User Interface Design
& Development

Lecture 07
Direct Manipulation

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today
direct manipulation

- window UIs
- support for operations
  - mouse, pen, eye tracking, multi-touch
  - new ops: scroll/pan, resize, rotate…
- elements
  - metaphoric vs. idiomatic
- operations & feedback
  - ops: select; feedback; drag & drop
- new modalities

window UIs
history

- Sketchpad is the first Direct Manipulation UI
  Ivan Sutherland's PhD thesis at the MIT in 1963
- WIMP introduced by Xerox Alto 70's and Star 1981
  Windows, Icons, Menus, Pointer
- Apple Lisa is first commercial PC to use GUI in 1983
  - quickly followed by the Macintosh 1984
  - and MS Windows 1.0 in 1985
- OO programming originates in software engineering
  David Parnas' work at Carnegie Mellon in 1972
  - concepts incorporated in research graphics libraries through the '70s and '80s
  - adopted by the Macintosh software in the late '80s

window UIs
how it started

- metaphoric interfaces
  - WIMP interfaces go back to Xerox Alto 70's and Star 1981
    Windows, Icons, Menus, Pointer
    http://www.youtube.com/watch?v=keSTN51PWoE&feature=related
- hit the market in 1983
  - the Apple Lisa
    http://www.youtube.com/watch?v=a4BlmsN4q2I&feature=related

new pointing technologies
multi-touch surfaces

- multi-touch wall
  - http://www.youtube.com/watch?v=mtLX52z4kPU&feature=related
  - watch CNN's weather forecast closely
- at a restaurant
  - http://www.youtube.com/watch?v=OmD0Dd02dFI
- in grade school
  - http://www.youtube.com/watch?v=gikZUDuy4OA
- hybrid solutions
  - http://www.youtube.com/watch?v=qIASBXG3-Sk&feature=player_embedded#
- impact on desktop metaphor: bumptop
  - http://www.youtube.com/watch?v=6jhoWsHwU7w

compare your reactions to these videos
with the reactions to the videos at the beginning of class

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elements of direct manipulation UIs

- operations achieved by physical manipulation & selection
  rather than articulated commands
  - actions
    - buttons, menu choices, switches, control bars...
  - immediate feedback
    - **effect on objects**, cursor shapes, mouse-over tags...
  - easy reversibility
- continuous visual representation of objects
  - icons
- metaphor: a model for representing meaningful objects and operations

metaphor in GUIs

first applied in storage systems

- dictionary definition
  a figure of speech in which a word or phrase literally denoting one kind of object or idea is used in place of another to suggest a likeness or analogy between them
  - they're *drowning in money*
  - let's take that discussion *off line*
  - a new person came *on board* today
- metaphor for computer storage
  - objects: desktop, file, folder, wastebasket
  - actions: drag-and-drop, other...
  - to this day, we call *file* system to data storage

metaphors
have pros and cons

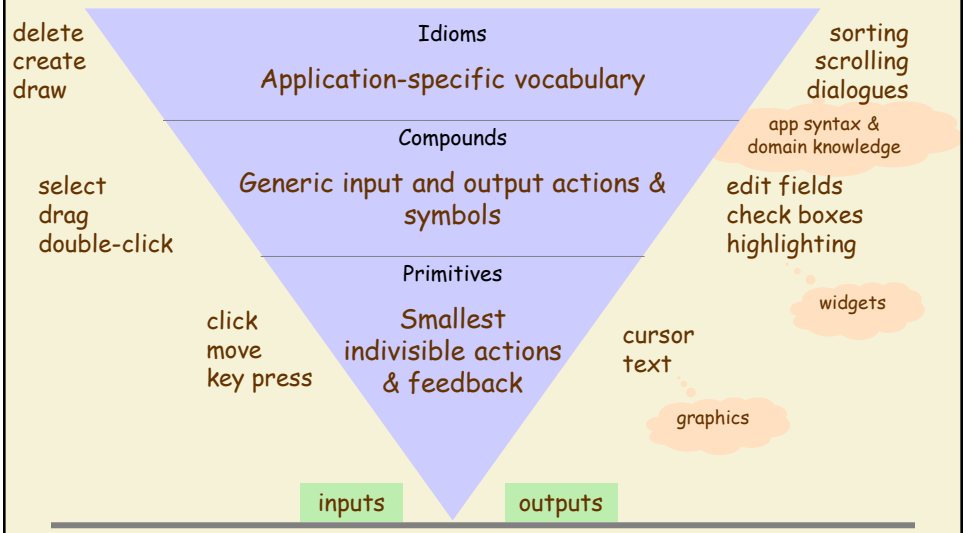
advantages
- appealing
- easy to learn
- easy to use
- reduced errors

disadvantages
- hard to come up with
- some users may not relate to the chosen metaphor
- hard to get entirely consistent
  - e.g., put file in wastebasket vs. put disk in wastebasket
- may suggest false limitations
  - scalability of desktop metaphor for thousands of files

idiom in GUIs

- dictionary definition
  expression peculiar to a particular group, individual, or style
  - they *jumped the broom*
  - he finally *kicked the bucket*
- develop idiomatic terms
  when no appropriate metaphor is found
- users easily remember idioms
  - e.g., the *mouse, google*
- idiom for multitasking operating system
  - *sheets of paper* metaphor in the Apple Lisa, became *windows* idiom in later OSs
  - *pull-down menus* and *popup menus* to access commands

vocabularies at different levels of abstraction



icons
vocabulary of user-level idioms

- limit the number of icons save user's memory
- icons should stand out from background
  - consider 2½-D aka 3D
  - consider icon motion vs. distraction
- icons should be
  - distinct at a glance
  - recognizable – evoke the idiom
  - consistent with each other

icons
guidelines

- highlighting
  - shading & thickness can indicate relative size
  - color can show age or category
  - animation can show processing status
    - e.g., printing, formatting, computing…
- composition as a metaphor for actions
  change the icons to reflect each operation:
  - delete file → trash can
  - print file → printer
  - append files file → file
  - secure(?) file → safe
- consider cultural aspects
  - e.g., different traffic signs in different countries

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commands vs. direct manipulation

- command languages focus on actions
  - form: **verb-object**
  - e.g., chose *copy*, then specify what to copy
- direct manipulation focuses on objects
  - form: **object-verb**
  - e.g. select a *file*, then choose *copy*
  - most GUI operations use this form
  - this makes selection a pre-requisite for all other operations

selection
comes in different flavors

- exclusive: selecting a new object drops the previous
- additive: adds the new object to the group
  - discrete data objects may be selected independently
    - e.g., picture elements in a drawing; files on a desktop
  - contiguous data objects may be selected as a group
    - e.g., spreadsheet cells; text elements in word processors
  - often implemented with a meta-key such as shift or ctrl
  - some objects may be selected in either flavor
    - e.g., files on the desktop
      - ctrl-left mouse for discrete selection
      - shift-left mouse, or mouse drag for contiguous selection

selection
also provides anchors

- in insertion operations such as *new* or *paste*
  the selected object is not the target of the operation
  but provides an anchor for the target
- insertion selection
  the inserted object is placed adjacent to the selected object
- replacement selection
  the inserted object replaces the selected object

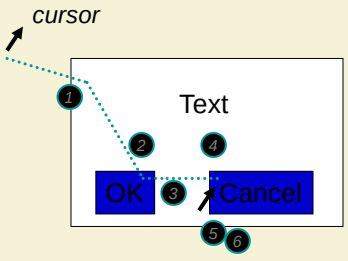
visual feedback
plays a key role

for all uses of selection:
whether and which object is selected
must be clear for the user

- [Cooper]
  I've seen many instances of direct-manipulation idioms implemented without adequate visual feedback, and these idioms fail to satisfy the definition of effective direct manipulation.

GUI events
enable feedback

- events are generated by the graphics library
  when the cursor enters/leaves objects, or the mouse is clicked
- the app's GUI may register to receive callbacks



Mouse Events

1. Into text box
2. Into OK button
3. Out of OK
4. Into Cancel button
5. Left mouse button down
6. Left mouse button up

drag-and-drop
direct manipulation's basic operation

two fundamental uses

- move objects
  - in GUIs: change the layout
  - in robotics: actuate on physical objects
- metaphor for commands:
  select one object, drag it, drop it on another object
  - delete file → trash can
  - print file → printer
  - append files file → file

drag-and-drop reached web-based interfaces

- traditional hypertext focused on browsing
  not much use for drag-and-drop
- new applications on the web
  e.g., social computing, games, e-commerce
  beg for direct manipulation
  - supported in Ajax
    (formerly Asynchronous JavaScript And Xml)
    - http://madrobby.github.com/scriptaculous/puzzle-demo/
    - http://madrobby.github.com/scriptaculous/draggable/
    - http://madrobby.github.com/scriptaculous/droppables/
    - http://madrobby.github.com/scriptaculous/sortable-lists-demo/

drag-and-drop feedback is fundamental

- change shape/color of objects or cursor
  - when selection/dragging is possible
  - when an object is being dragged
  - when dragged over other objects
    - feedback when an operation is possible/impossible
    - feedback should be a metaphor/idiom for operation
- users need to know what happens if they "let go"
  - dropping is easy to do accidentally
  - always provide undo

drag-and-drop guidelines

- make it easy for users: principle of locality
  - place closely in space objects that users will use closely in time
- provide a way to abort dragging
  - drop on an empty spot
  - press a key, e.g., Esc
- scroll automatically
  when user drags an object beyond the borders
  - choose appropriate speed carefully
  - possible strategies
    - constant speed: may be frustrating in large spaces
    - increase speed proportionate to the time the cursor remains outside
    - increase speed if user keeps moving the pointing device

drag-and-drop more guidelines

- avoid hand twitchiness:
  desensitize the pointing device
  - when pressing and releasing buttons,
    the hand often twitches by a few pixels
  - don't actually move objects unless the *move* event from the pointing device is more than a few pixels
    - how many pixels, depends on the nature of the application
      e.g., surgery by wire is different from moving files around
  - if that is important for the app,
    support movement a pixel at a time with key presses

summary
the story so far

- users increasingly expect direct manipulation
  - everything can be dragged including on the Web
  - structure: object selection – verb action
  - keyboard accelerators
    may complement direct manipulation for frequent users
- always provide appropriate feedback during manipulation
  - tell users what's possible, what's not
- strong support for undo

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many modalities
of interfacing humans and computers

- mouse & keyboard dominated WIMP since the early 1970s
  Windows, Icons, Menus, Pointer
- but other modalities are widely used today
  - speech recognition & synthesis
  - tag reading (bar code, RFID…)
  - tangible (automotive, appliances…)
- and others are emerging
  - vision & gesture recognition
  - speech technologies (still)
  - tag reading (still)
  - tangible (still)
- …many applicable to direct manipulation

looking ahead

- eye tracking
  - play Quake http://www.youtube.com/watch?v=3pRWYE2LRhk&feature=related
- touch surfaces
  http://www.youtube.com/watch?v=DGyXzxGCHTY&feature=fvsr
  - wearable version
    http://www.youtube.com/watch?v=fQEHtvNsfKE
- integrate several modalities
  - shopping http://www.youtube.com/watch?v=16GiO8EEVpE