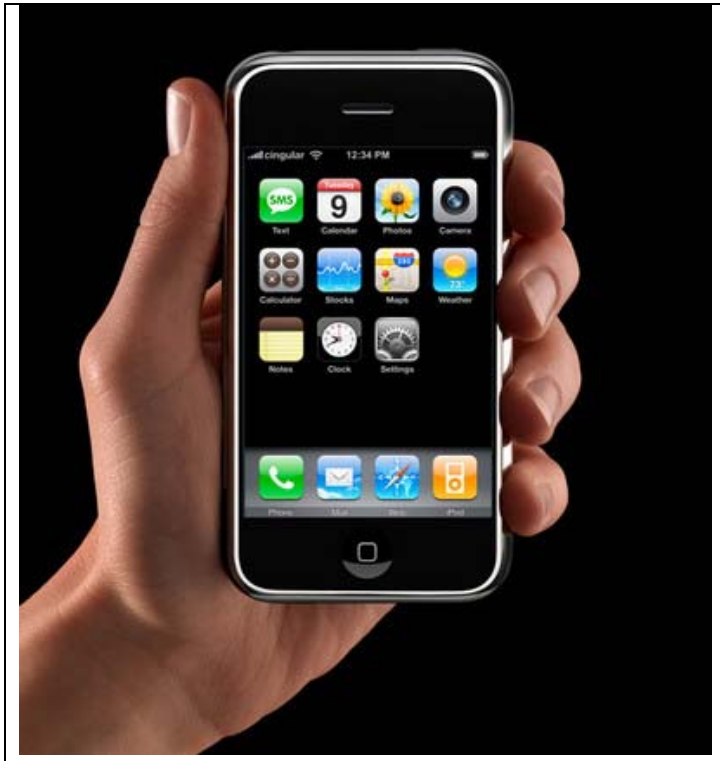
- Touchscreen
  - Detect the presence of finger on the screen

Input Devices

- Advantages:
  - Direct (vs. select an item on screen with a mouse)
  - Fast
  - Good for menu selection
- Disadvantages:
  - Finger print can mark screen
  - Hand obscures screen
  - Fatigue
  - Imprecise - difficult to select small regions or a larger screen is needed, although pointing at a single pixel is possible using the lift-off strategy:
    - Touch the screen surface
    - A cursor then appears for dragging around
    - Lift off finger when the desired position is reached

Input Devices

- Multi-Touch Display

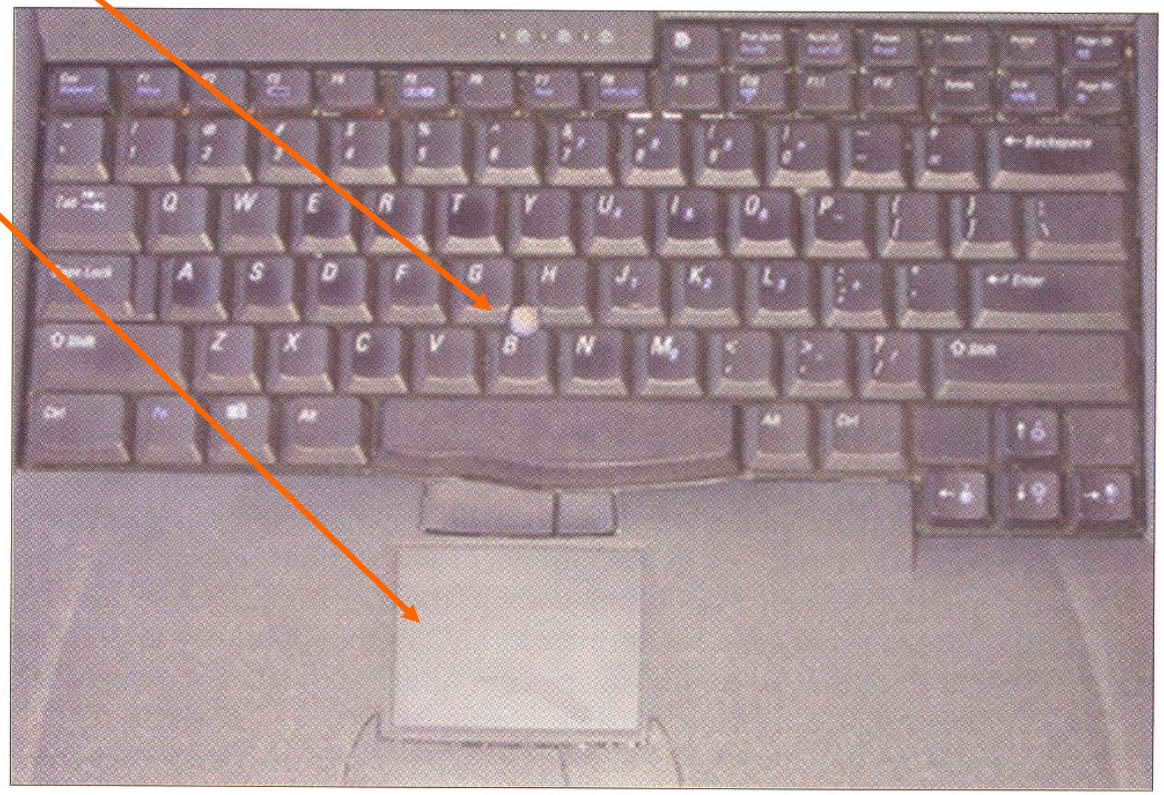


i-phone by Apple

Surface by Microsoft

Input Devices

- Trackpoint
  - Joystick in notebook PC
- Touchpad
  - Similar to touchscreen



Input Devices

Some guidelines for pointing device selection:

- Use touchscreen when training is low, targets are large, discrete & spread out, frequency of use is low, desk space is small, & the task requires little or no text input
  e.g., information desk for tourist, cashier system in shops
- Mouse is faster than trackball
- Minimize hand & eye movement between input devices
  e.g., if a fill-in form includes some text entry & some multiple-choice selections, each input type should be grouped together

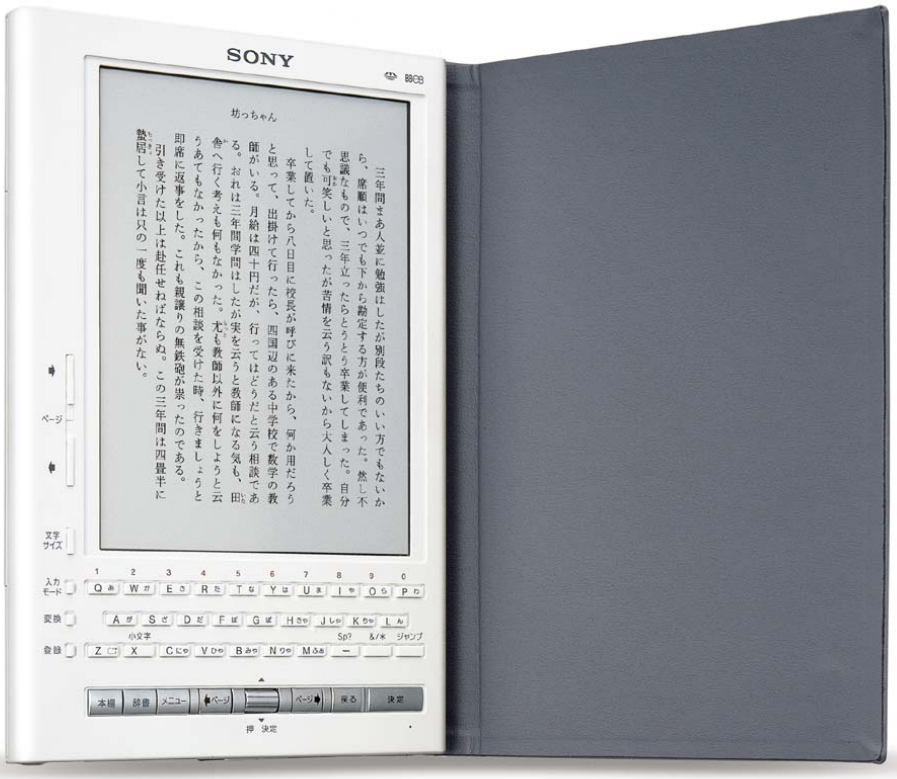
Output Devices

- Computer screen
  - Cathode ray tube (CRT)
  - Liquid crystal display (LCD)
    - Apart from safety and comfortable reasons, LCD can be more flexible and has more functions:

http://www.direct2u.com.au/html/sharp_3d_laptop.html

Output Devices

- Electronic ink
  - Paper like readability (~170 pixels per inch)



http://www.eink.com/products/matrix/High_Res.html

Output Devices

- Speech output
  - Digitized speech - recorded human speech directly in digital format
  - Synthesized speech - generated using computers via speech processing techniques

Which one is more preferable?

- Current technology supports different spoken language output, e.g., English, Japanese, Mandarin

  http://www.microsoft.com/downloads/

  http://www.nuance.com/realspeak/demo/

  http://dsp.ee.cuhk.edu.hk/html/cutalk.html

Output Devices

- Advantage:
  - Useful when user's eyes are busy or user cannot access the screen
- Disadvantages:
  - Limited information because speech is transient
  - Lack of privacy & security under open environment
  - Speech is a single channel mode, i.e., we cannot listen multiple messages simultaneously
  - Spoken rate (~120-180 words/min.) is slower than reading (~200-300 words/min.)

Output Devices

- Some guidelines for use of speech output
  - Consider as output device when user's eyes are busy or user cannot access the screen
  - Avoid as output device in open environment, when privacy & security are important, when frequency of use is high, when multiple messages must be sent simultaneously, when human memory is overloaded
  - Use output rate of approximately 180 words per min.
  - Structure voice instructional prompts to present the goal first & the action last
    e.g., telephone banking system
    "For playing message, press two" is better than
    "Please press two to play message"
    Why?

Output Devices

- Audio
  - Used as feedback, localization and entertainment, e.g.,
    - Confirm actions
    - Offer warning
    - Provide directional guidance for visually impaired persons using electronic audible signals http://www.td.gov.hk/about_us/video/electronic_audible_traffic_signal/index_t.htm
    - Provide mood context in games
    - Simulate various musical instruments
    - Simulate various animal sounds

Output Devices

- Braille display
  - Pins provide output for the blind

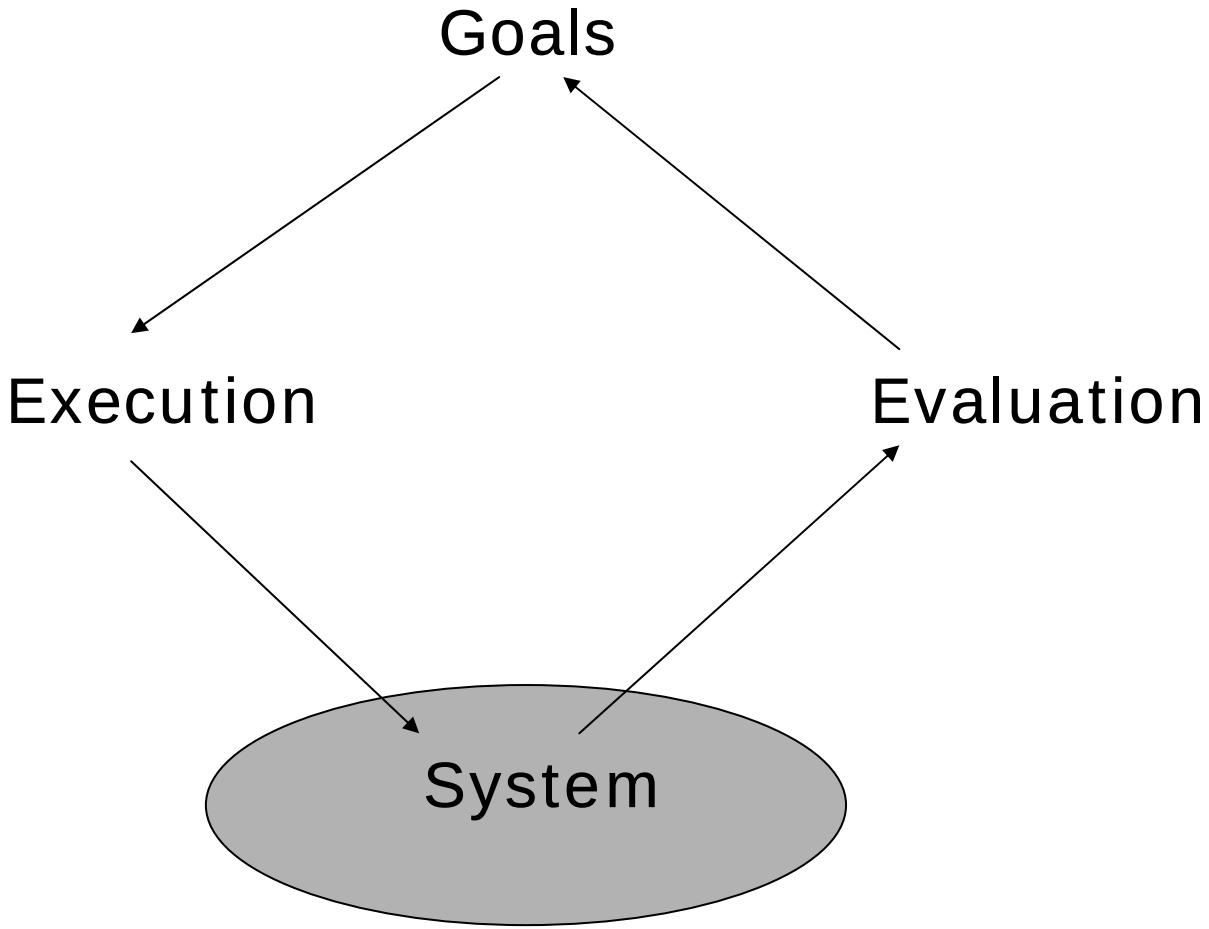
Interaction Model

- Interaction: communication between user & system

- Why study interaction models?
  - Help us to understand what is going on in the interaction between user & system
  - Help us to identify problematic areas within the design
  - Address differences, if any, between what user wants & system does

Interaction Model

- Norman's interaction framework
  - 2 major phases: execution & evaluation



Interaction Model

- Can be subdivided into further stages:

1. Establish the goal (Desired output from a performed task, some idea of what we want to happen)
2. Form intention (Specific action required to meet the goal)
3. Specify action sequence at interface
4. Execute action
5. Perceive system state
6. Interpret system state
7. Evaluate the outcome

Interaction Model

Establish goal	Move a sentence from one paragraph to another paragraph in a WORD document
Form intention	Use Edit menu to move a piece of text from one paragraph to another (Shortcut keys can be used)
Specify action sequence	(1) Highlight the text by moving & clicking a mouse (2) Click the cut button, (3) Move the cursor to new position and (4) Click the paste button
Execute action	Execute the actions: An error scenario - the user highlights the text correct but clicks on the *copy* button instead of the *cut* button then completes the action
Perceive result	User sees the text in correct position but notices that it is still in the original position as well
Interpret result	User realizes, he or she uses the copy rather than cut
Evaluate outcome	User knows that the goal has not been completed & it is necessary to delete the text in the original position, this lead to a new goal & set of actions

Interaction Model

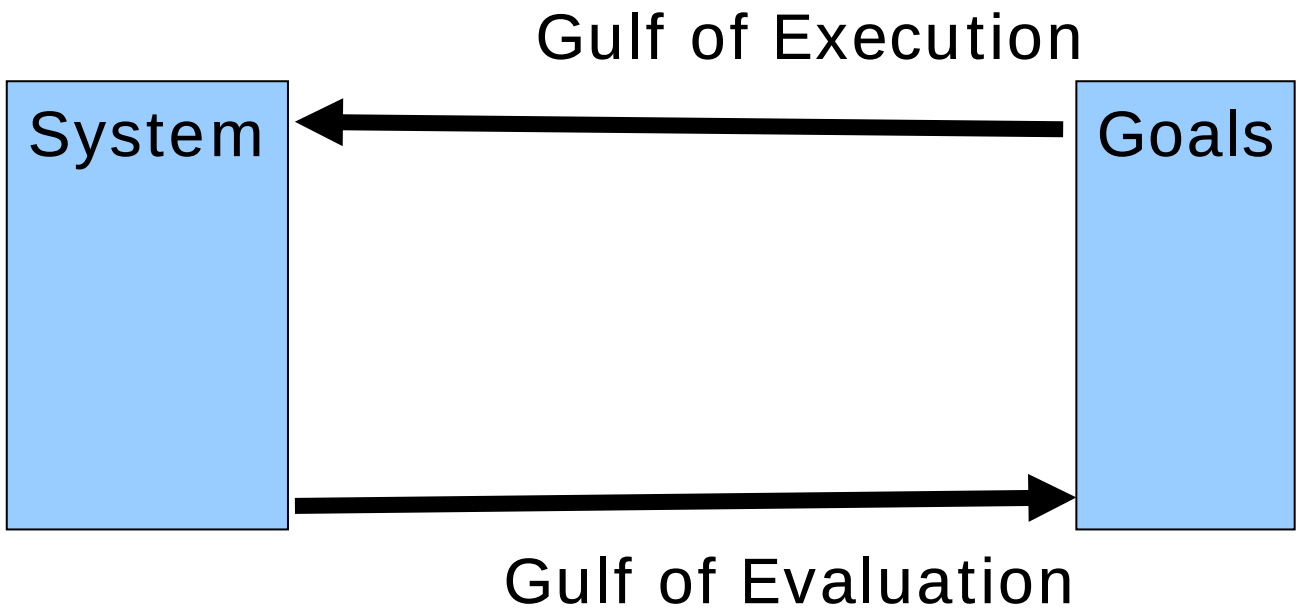
Explain why some interfaces cause problems to users:

- Gulfs of execution
  - Mismatch between user's intention & allowable actions, e.g.,
    - The system does not support the user's goal
    - Sequence of actions is invalid
  - Does the interface allow us to carry out the actions required by the intention? E.g.,
    - Goal is to save a file
    - Intention is to use the file menu
    - Action is to click the save option
    - Is there a save option in the file menu?

Interaction Model

- Gulfs of evaluation
  - Mismatch between system's presentation & user's expectation, e.g.,
    - Failure to notice current system status
    - Poor feedback from system
  - Given a particular interface design, how easily can you:
    - Determine the function of the device?
    - Determine whether the system is in the desired state?
    - Determine what actions are possible?
    - Perform the action?

Interaction Model



We aim to minimize these two gulfs

Interaction Model

This can be achieved:

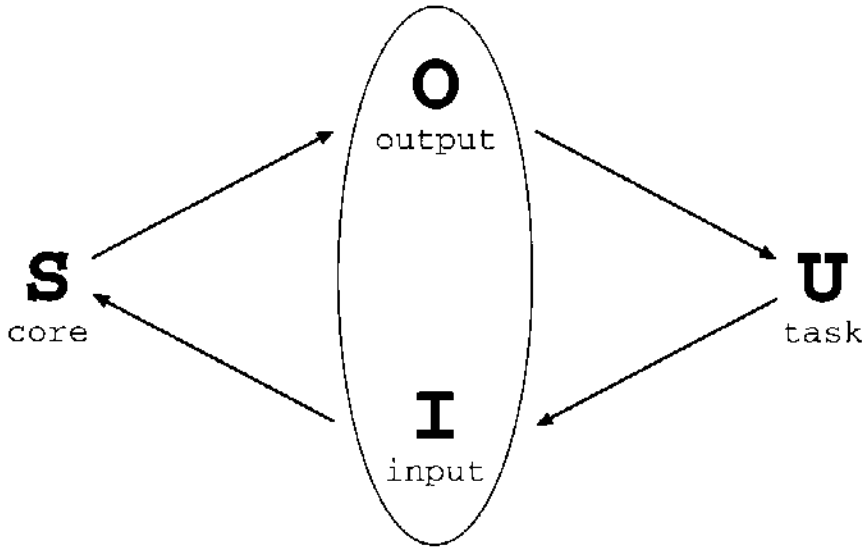
- Good visibility – State and action alternatives should be visible
- Good conceptual model – Agree with user's intention
- Good mapping
- Feedback – User should receive continuous feedback

User failures can occur:

- Users form an inadequate goal
- Might not find the correct interface object because of an incomprehensible label or icon
- May not know how to specify or execute a desired action
- May receive inappropriate or misleading feedback

Interaction Model

- Model by Abowd & Beale
  - Extended Norman's model
  - 4 components
    - User (U)
    - Input (I)
    - System (S)
    - Output (O)
  - Steps involved
    - User intentions translated into actions at the interface
    - Translated into alternations of system state
    - Which in turn are reflected in the output display
    - Which is then interpreted by user



Interaction Model

- Each component has its own unique language: problems occur when language translation between two adjacent components is in error
- Example of translation problem: user is not sure if the VCR is set to record properly

  Maybe:
  - From user to interface, the user has pressed keys on remote control in the wrong order
  - From interface to system, VCR can record on any channel but remote control cannot select channels
  - From system to interface, VCR display panel does not indicate that the program has been set
  - From interface to user, user does not interpret the indication properly

Interaction Styles

- Command line interface
  - Can be:
    - Single characters
    - Short abbreviations
    - Whole words
    - Combination of them
  - Typical examples: Unix system & DOS

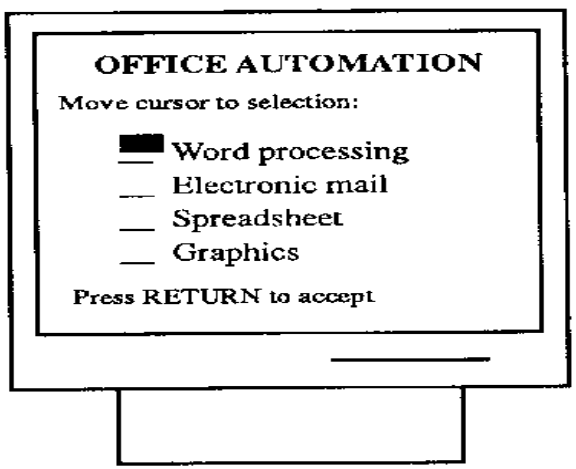
```
sable.soc.staffs.ac.uk> javac HelloWorldApp
javac: invalid argument: HelloWorldApp
use: javac [-g][-O][-classpath path][-d dir] file.java…
sable.soc.staffs.ac.uk> javac HelloWorldApp.java
sable.soc.staffs.ac.uk> java HelloWorldApp
Hello world!!
sable.soc.staffs.ac.uk>
```

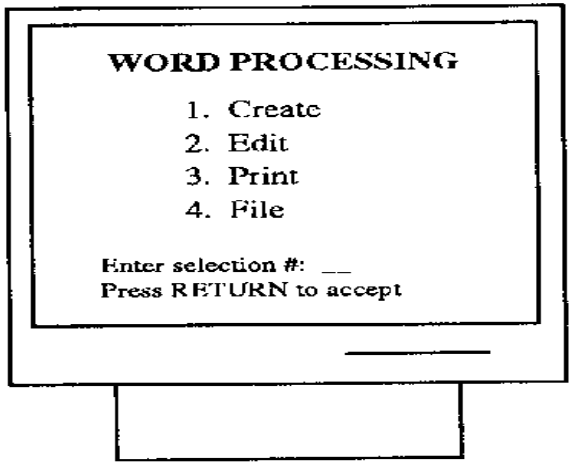
  - Suitable for repetitive tasks
  - Better for expert users than novices

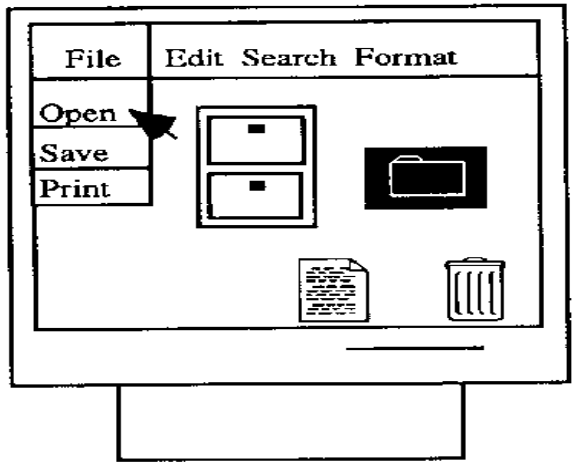
Interaction Styles

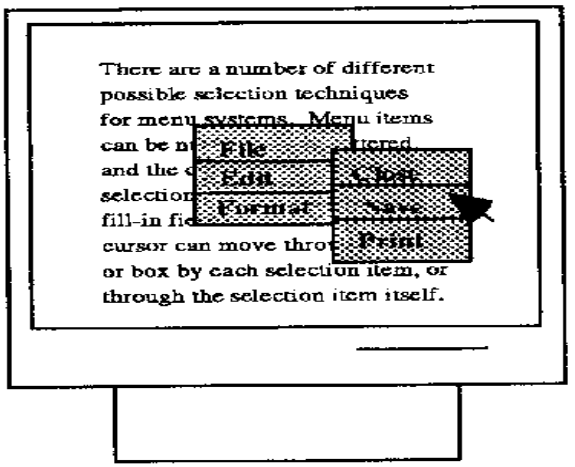
- Menus
  - Set of options displayed on the screen
  - Options visible: rely on recognition rather than recall
  - Selected by using mouse, numeric, cursor, function or alphabetic keys
  - Menu systems can be purely text based, with options presented as numbered choices
  - Menu can have graphical component, with menu appearing in box, & choices are made either by typing initial letter, or moving around with arrow keys or mouse

Interaction Styles









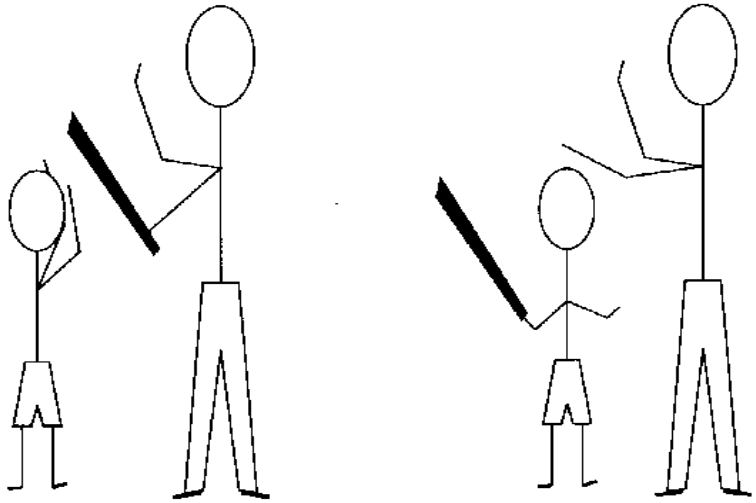
Interaction Styles

Natural language

- An attractive option: familiar
- Speech recognition or typed natural language
- Problems
  - Vague & ambiguous
    e.g. ,The man hits the boy with the stick.

    Is “The man uses a stick to hit the boy” or

    “The man hits the boy who holds a stick”?



Interaction Styles

- Form fill
  - Screen like paper form
  - A number of fields in which user is expected to type in data
  - Each field has a label (caption) that indicates the type of data to be entered in that field
  - Spreadsheet is a variant of form filling

Improved:

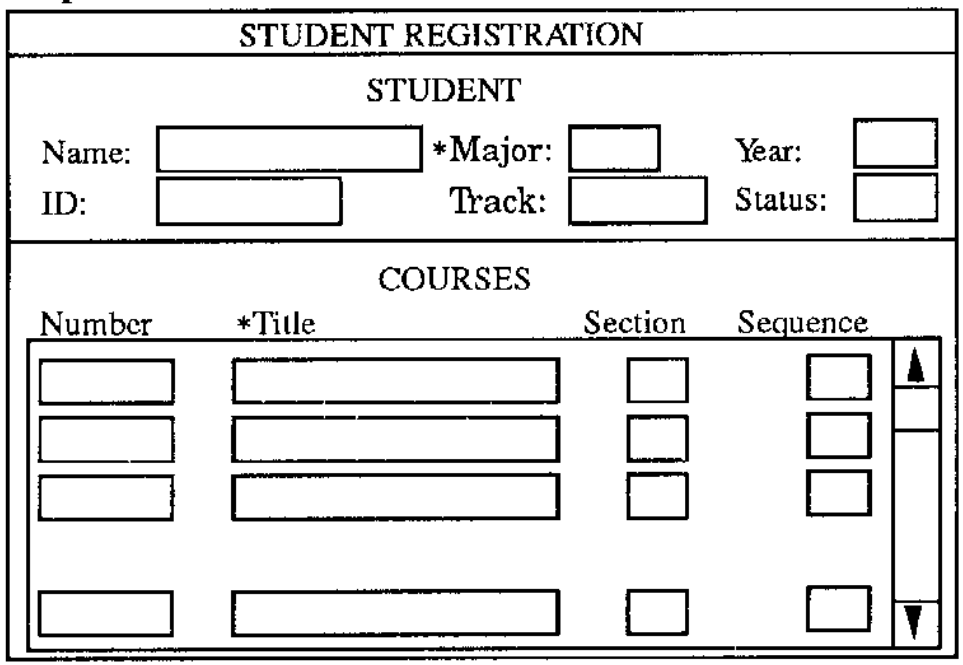
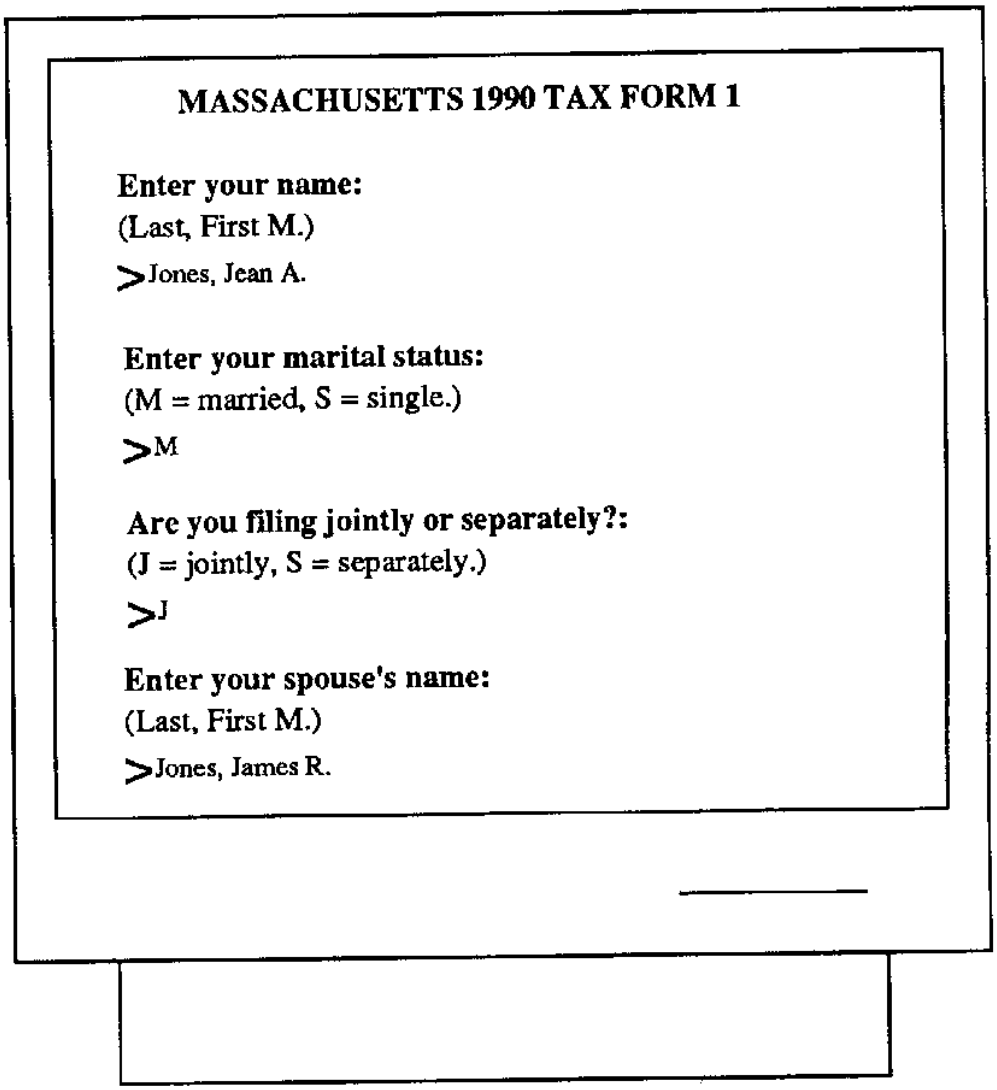


Figure 5–5 Fill-in form caption and field design.

Interaction Styles

- Question & answer
  - Combine some of the features of both menus & fill-in form
  - User is led through interaction via a series of questions, yes/no, multiple choice, etc.

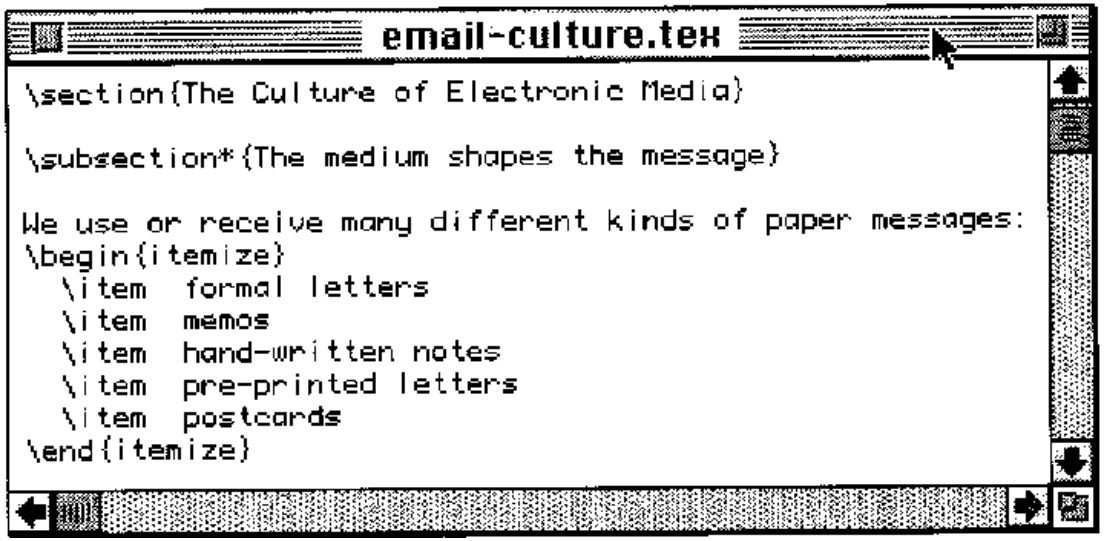


Interaction Styles

- WIMP
  - Consist of
    - Windows
    - Icons
    - Menus
    - Pointers
  - Another form: windows, icons, mice & pull-down menus
  - Default style for majority of interactive computer systems today, especially PCs & desktop machines
  - Support direct manipulation of selecting, moving and resizing objects

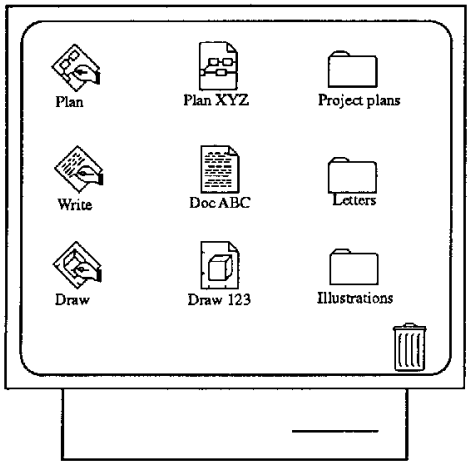
Interaction Styles

- Windows
  - Areas of the screen that behave as if they were independent terminals
  - Can contain text or graphics
  - Can be moved or resized
  - Can overlap & obscure each other, or can be laid out next to one another (tiled)
  - Scrollbars allow the user to move the contents of the window up & down or from side to side
  - Title bars describe the name of the window

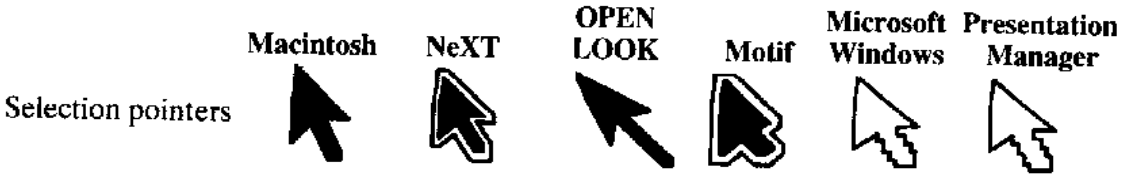


Interaction Styles

- Icons
  - Small picture or image, used to represent some objects (file, folder, etc.) in the interface
  - Windows can be closed down to this small representation (iconised) allowing many windows to be accessible

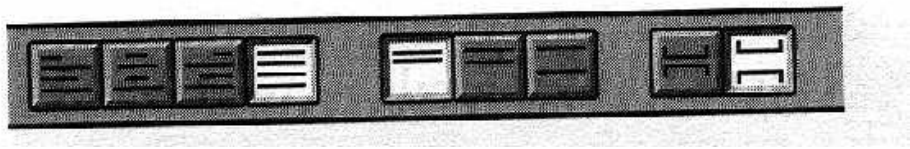


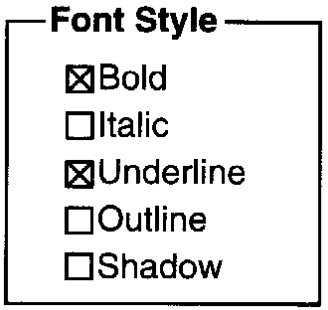
- Pointers
  - The pointer is controlled by mouse, joystick, trackball, cursor keys or keyboard

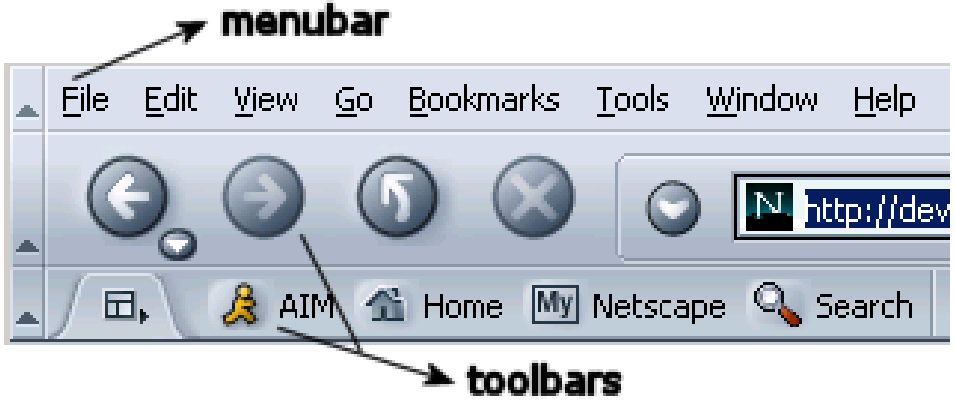


Interaction Styles

- Other WIMP related styles
  - Radio button - set of mutually exclusive choices
  - Check box - set of non-exclusive choices
  - Toolbar – collection of small buttons, each with icons







How to distinguish a menubar and a toolbar?

Interaction Styles

- Dialogue box - information windows that pop up to inform of some important event or request certain information

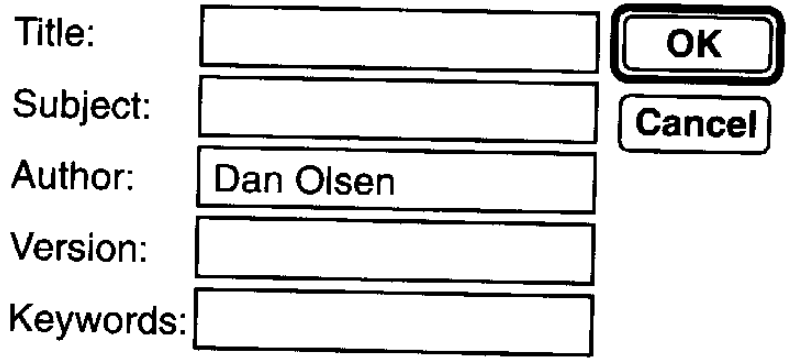
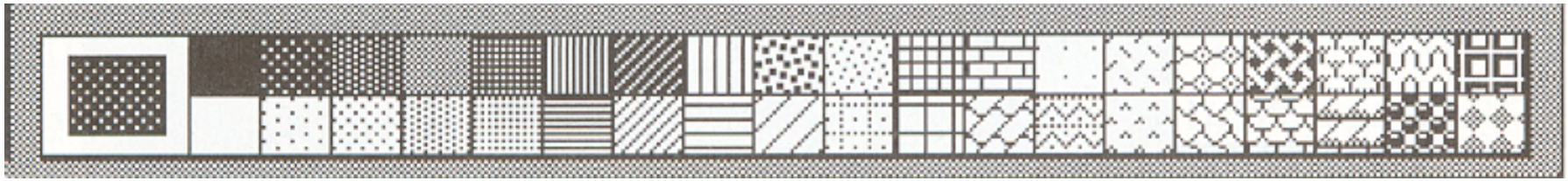


Figure 6-29 Dialog box

- Palettes – mechanism for making the set of possible modes and the active mode visible to user



Interaction Styles

- 3D
  - Motivation: easier interaction because real world is 3D
  - Find applications in games, virtual reality, medical imagery, architectural drawing, scientific simulations, on-line shopping, etc.

http://www.vaiopro.sony-europe.com/360_view/fs/index.html

http://www.stylepath.com/vr