## Interaction styles

- Command language
- Menu selection
- Form fill-in
- Natural language
- Direct manipulation

## Menu selection

- the computer displays a list of items from which the user selects
  - advantages:
    - reduces keystrokes
    - recognition vs. recall
    - accurate
    - structures decision making
  - disadvantages:
    - requires screen space
    - complexity of several levels of menus
    - slows expert users
    - difficult to find appropriate terminology

## Menu selection

- Use task semantics to organize menus
  - binary menu
  - multiple-item menu
  - multiple-selection menu
  - tree structure
  - acyclic and cyclic networks
  - pull-down and pop-up menus
- depth vs. breadth
  - ~ 4-8 items per menu
  - no more than 3-4 levels
    - breadth preferred over depth

## Menu selection

- meaningful grouping of items
  - create groups of logically similar items
  - form groups that cover all possibilities
  - make sure that items are non-overlapping
  - use familiar terminology but ensure that items are distinct from one another
- meaningful presentation sequence
  - time
  - numerical ordering
  - physical properties
  - alphabetic
  - grouping of related items
  - most frequently used first
  - most important items first

## Menu selection

- Phrasing of menu items
  - short menu items
  - begin with a keyword
  - consistent grammar and terminology
  - ensure items are distinct from one another
- type-ahead, jump-ahead, or other short-cuts
- jump to previous or main menu

## Menu selection

- graphic layout and design issues
  - titles
    - some prefer centered titles but left justification is acceptable
  - item placement
    - typically left justified with the item number or letter preceding the description
    - blank lines are used to separate groups of items
  - instructions
    - should be identical in each menu and placed in the same position
  - error messages
    - should appear in a consistent position and have a consistent structure
  - status reports
    - should appear in a consistent position and have a consistent structure

## Form fill-in

- the user provides data in labeled fields clustered on one or more screens
  - advantages:
    - simplifies data entry
    - fast for specific types of data
    - all information is visible
    - modest training
  - disadvantages:
    - consumes screen space
    - requires typing skills

## Form fill-in

- List and combo boxes
- coded fields
  - telephone numbers
  - SIN numbers
  - times
  - dates
  - dollar amounts

## Form fill-in

- Design guidelines
  - meaningful title
  - comprehensible instructions
  - logical grouping and sequencing of fields
  - visually appealing layout of the form
  - familiar field labels
  - consistent terminology and abbreviations
  - visible space and boundaries for data-entry fields
  - convenient cursor movement
  - error correction for individual characters and entire fields
  - error prevention
  - error messages for unacceptable values
  - optional fields clearly marked
  - explanatory messages for fields
  - completion signal

## Command language

- Type in specific commands
- advantages:
  - flexibility
  - supports user initiative
  - appeals to power users
  - potentially rapid for complex tasks
  - supports macro capabilities
- disadvantages:
  - requires substantial training and memorization
  - difficult to retain
  - poor error handling

## Natural language

- Interact through users' own natural language
- advantages:
  - relieves burden of learning syntax
- disadvantages:
  - may require more keystrokes
  - requires clarification dialog
  - unpredictable
  - may not show context

## Natural language

- The man hit the boy with the stick

## Direct manipulation

- Create visual representations of objects and actions, then with pointing, zooming and panning the user can rapidly perform operations
  - advantages:
    - visually presents the task
    - easy to learn
    - easy to retain
    - errors can be avoided
    - encourages exploration
    - high subjective satisfaction
  - disadvantages:
    - requires graphics display/pointing devices
    - more programming effort
    - hard to record history or write macros
    - some tasks difficult

## Direct manipulation

- Design guidelines
  - represent objects or actions in a familiar and recognizable manner
  - limit the number of different icons
  - make the icon stand out from its background
  - consider 3-D icons, they are eye-catching but also can be distracting
  - ensure that a single selected icon is clearly visible when surrounded by unselected icons
  - make each icon distinctive from every other icon
  - create “families” of icons
  - design the movement animation
  - add detailed information (ie. shading to show size of a file)
  - explore the use of combinations of icons to create new objects of actions

## Blend styles

- Form fill-in with drop-down menus

## Choosing an interaction style

- if lots of data entry
  - form fill-in or commands
- if a paper form exists
  - form fill-in
- if familiar notation exists
  - commands
- if a natural visual representation exists or there are a reasonable number of objects/actions in the domain
  - direct manipulation
- if multiple decisions are required or selections from a large unfamiliar state space
  - menu selection, direct manipulation, or commands
- if poor keyboard skills
  - menu selection, direct manipulation
- if exploration and intuition are important
  - direct manipulation

## Choosing an interaction style

- if novice
  - menu selection or direct manipulation
- if modest knowledge of task domain with some computer skills
  - menu selection, direct manipulation or form fill-in
- if intermittent knowledge
  - menu selection, direct manipulation, form fill-in, commands with one-line help or pocket guide, or natural language
- if frequent user
  - commands with macros, menu selection with type-ahead, direct manipulation with shortcuts, or form fill-in with dense display

## Choosing an interaction style

- if novice
  - meaningful labels
  - informative feedback
  - slower pace
  - introductory tutorial/demo
  - limited subset of actions and functionality
- if knowledgeable intermittent
  - modest use of labels
  - modest use of informative feedback
  - moderate pace
  - on-line help to explain objects and actions
- if frequent user
  - short, sparse or no labels
  - short, sparse or no informative feedback
  - faster pace
  - on-line reference with elaborate search mechanisms
  - abbreviations, shortcuts, user-defined macros

## The WIMP interface

- Windows
  - areas of the screen that behave as if they were independent terminals
  - can contain text or graphics, can be moved or resized
  - random, tiled or cascading
- Icons
  - a small picture used to represent a closed window
  - waste paper basket, files, programs, etc.
- Menus
  - a choice of operations or services that can be performed by the system at a given time
- Pointers
  - a cursor that points and selects objects or actions through an input device

## Input Devices

- "a device that, together with the appropriate software, transforms information from the user into data that a computer application can process"
  - match the physiological and psychological characteristics of the users, their training and their expertise
  - is appropriate for the tasks that are to be performed
  - suitable for the intended work and environment

## Keyboards

- Discrete entry device
- Types of keyboards
  - qwerty keyboard
  - alphabetic keyboard
  - dvorak keyboard
    - layout arranged based on the frequency of usage of letters and the frequency of letter patterns and sequences in the English language
    - all vowels and most frequently used consonants are on the second or 'home' row so ~70% of common words are typed on this row alone
    - tapping with fingers on alternate hands (particularly the index fingers) rather than repatitive typing with one finger
  - chord keyboard
    - several keys must be pressed at one to enter a single character
    - small number of keys needed

## Pointing devices

- Pointing tasks
  - select
  - position (choose a point in 1-, 2- or 3-D space)
  - orient (choose a direction in 1-, 2- or 3-D space)
  - path (selects a series of position and orient operations)
  - quantify (specifies a numeric value)
  - text (indicates the location of an insertion, deletion, or change)

## Direct control pointing devices

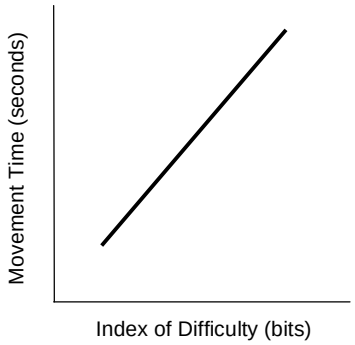
- light pen
  - an early device that enabled users to point to a spot on a screen and perform a select, position, or any of the six tasks
  - can cause arm fatigue
  - users' hands obscure part of the screen
  - user has to remove their hands from the keyboard to use the light pen
- touchscreen
  - interact with the screen by touching it with a finger
  - similar disadvantages as above
  - difficulty of precise selections and smudging on screen
- stylus entry on handheld computers
  - confortable because of it's similarity to a pen

## Indirect control pointing devices

- Mouse
  - comfortable, buttons are easily pressed, long motions can be rapid, positioning precise
  - takes up desk space and the user must remove their hands from the keyboard
- trackball
  - takes up less space, preferred in high-stress environments (air-traffic control or video games)
- joystick
  - absolute
  - isometric
- trackpoint
- touchpad
- digitizing tablet

## Fitts' Law

- Prediction of movement time in human-computer interfaces
- ID = log2(2A/W)
  - ID index of difficulty
  - A distance to move
  - W width of the target
- MT movement time
  - MT is a linear function of ID
  - MT = a + bID
- IP index of performance
  - IP = ID/MT bits/sec
  - higher the IP, higher the rate of human performance

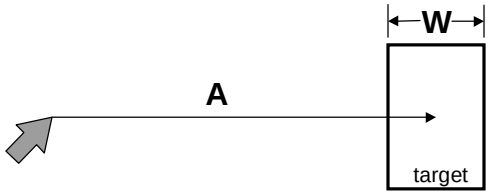



## Serial tapping task - Fitts 1954

- A & W varied over four levels
  - easiest A = 1" & W = 1", ID = $\log_2(2)$ = 1 bit
  - hardest A = 16" & W = 0.25", ID=$\log_2(128)$ = 7 bits

## Variation for cursor manipulation on a screen

- Discrete task - a single movement toward a target from a home position




## Building a Fitts' Law model

- Slope (b) and intercept (a) coefficients are determined through empirical tests
  - controlled experiment using a group of subjects and one or more input devices
  - tasks are designed to cover a range of difficulties (varying A & W)
- measurements are aggregated across subjects resulting in one data point for each task condition
- Perform a test of correlation and linear regression on the MT-ID points
  - a high r suggests the model provides a good description of observed behaviour
  - correlations above .900 are considered very high

## Refinements to Fitts' Law

- Welford
  - ID = $\log_2(A/W + 0.5)$
- Shannon
  - ID = $\log_2(A/W + 1)$
- Speed/Accuracy tradeoff
  - adjust target width based on the distribution on "hits" (selection coordinates) for each target
  - We effective target width
    - target width is adjusted depending on the error rate