Interaction Design

- Specifying the action sequences for planning and achieving one or more task goals
  - Conveying what system goals are possible, plans for accomplishing them, physical actions to execute
- Usability engineering of an interaction design
  - Ensure users can predict how to pursue goals, and that doing so is a comfortable and pleasant experience
  - Again, depends inherently on task, hence an important role of user interaction scenarios

Stages of Action in HCI
Selecting a System Goal

- Going from users’ task concept to system concept: the *cognitive distance* between two models
  - Mental model held by users tells them what to do
  - This must make connection with designers’ model that is conveyed and supported by the user interface

- The closer the match, the easier to find and pursue a relevant goal

Suggesting Goals to the User

- Menu titles, folder names, application names, ...
- Decreasing the distance via direct manipulation:
  - UI controls appear as *physical analogs* of real objects; their affordances suggest interaction goals
  - Key ideas are visual representation, immediate and continuing feedback, and simple reversibility
- Visual or auditory UI elements sometimes lead to *opportunistic* selection of goals
  - Interesting object or message intrudes on a task
  - Or user is paused, choosing among things to do; especially common among novice users
To Intrude or Not

EAGER To Help
Treemaps vs SunBurst

Recall Instead of Recognition

- Commands refer to system objects and actions
  - Cognitive distance determined by words and phrases a system understands as user requests
  - Recall more demanding, but flexible & saves screen space
  - Design issues: vocabulary size and structure, familiarity and ambiguity (as discussed earlier)
  - Also the syntax (grammar) of the command language

- Compromise: nested menus support “hierarchy-path recall” of a large set of commands
  - e.g., Format → alignment → center

- What about using natural language for commands?
Action Planning

- Plan analysis of required action sequences
  - Like HTA, goals decomposed into subgoals, steps, etc.
  - Includes choices and decision rules as relevant
  - Examine what *plan knowledge* is expected of the user
  - Look for arbitrary sequences, overall complexity, consistency, interference from one plan to another
- Ex: action plan for changing to double-space?

MODELING PLAN KNOWLEDGE WITH GOMS

**GOAL:** CLOSE-ACTIVE-WINDOW

**GOAL:** USE-MENU-METHOD
MOVE-MOUSE-TO-MENU-BAR
DRAG-DOWN-FILEMENU
RELEASE-ON-CLOSE-OPTION

**GOAL:** USE-HANDLE-METHOD
MOVE-MOUSE-TO-CORNER
CLICK-ON-CLOSE-BOX

**GOAL:** USE-CONTROL-KEY
PRESS CONTROL+W]

*Goals, operators, methods, and selection rules*
Designing Learnable Action Plans

- Try to make the sequence of actions match how user thinks about the real world task
  - design (or select from toolkit) interaction widgets that have good affordances
- Design a sequence, then analyze and refine
  - limited storage capacity of short-term memory (7 +/- 2)
  - look for ways to chunk long sequences of steps
  - use intermediate feedback or physical action to “mark” boundaries of subplans
  - ensure that subplan chunks match task subgoals

1. Select text
2. Specify text selection start
3. Specify text selection end
4. Select Format menu
5. Select Paragraph option
6. Set Special to FirstLine
7. Type value for FirstLine
8. Accept new settings

2. Open Paragraph settings

3. Set indentation
Guiding Action Planning with Forms

• Users are already familiar with form fill-out
• Procedure (action plan) is implicit in the layout
  – numbering or instructions may emphasize
  – tabs, or auto-advance for convenience
• Design issues similar to those with menus
  – size and complexity can be intimidating
  – decomposing into simpler forms that match task
  – flexibility, not everything is text-based
  – consistency in look and feel

Giving Control to the User

• Humans are good at—and expect support for—doing multiple things at once
  – Working in parallel or “stacking” then reinitiating a task
  – Internal rather than external *locus of control*
  – When computer drags them along, it’s unpleasant!
• BUT, what does this mean for interaction design?
Multi-threaded Interaction

- Multiple windows, each holds one thread
  - Tradeoffs between tiled versus overlapping?
  - Implies good support for *window management*
- Avoid *modal dialogs* unless they have task purpose
  - e.g., a preemptive dialog box that must be dismissed
  - When should you *deliberately include* modal dialog?
- Crucial role of status information
  - Users must be able to tell when they return to a window what they have done so far, what is possible now, etc.
  - Scenario-based design of “picking up the pieces”

Action Execution

- Physical actions of dragging, clicking, typing, etc.
  - Design goal is to minimize, make things “hang together” as movements, not just plans
- Crucial role of *input device*—just like icons, etc., different devices have different affordances:
  - keyboard?
  - mouse?
  - joystick?
  - trackball?
  - data glove?
### Common User Input Devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Characteristics</th>
<th>Sample Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Button</td>
<td>Simple discrete input</td>
<td>Command execution or attribute specification</td>
</tr>
<tr>
<td>Keyboard</td>
<td>Spatial array, small finger movement, allows combination keypresses, discrete</td>
<td>Open-ended continuous symbolic input</td>
</tr>
<tr>
<td>Mouse</td>
<td>Grasped with hand, one or more buttons, large arm movement, analog</td>
<td>Pointing and selecting in a 2D space</td>
</tr>
<tr>
<td>Trackball</td>
<td>Grasped and rolled with hand, constrained movement in horizontal plane, one or more buttons, analog</td>
<td>Panning (rolling over) large maps or other 2D surfaces</td>
</tr>
<tr>
<td>Joystick</td>
<td>Grasped with hand, pushed or twisted, one or more buttons, constrained movement in three dimensions, analog</td>
<td>Setting direction of movement in virtual space, continuous zooming</td>
</tr>
<tr>
<td>Data glove</td>
<td>Tracking of finger and hand position in three dimensions</td>
<td>Grabbing and positioning objects in virtual space</td>
</tr>
</tbody>
</table>

### Speech Input and Output

- Speech I/O inherently **linear**, relatively slow
  - Trades off with familiarity, naturalness
  - May address with restricted vocabularies—commands
- Speech recognition accuracy still limited
  - Depends on speaker, amount of training up front
- Synthetic speech output quality also limited
  - Biggest challenge is **prosody** (intonation contours)
  - Many systems use digitized natural speech snippets
  - BUT useful for alerts, warnings (why?)
- Biggest benefit: parallel processing, multi-modal
  - Also critical for hands-busy, heads-up tasks
Designing for Errors

- Carefully analyze physically challenging actions
  - *Fitts Law*: time to select target is a regular function of distance and size of the target
  - But of course not all targets can be big and large :-)
- Overlearned procedures (e.g., From other systems) lead to *intrusions* (slips, not mistakes)
  - Most common form is typos, transposition of letters
  - e.g., Hitting delete before I get the text selected
  - Making a menu selection before menu pops-up

<table>
<thead>
<tr>
<th>Type of Error</th>
<th>Example Situation</th>
<th>Design Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mistake</strong>: asking for non-existent function or object</td>
<td>Mistyping the name of a command so that its function can not be executed</td>
<td>Represent (e.g., in lists, icons) what is available</td>
</tr>
<tr>
<td><strong>Mistake</strong>: over-generalizing an earlier experience</td>
<td>In a listserv, using “reply” when intending to reply only to the sender of a message</td>
<td>Present through training or documentation a more complete set of examples</td>
</tr>
<tr>
<td><strong>Slip</strong>: doing something that is appropriate, but not in current mode</td>
<td>Trying to input text into a document while the Font dialog box is open</td>
<td>Minimize modes and when necessary mark well with status and feedback cues</td>
</tr>
<tr>
<td><strong>Slip</strong>: making a request that is interpreted as something else</td>
<td>Using keyboard short-cut to turn off underline before adding space (in PowerPoint reverses existing underline)</td>
<td>Improve consistency of low-level controls within and across applications</td>
</tr>
<tr>
<td><strong>Slip</strong>: completing an automated (but inappropriate) action</td>
<td>Deleting a text selection before the selection has not been correctly specified</td>
<td>Predict locus of such errors and increase the amount of feedback (or alerts) provided</td>
</tr>
</tbody>
</table>
Supporting Error Correction

- Forward/backward delete, click to de-select
  - usually not a question of design, built into UI platform
  - but what does “Back” on a browser get you?
- Common design problem is providing for **Undo**
  - predicting, supporting right level of reversibility
  - what are the issues here?

Optimizing Execution Sequences

- Feedback and good **defaults** are essential!
  - especially in long, costly, or tedious transactions
- Consider implications of long term use
  - focus on actions for frequent choices, fast-paths
  - BUT, be careful to note when you are
    - violating overall consistency, or favoring one task at expense of other important or common tasks
- Customization: users define their own sequences
  - e.g., mapping commands to key combinations
  - can be critical when supporting users with special needs
Example: Metaphors for Virtual School Fair

<table>
<thead>
<tr>
<th>Phase</th>
<th>Design Ideas</th>
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</thead>
<tbody>
<tr>
<td>Activity Design: <em>Cocktail party</em></td>
<td>Informal discussions among visitors, as they move from group to group</td>
</tr>
<tr>
<td>Information Design: <em>Documentary</em></td>
<td>Movie or animated sequences of screens and audio; timeline visualization</td>
</tr>
<tr>
<td>Interaction Design: <em>Public lecture</em></td>
<td>Constant stream of visual/auditory output; visitor relatively passive, may be writing</td>
</tr>
</tbody>
</table>
### Example: Technology for Virtual School Fair

<table>
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<th>Phase</th>
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<tbody>
<tr>
<td>Activity Design:</td>
<td>Visitors view exhibits, post comments by topic; students/others may then reply</td>
</tr>
<tr>
<td>Threaded discussion</td>
<td></td>
</tr>
<tr>
<td>Information Design:</td>
<td>Sequential list of text messages; each is identified with name, perhaps color</td>
</tr>
<tr>
<td>MOOsburg chat</td>
<td></td>
</tr>
<tr>
<td>Interaction Design:</td>
<td>Click on a location to go there; pan to see more map; annotate or ‘mark up’ map</td>
</tr>
<tr>
<td>MOOsburg map</td>
<td></td>
</tr>
</tbody>
</table>

### Analyze
- Problem scenarios
- Claims about current practice
- Analysis of stakeholders, field studies
- Iterative analysis of usability claims and re-design
- Metaphors, information technology, HCI theory, guidelines

### Design
- Activity scenarios
- Information scenarios
- Interaction scenarios
- Usability specifications

### Prototype & Evaluate
- Formative evaluation
- Summative evaluation