UX Design Principles and Guidelines
- **Principles** – abstract design rules
  - “an interface should be easy to navigate”
- **Guidelines** - advice on how to achieve principles
  - “use color to highlight links”
- **Standards** - specific rules, measurable
  - “button icons should be 48x48 pixels”
- **Patterns** – proven design solutions to reoccurring problems
Design Principles and Guidelines

User Populations
(Shared human ability and behavior)
(Problem domains)

Computing Paradigms
(Platform guidelines and conventions)

Foundation Design Principles
(Empirical)
Design Thinking

Users

Characteristics
Mental models
Goals and Tasks
Emotions

Designers

Metaphors
Design vision
Design experience
Innovation

Designers

Standards, Conventions,
Guidelines, Principles
Interaction model
Affordances

Conceptual Designs

Intermediate and Detailed Designs
Design Decisions

- Task steps and actions (HTA)
- Novice to expert
- Human diversity
- Aesthetics
Norman’s Interaction Model
Execution/Evaluation Action Cycle

Goals
What we want to happen

Execution
What we do to the world

Evaluation
Comparing what happened with what we wanted to happen

WORLD

Donald Norman, *The Design of Everyday Things*, 1990
Execution/Evaluation Action Cycle: Stages of Action

**Goals**
What we want to happen
Event (data) driven
Person initiated

**Example – frozen pizza**

**Semantic Distance**
Forming intention
Specifying action
Executing action

**Articulatory Distance**
Evaluating interpretation
Interpreting perception
Perceiving world state

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**WORLD**

**Feedforward**

**Feedback**

New state
Framework to structure UX design principles and guidelines
## Stages of Learning

<table>
<thead>
<tr>
<th>Stages</th>
<th>Behaviors</th>
<th>Moods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginner</td>
<td>Limited or no knowledge</td>
<td>Ambition to learn, but fear of failure, impatient</td>
</tr>
<tr>
<td>Advanced Beginner</td>
<td>Familiarity with common situations, still needs help</td>
<td>Ambition but potential boredom or apathy</td>
</tr>
<tr>
<td>Competent</td>
<td>Has learned the norms for common situations unassisted</td>
<td>Confidence but anxiety, insecurity, frustration</td>
</tr>
<tr>
<td>Proficient</td>
<td>High level of skill, new standards of performance</td>
<td>Ambition, confidence but impatience, frustration, arrogance</td>
</tr>
<tr>
<td>Expert</td>
<td>Extensive experience, teaches others</td>
<td>Ambition, confidence and serenity but arrogance and impatience</td>
</tr>
<tr>
<td>Master</td>
<td>Big picture view, can make change happen to improve</td>
<td>Ambition, exploration but arrogance, boredom, disinterest</td>
</tr>
</tbody>
</table>

“A five-stage model of the mental activities involved in directed skill acquisition”, Dreyfus, 1980
Planning – Help Users Know *What* to Do

User starting point …

- **High-level** system understanding
- **Goal decomposition**
- **Workflow** task/step structuring and sequencing
- **Conceptual** model, *metaphors*, work context
# Planning – Design for Understandability

<table>
<thead>
<tr>
<th>Task Completion Reminders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Match user’s <strong>mental model</strong> of high-level task organization</td>
</tr>
<tr>
<td><strong>What</strong> system <strong>features</strong> exist, what users can do at every point</td>
</tr>
<tr>
<td>Help users <strong>plan</strong> how to <strong>complete tasks efficiently</strong></td>
</tr>
<tr>
<td>Keep users aware of <strong>task progress</strong></td>
</tr>
</tbody>
</table>
## Translation

### Content and Meaning of Cognitive Affordance

<table>
<thead>
<tr>
<th><strong>Timely</strong> and <strong>visible</strong> cognitive affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precise wording and naming</strong></td>
</tr>
<tr>
<td><strong>Make choices distinguishable but consistent</strong></td>
</tr>
<tr>
<td><strong>Avoid multiple synonyms</strong> for the same thing</td>
</tr>
<tr>
<td><strong>Control complexity with object proximity and grouping</strong></td>
</tr>
</tbody>
</table>

**Recognition over recall**
- **Recognition**: remembering with the help of a **visual clue**
- **Recall**: remembering with **no help**

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Enter the model number and description of the product you wish to purchase.
How We Remember Things

- **Knowledge in the world**
  - Intrinsic properties of real objects act as perceivable cues
  - Environment interpretation rather than learned
  - E.g., keyboard typing

- **Knowledge in the head**
  - Must be recalled from short and/or long term memory
  - May require significant effort, may be inaccurate
  - E.g., spelling a word

- They work together
Learnability, Memorability and Human Memory

- **Working short term memory**
  - Small 7 ± 2 chunks
  - <10 sec decay
  - Rehearsal can impact decay

- **Long term memory**
  - Infinite in size and duration
  - Extensive rehearsal transfers **chunks**

- **Chunk** is a unit of memory or perception
  - Hard: M W B C R A L O A B I M B F I
  - Easier: MWB CRA LOA BIM BFI
  - Easiest: BMW RCA AOL IBM FBI

- **Stacking** – task interruptions, limited depth
"To Err is Human"

Intend to do one action, end up doing something else

Slips
- Action-Based
- Memory-Lapse

Mistakes
- Rule-Based
- Knowledge-Based
- Memory-Lapse

Errors

Pursue the wrong goal, or execute the wrong plan

The Design of Everything Things, Don Norman
Understandability: Human Errors

- **Slips** – lack of attention to the task
  - **Action-Based** – intend to do one action but do another; “strong but wrong”
    - Pour milk in your coffee, put the coffee in the fridge
  - **Memory-Lapse** – forget to do something
    - Make copies, leave original in the copier
  - **Mode errors** – states in which same actions have different meanings
    - cAP IOCK
Understandability: Human Errors

- **Mistakes** – wrong goal or plan is selected
  - **Rule-Based** – right goal selected but then an incorrect course of action chosen
    - Turning left onto a freeway exit ramp
  - **Knowledge-Based** – incorrect or incomplete knowledge
    - Choosing an English unit wrench for a metric bolt
  - **Memory-Lapse** – failure to complete an action due to distraction
    - After an interruption forgetting to commit recent code changes
## Understandability: Error Prevention
Avoid Inappropriate and Erroneous User Choices

<table>
<thead>
<tr>
<th><strong>Disable</strong> buttons, menu choices to make <strong>inappropriate choices unavailable</strong> or gray out to make inappropriate choices <strong>appear unavailable</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Different things should look and act differently</strong></td>
</tr>
<tr>
<td><strong>Separate risky</strong> (consequential, hard to recover from errors) <strong>actions</strong> from frequently used ones</td>
</tr>
<tr>
<td>Solicit user <strong>confirmation</strong> before potentially destructive actions; <strong>risk</strong> of user annoyance</td>
</tr>
<tr>
<td><strong>Avoid memory lapses</strong> – short task steps, consider imposing a <strong>required sequence of steps</strong> (trade off of user freedom)</td>
</tr>
<tr>
<td><strong>Avoid modes</strong> entirely, don’t duplicate actions across modes</td>
</tr>
</tbody>
</table>
| Provide cognitive affordances for **error recovery**  
  Provide a clear way to **undo** and reverse actions  
  Offer constructive **help** for error recovery |
Translation (cont)
Task Efficiency

<table>
<thead>
<tr>
<th>Provide <strong>alternative ways</strong> to <strong>perform tasks</strong>; e.g., keyboard alternatives to avoid physical switching actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task thread continuity</strong> - anticipate most likely next action, step, or task path</td>
</tr>
<tr>
<td>Do <strong>not</strong> make user <strong>redo</strong> any work, <strong>reenter data</strong></td>
</tr>
<tr>
<td><strong>Retain</strong> user <strong>state</strong> information</td>
</tr>
<tr>
<td>Example, having to find folder you are working in, over and over</td>
</tr>
<tr>
<td><strong>Keep the user in control</strong></td>
</tr>
<tr>
<td>Good interfaces are explorable, errors are forgiven</td>
</tr>
</tbody>
</table>
Translation (cont)
Task Efficiency

Response times:
- **< 100 msec** – perceptual fusion as two stimuli appear to be instantaneous
- **0.1 – 1.0 sec** – user notices the delay
- **1.5 sec** – display busy indicator
- **>1.5 sec** – display progress bar

2-Second-Rule: users should not have to wait longer than 2 seconds for common UI actions

3-Click-Rule – users should not have to wait longer than three clicks to do something useful
### Physical Actions Help Users Do Tasks

<table>
<thead>
<tr>
<th>Physical affordances for sensing and manipulating UI objects for and during making physical actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Avoid</strong> physical awkwardness and fatigue; e.g., shifting from mouse to keyboard constantly</td>
</tr>
<tr>
<td><strong>Accommodate disabilities</strong></td>
</tr>
<tr>
<td>Range of motion, fine motor control, vision, or hearing</td>
</tr>
<tr>
<td>Fitts’ Law issues</td>
</tr>
</tbody>
</table>
Outcomes

- **Internal**, invisible **effect/result** within system
- **Outcomes must be revealed** to user via system feedback
- Where **usefulness** lives
- Functional affordance of non-user-interface system functionality
- **Issues** are about **computational errors**, software **bugs**
Assessment

- Help users know if interaction was successful
  - Existence of feedback
  - Presentation of feedback
  - Content, meaning of feedback
### Assessment

<table>
<thead>
<tr>
<th>Provide some type of feedback for all user actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Presentation</strong> of feedback – <em>visible, noticeable</em> location; augment with audio</td>
</tr>
<tr>
<td><strong>Understandable error messages</strong> when things don’t work</td>
</tr>
<tr>
<td><strong>Progress</strong> feedback on <em>long operations</em></td>
</tr>
</tbody>
</table>
| **Feedback wording**  
  Helpful, informative  
  Positive psychological tone; it’s the system’s fault  
  Language of the user and domain context |
| **Feedback consistency** – label *departure* and *destination* screens consistently |
Assessment (cont)
Assessment (cont)

Mail Server Query

Results for hartson.cs.vt.edu

send: invalid spawn id (6) while executing "send "1$pid\r"" (file "./genpid_query.pass" line 31)
Assessment (cont)

<table>
<thead>
<tr>
<th>Simple Search</th>
<th>Advanced Search</th>
<th>Browse</th>
<th>Register</th>
<th>Submit to CoRR</th>
</tr>
</thead>
</table>

**Simple search:** Search all bibliographic fields

<table>
<thead>
<tr>
<th>Search for</th>
<th>Archive</th>
<th>Relevance ranking</th>
</tr>
</thead>
</table>

[Search]
**Presentation**

<table>
<thead>
<tr>
<th>Provide <strong>user control</strong> over <strong>amount</strong> and <strong>detail</strong> of <strong>feedback</strong>; most <strong>important</strong> information at <strong>first</strong>, more on demand</th>
</tr>
</thead>
</table>
| **Information display**  
  Eliminate **unnecessary words**  
  **Group** related information  
  Control density of displays; use **white space** to set off  
  **Columns are easier** to read than wide rows (see newspapers)  
  **Responsive design** – format information to fit the screen size (more on this later) |
# Broad Guidelines

<table>
<thead>
<tr>
<th>Given two otherwise equivalent designs, the <strong>simplest is best</strong> (Ochham’s Razor)*</th>
<th>A design challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>80/20 rule</strong> – 20% of functionality gets used 80% of the time</td>
<td></td>
</tr>
<tr>
<td><strong>Good enough</strong> – choose a <strong>satisfactory</strong> solution <strong>rather than</strong> the <strong>optimal</strong> solution; avoid complexity</td>
<td></td>
</tr>
<tr>
<td><strong>Consistency</strong> - label and do <strong>similar things</strong> in <strong>different places</strong> the <strong>same way</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Use of language</strong> – avoid use of <strong>poor humor</strong>, <strong>anthropomorphism</strong>, <strong>first person speech</strong>, <strong>condescending</strong> and other <strong>psychologically negative words</strong> (e.g., violent, demeaning, threatening)</td>
<td></td>
</tr>
</tbody>
</table>

* “Entities should not be multiplied without necessity.” William of Ockham, 14th century Franciscan friar
Broad Guidelines (cont)

More later on …

- Grouping
- Color
- Text
- Accessibility
- Web and small screen
- Internationalization