Interaction Design

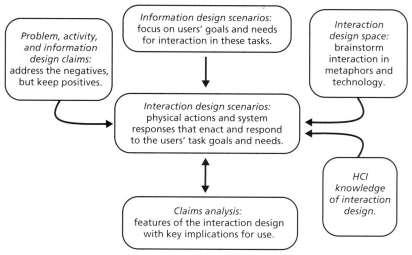
Lecture 6
Chapter 5 Rosson & Carroll

Dilbert
by Scott Adams

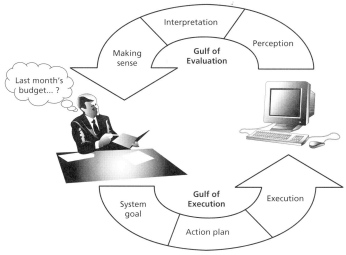
Interaction Design

- Definition
  - Specifying mechanisms for accessing & manipulating information (user input)
  - Motor control
  - User Interface
    - Controls as well as selection of points or areas in display
    - Widgets
- Purpose: Make sure people do the right thing at the right time
- Transforms information design into interaction

Interaction Design: How it fits in



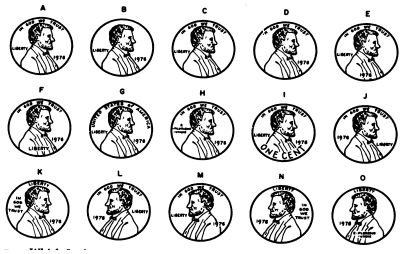
Stages of Action in Human-Computer Interaction



System Goal

- How do I know what I *can* do? Functionality
- What is system goal?
  - Translate real-world goal into system goal
  - Example:
    - "I want to indent this paragraph."
      --->
    - "Set indentation format for this paragraph."
- Semantic directness
  - Affordance: label or icon suggests function
  - Opportunistic goal
  - Recall vs. recognition (command language vs. GUI)

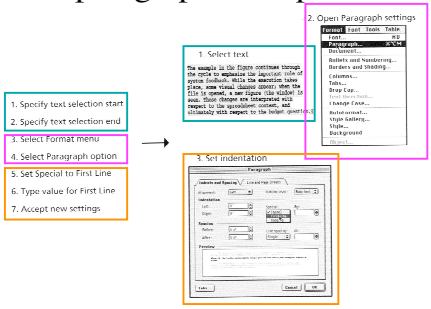
A Test of your Memory!



Action Planning

- How do I know what to do next?
- System goal broken down into sub-goals to achieve it

Action Planning: Indent paragraph example



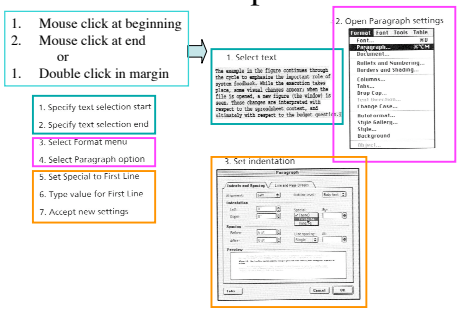
Action Planning

- Good design
  - Emulate real-world tasks
    - Metaphors used cautiously
    - Labeling suggests semantics
  - Expectation from past experience
    - consistency in UI design
    - Similar form = similar function
  - Grouping by steps in action
  - Flexibility in design: multiple ways to achieve same system goal
    - Menus vs. keyboard shortcuts

Execution

- Performing the necessary actions to achieve the steps in the plan
- Widgets
  - Actions plus feedback display
  - Example: menu item highlights when cursor (mouse) passes over it
- Motor control and device-level
  - Pointing devices
    - Mouse, joystick, touchpad

Execution: Indent paragraph example



Execution

- Input devices
  - Which to choose?
- Widgets
  - Which to choose?
- Optimizing performance
- Avoiding and handling failure (errors?)

Control (Input) Devices

- Keyboard
  - Alphanumeric (invented 1880)
- Pointing Devices
  - Joystick (invented 1940's)
  - Trackball (invented 1940's)
  - Digitizing Tablet (invented 1960's)
  - Mouse (invented 1967)
  - Eye Tracker (invented 1980's)
  - Brain Activity Sensors (invented 1990's)
  - Haptic (touch) sensing 3D device (invented mid-1990's)

Keyboard 2003

- Adesso Tru Form USB Touchpad & Keyboard
- Note contoured "ergonomic" shape

Mouse 2003

- Microsoft
- Wireless, optical
- Note ergonomic shape, integrated scrollbar

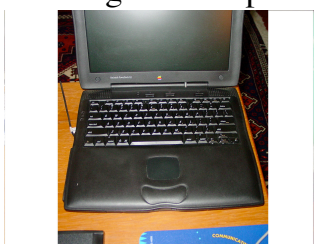
Tablet

- Wacom Intuos2
- Drawing surface as well as control

Joystick 2003

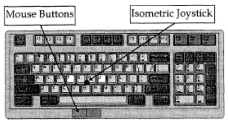
- Logitech WingMan Joystick
- Note multiple controls and ergonomic shape

Finger Touchpad



- Portable computer: Apple Powerbook G3
- Button below touchpad

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

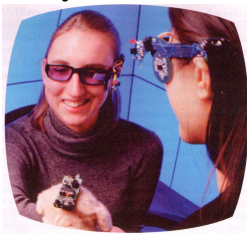
Head Mouse

- Special accessibility: Infogrip Headmaster plus
- Move head to move cursor, puff on tube to select

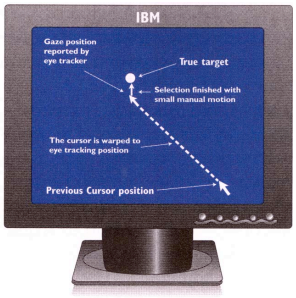
Footmouse

- Special accessibility: Hunter Digital “No Hands” Mouse
- Left pedal for mouse clicks, right for cursor movement

Eye Tracker

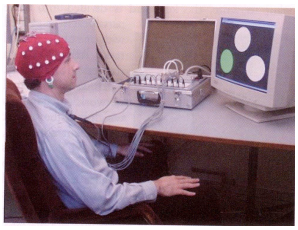


- Special accessibility: Eye aRe glasses
- Detects simple eye movement



MAGIC
pointing on screen.

Brain Tracker

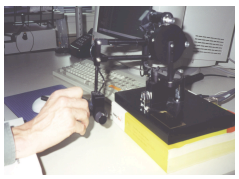


- Special accessibility: EEG system
- 22.0 seconds on average to select a letter

SpaceBall

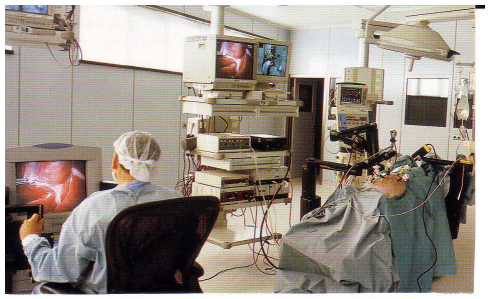
- Spaceball
- Move or rotate 3D by gently pushing, pulling or twisting the ball. Cursor then moves in the direction of the force or twist applied.

3D Haptics Device



- 3D control + touch display: SensAble PHANToM
- Commercially available

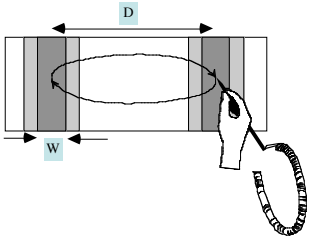
Telesurgery with Haptics



How do we know which device is best?

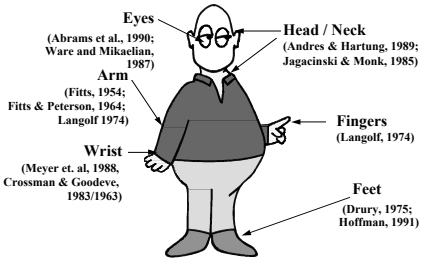
- Tasks
  - Pointing
  - Dragging
  - Typing/Pointing (Mode Switching)
  - Drawing
- Performance Measures (ISO 9241, Part 9)
  - Learning time, practiced performance time, accuracy
  - Satisfaction of use
  - Fatigue and strain

Fitts Law

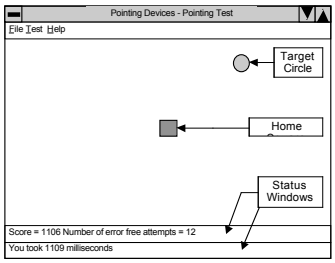


$$Time_{position} = a + b\log_2(\frac{Distance}{Width} + 0.5)$$

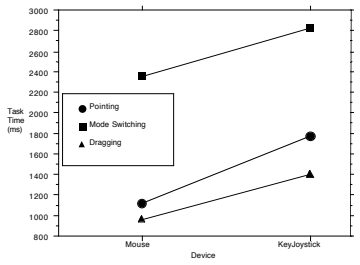
Limbs that follow Fitts Law



Fitts Pointing Task on the Computer



Pointing Time: Skilled Users



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=.096
    - Average pointing time approximately 1.1 sec (NOTE: This is about 5 times slower than keying.)
    - 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 <u>not</u> the superior device?

Types of Widgets

- Window
- Menu
- Dialog Box
- Alert Box
- Control Object
  - Discrete choice: Button (Push, Radio), Check box
  - Continuous choice: Scrollbar
- Word/Icon
- Editable Field

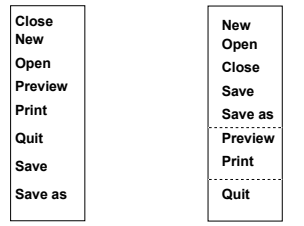
Menus

- Choosing types
  - Pull-down: Best for novices; use screen space, may cover window
  - Pop-up: Hidden functionality; best for casual & expert users
  - Icon / button panel: Best for novices; efficient-close to workspace

Menus- cont.

- Number of items< 10, but depends on context
- Ordering of items
  - Order by task frequency. Most frequently used at beginning (minimize search and pointing time)
  - Order by sequencing of task
  - Order by functional similarity into groups
  - Order by hierarchical structure if natural subclasses exist
  - Most dangerous put at end (maximize pointing time)
  - Order of items should remain the same to promote skill

Menu Ordering Example



Random order

Improved order
Why?

Dialog Box/Alert Box

- Dialog Box
  - Purpose: Collect several parameters of information at once, or to collect text
  - May contain message, editable fields, buttons
  - Frequently moded
- Alert Box
  - Purpose: Notify of problem
  - Contains message and acknowledgement button
  - Moded

Dialog Box

- Most dialog boxes are “modal”
  - user must respond to the dialog
    - window without a close box
    - button to close dialog better than just clicking on box
  - cannot choose other widgets on the desktop
    - use sound feedback to alert if click outside dialog box

Control Objects

- Buttons
  - Purpose: Selection of Discrete Parameters (Actions, Objects, Properties, States)
  - Push (or command) Buttons (activates)
  - Radio Buttons (select 1 of n choices)
  - Check Boxes (select either “on” or “off”)
- Scrollbars
  - Purpose: Selection of Continuous Parameters

Words

- Problems in Choosing Words
  - Vocabulary problem
    - Two people favoring the same name has a probability of < .20
    - Need 20 names to get average of 80% +/- 15%
  - Zipf’s distribution: A few words are used very frequently, the vast majority only rarely
- Solutions
  - Use synonyms, alternative language such as in help descriptions
  - Use aliases
  - Conduct empirical studies of users to find out what vocabulary they use and prefer

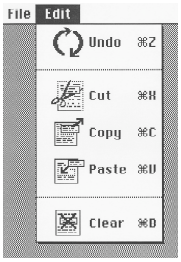
Words cont.

- Suggestible
  - Does the name suggest its function or object?
  - Is it a concrete name and not vague and general?
  - Is it the user’s word?
  - Word meaning is context dependent
  - Make synonyms available
- Memorable
  - Is it easy to remember?

Choosing Icons

- Icons can represent
  - objects in domain
    - Example: Spray can
  - actions in domain
    - Example: Pouring paint from can to “fill” polygon
  - state changes in domain
    - Example: Filled polygons
  - metaphors
    - Example: Lasso to select “herd” objects
- More concrete the better
  - Example: What is a good icon for “undo”
- Be consistent within the domain

Icons



Icons

- Suggestible
  - Does the picture suggest its function or object?
  - Is the picture consistent with the design metaphor?
  - Is it the user’s picture?
  - Icon meaning is context dependent
  - Be aware of cultural differences
  - Use labels or help if possible
- Memorable
  - Is it easy to remember?

UI Control Questions

UI Control	Sample questions about specific interaction mechanisms
Pointing/Selection	How many pointer shapes are available? What is the relation between pointer and insertion point? What keys can be used to position the pointer and how? What selection short-cuts are available, and how do these vary across tasks?
Menus	How are they opened? Where do they appear? How are sub-menus accessed? How are inappropriate items indicated? What shortcuts or fast-paths are supported?
Text input field	How is insertion pointer positioned? How is unacceptable input signaled? How are defaults initialized and removed?
Undo	What is the unit of change? How does it vary across tasks? How far back can you go? What is the Undo/Redo relationship?
Buttons	How is pressing signaled? How are active and inactive buttons distinguished? What happens when window is resized?
Icons	How is selection indicated? How does the icon draw itself when its referent is moved or copied? Are multiple images supported and if so how?
Dialog Boxes	Are they modal or not (or either)? How are they positioned? Can they be re-positioned? How is embedding indicated? How is navigation among fields supported? How are defaults set, re-set?
Alerts, information	Where do they appear? Do they include sound? Are they modal? Do they have a time-out mechanism?
Windows	How are they opened and positioned? How are they moved, resized? How are hidden (but active) windows surfaced? What window relationships can be signaled?

Execution

- Optimizing performance time
  - Recall vs. recognition
    - Select menu item (recall)

      1.1 sec to point to menu
      + . 2 sec to press mouse button down
      + 1.1 sec to drag to menu item
      + . 2 sec to release mouse button
      2.6 sec
    - Keyboard shortcut

      . 2 sec
      + . 2 sec
      . 4 sec

      Six times Faster!
- Defaults

Execution

- Failure of execution
  - Mistakes vs. slips
  - Errors?
- Avoiding and handling failure
  - Anticipate user's problem
    - Give warning
    - Moded interaction
    - Auto-correct
    - Intervene and coach (paperclip?)
  - Help user recognize a failure
    - Give user feedback after all actions
  - Help user recover
    - Undo
    - System learns

Some Resources

- *The Cross-GUI Handbook for Multiplatform User Interface Design* by Aaron Marcus, Nick Smilonich & Lynne Thompson. Addison-Wesley, 1995
- *The Ergonomics of Computer Pointing Devices* by Sarah Douglas & Kartik Mithal. Springer-Verlag, 1997.

Process of Interaction Design

- Explore
- Elaborate
- Rationale

Explore

- For core activity scenarios
  - Brainstorm about possible overall information design
  - Many alternative approaches: Choose best
  - Prior user knowledge (metaphors) & technology options

Use of Interaction Metaphors

VSF Interaction	Real World Metaphor	Implications for VSF Interaction Design
Visiting the fair is like...	Study room	Gesture or hand recognition as notes are written by hand
	Public lecture	Constant stream of auditory and/or visual input
	Cocktail party	Walking in a door, waving at friends, shaking hands
Viewing an exhibit is like...	Lab journal	Open to a page, read whole page, turn page to continue
	Documentary	Buttons to start/stop play; pause or replay if desired.

Interaction Technology Options

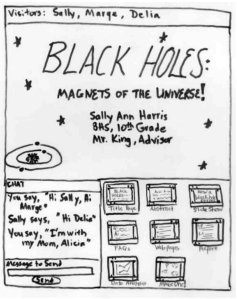
VSF Information	MOOsburg Technology	Implications for VSF Information Design
An exhibit looks like a...	Multimedia notebook	A video and audio presentation organized into pages
	Electronic Whiteboard	Rectangular white space with colored lines and text
	Web pages	Netscape-like browser with underlined hot links

VSF Interaction	MOOsburg Technology	Implications for VSF Interaction Design
Viewing an exhibit is like...	Multimedia notebook	Choose a page, scroll up and down to view elements
	Electronic Whiteboard	View entire board or magnify portions by zooming
	Web pages	View one page at a time, click on links to see related pages

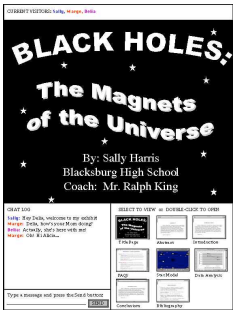
Elaborate

- *Mockup* screens for activities
- Develop *storyboards* and *interaction networks*
- Write *interaction scenarios*
  - Check coherence
    - Do the designs integrate with each other?
  - Check completeness
    - Do the designs cover the major functions and possible difficulties?
- Participatory design

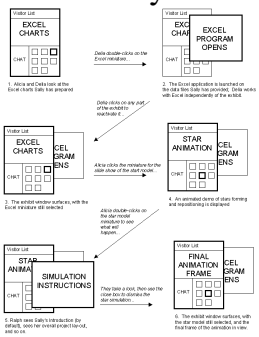
VSF Exhibit Window Sketch



VSF Exhibit Window Mockup



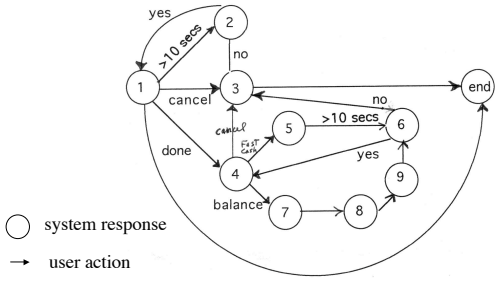
VSF Storyboard



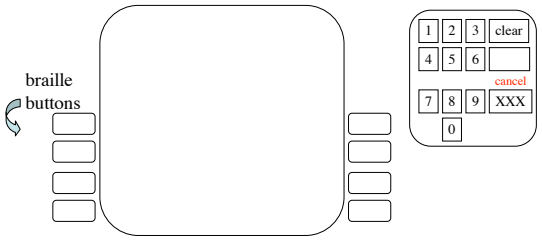
Beyond Storyboards to Interaction Networks

- Definition: Interaction network
  - Abstract representation of the interaction between the user input and the display
  - Augmented Transition Network (ATN)
    - Nodes
      - System response
    - Arcs
      - User action
  - Finite State machine

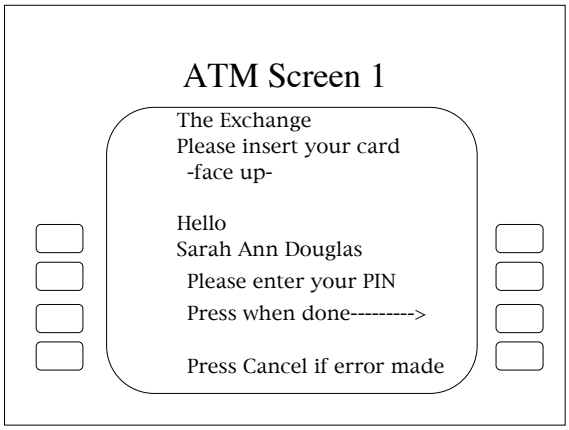
Interaction network: ATM Example



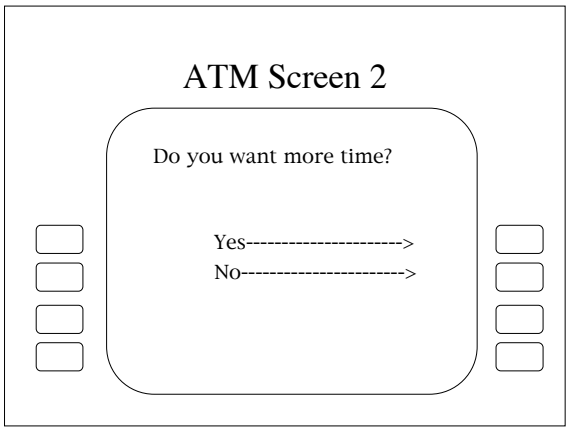
ATM User Interface Layout



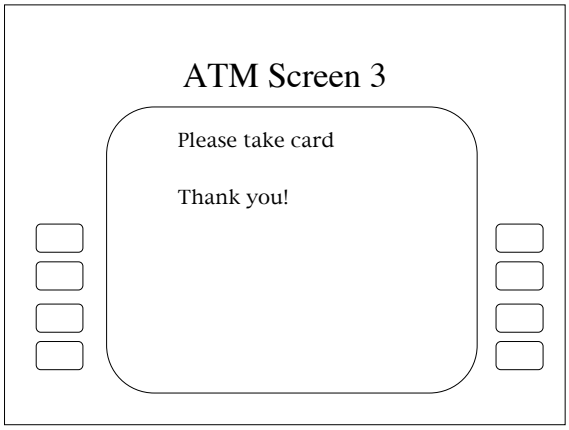
ATM Screen 1

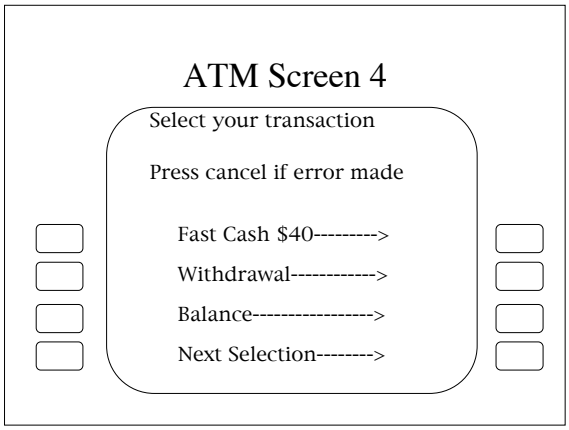


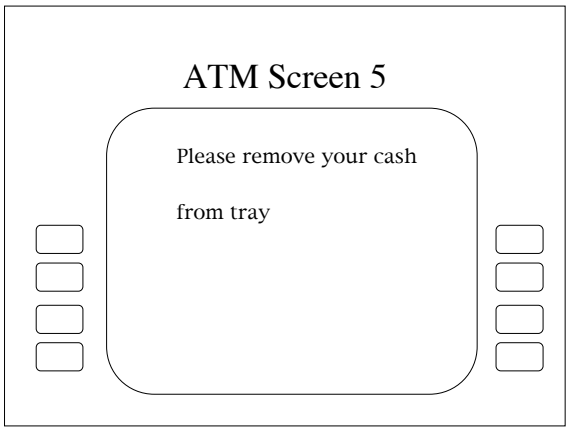
ATM Screen 2

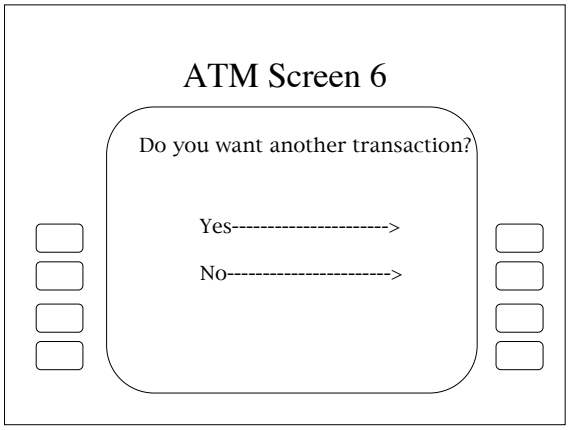


ATM Screen 3

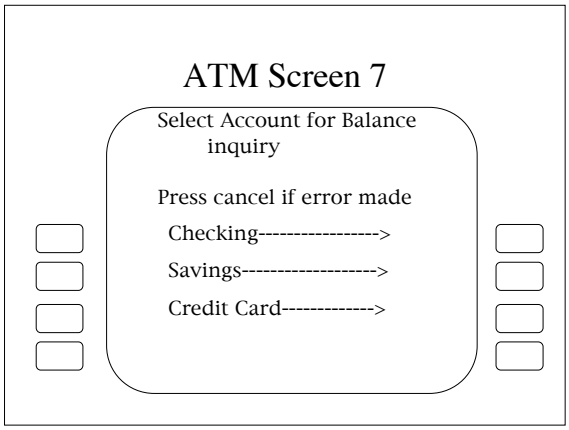



ATM Screen 4
Select your transaction
Press cancel if error made
Fast Cash $40--------->
Withdrawal---------->
Balance---------->
Next Selection------->

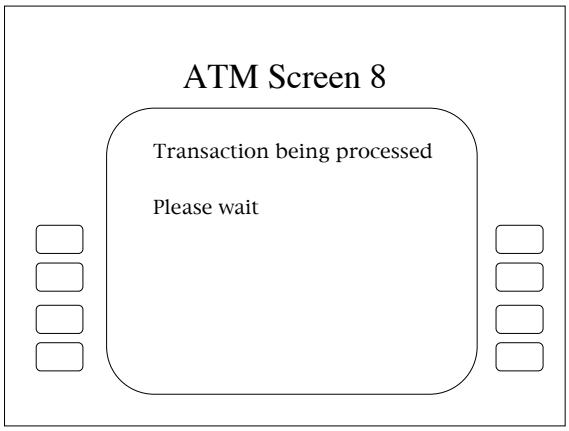

ATM Screen 5
Please remove your cash
from tray


ATM Screen 6
Do you want another transaction?
Yes---------->
No---------->

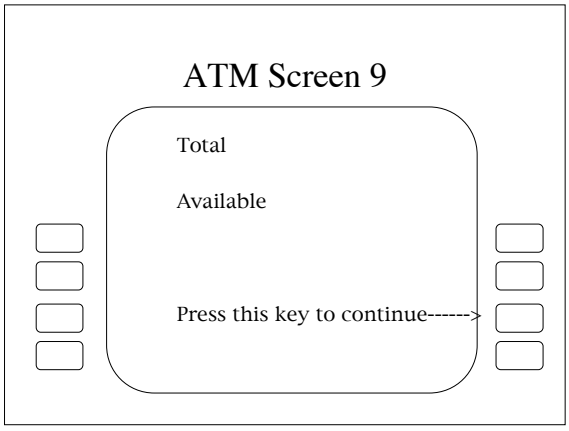
ATM Screen 7



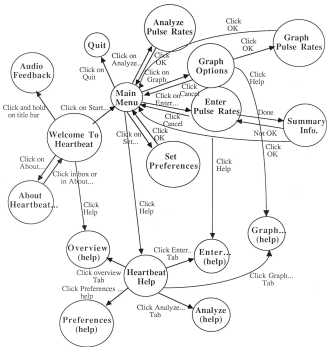
ATM Screen 8



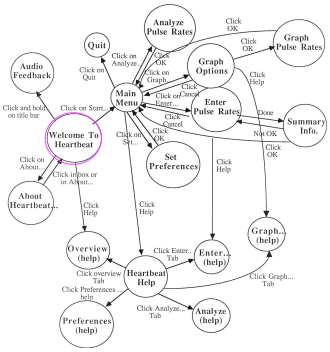
ATM Screen 9



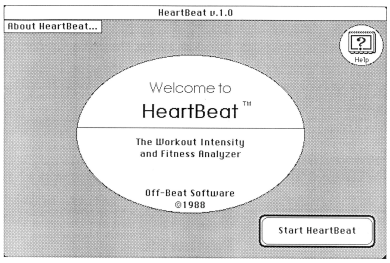
Example: Heartbeat



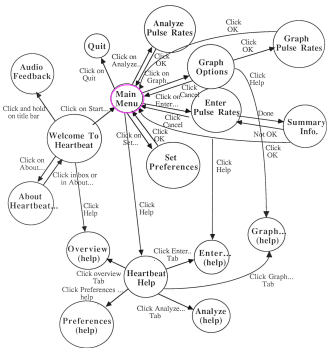
Example: Heartbeat



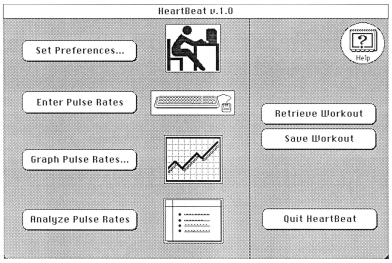
Heartbeat Welcome Screen



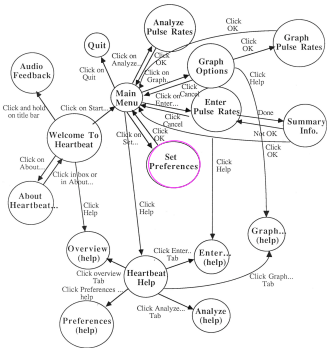
Example: Heartbeat



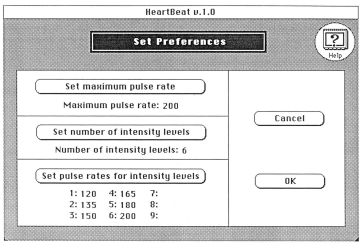
Heartbeat Main Menu



Example: Heartbeat



Heartbeat Set Preferences



Writing Interaction Scenarios

- Start with the information scenario
- Add in the descriptions of the interaction design

Interaction Scenario

[2] Alicia and Delia go to the science fair.

<Background on Alicia, her attitudes about science fairs, motivations regarding Delia, etc.>

Delia calls her mom over to see an email reminder about the virtual science fair. She points to the underlined text and says that it's a URL and they can go right now if she wants. So they do.

When they arrive, Alicia sees that they are in MOOsburg (she has recently worked with some Tech grad students to create a site for her store). She recognizes the layout-a main view in the top, a map in the lower left with a green dot indicating their position, various icons placed around in the view, a chat tool in the lower left. But the map is not of Blacksburg as usual; after looking for a moment, she recognizes the floor plan of the high school, and shows Delia the main office where she worked for a while. She can see by the green dot that the VSF is located in the high school gym; the panorama photo in the main view reinforces this, she even sees the bleachers to the side.

There are lots of objects in the main view. A banner on the back wall welcomes them, thanks the organizers, and announces that judging will be on Thursday. They see other visitors-Alicia explains to Delia that some of them have custom icons because they have edited their personal profiles. Delia and she show up as the default "middle school girl" icon because Delia has never changed this part of her profile. Their icon flashes red briefly, which Delia finds a bit embarrassing; she hates to be noticed in a crowd.

There are also a number of objects that Alicia and Delia infer are exhibits: they all have the same icon, a miniature board with graphics; Alicia sees her neighbor Jeff Smith's name underneath one. Delia points to some black and yellow flags across some of the exhibits, suggesting that these must be under construction".

Delia starts to open an exhibit in the middle with lots of people around it, but then Alicia notices her friend Marge. She tries the technique she has used elsewhere in MOOsburg, selecting Marge's icon then using "Control+I" to see if she is working with anything. An exhibit with the label "Sally Harris" flashes briefly in red, so they decide to open this one instead.

Rationale

- Write interaction design claims analysis
  - How does the design work?
  - How does the design *not* work?
  - Note tradeoffs
  - Sometimes need evaluation with real users

Interaction Claim: Flashing icon

Situation Feature	Possible Pros (+) or Cons (-) of the Feature	Scenarios
Highlighting and flashing a new arrival's name	⊞ encourages current participants to notice and welcome arrivals ⊞ suggests to the arrivals that their presence and participation is desired ⊟ but some arrivals may be embarrassed by the personal attention ⊟ but current participants may be distracted from ongoing activities	■ Mr. King coaches Sally on her project. ■ Alicia and Delia go to the science fair.

Interaction Claim: Control-I

Situation Feature	Possible Pros (+) or Cons (-) of the Feature	Scenarios
Using "Control-I" to find out what a co-present user is working with	⊞ ties information about people directly to their representation on the display ⊞ simplifies the screen display by hiding activity information cues ⊟ but this conflicts with the real world strategy of just looking around ⊟ but not all users will know how to find out about others' activities ⊟ but it may be difficult to integrate awareness information about multiple people	■ Mr. King coaches Sally on her project. ■ Alicia and Delia go to the science fair.

Review of Interaction Design

- interaction design = specification of what the user does
- Process: Explore, elaborate, rationalize
- Elements
  - Check for coherence, consistency, feedback
  - Tools: mockups, storyboards, interaction networks, participatory design
- Products
  - Storyboards, interaction networks
  - Interaction scenarios
  - Interaction claims analysis