HCI: Design

Task

Technology

Organizational & Social Issues

‘Design’

- Conceptual design
  - Designing the system in the abstract.
  - What information and what functions are needed for the system to achieve its purpose?
  - What will someone have to know to use the system?
  - It is about helping users develop a clear mental model of the system

- Formal/physical design
  - How things are going to work
  - Detailing the look and feel of the product
  - Structuring interactions into logical sequences
  - Clarifying and presenting the allocation of functions and knowledge between people and devices.

Proper design should consider

- Physical interaction: system input – mouse, speech (or noise), gesture
- Perceptual interaction: system output – visual, audio, haptic?
- Conceptual interaction: do we know how the system works and what we should do?

- Affected by people, activities, contexts, technologies (PACT framework)
  - A student uses a phone to send a text message whilst sitting on a bus
  - Air traffic controllers work together using computers and flight strips to ensure smooth running of an airport in the air traffic control centre.
  - A 70-year-old woman programs various buttons to set the intruder alarm in her house.

Interactions

What to design

Strategy = users, usage, goals

**Surface**

- User interface

**Skeleton**

- Data structures

**Structure**

- Navigation logic

**Scope**

- System boundaries

**Strategy**

- Implementation plan

**Goals**

- Established user needs

**User Profiles**

- User demographics

**Usage Contexts**

- Operational environments
Scope = user tasks supported

**user tasks:**
- enter numbers
- enter text
- enter formulas
- format cells
- sort information
- filter information
- aggregate information
- graph data
- save data
- import data
- export data
- print
- ...

Structure = Dialog progression

Skeletal = Screen Layout and Functional Compartments in the Screen

Surface = Visual Design Aspects

(Hierarchical) Task Analysis

- Methods of analysing what people can do, what things they use and what they know.
- Description of work by hierarchical decomposition.
- Divided into goals, tasks and actions
  - Goals: The end-point of work (may be several)
  - Tasks: Reasoning about combinations of actions
  - Actions: Simple, cognitively singular operations
- Not timing, precedence, order of task performance
- Arbitrary level of elaboration by the analyst
  - Depends on scope of problem
  - Depends on likely value of elaboration
Task Analysis: Plans

► fixed sequence - 1.1 then 1.2 then 1.3
► optional tasks - if the distance is big, do 1.2
► waiting for events - when the prescription is ready, do 1.4
► cycles - do 5.1 then 5.2 while there are still prescriptions to fill
► time-sharing - do 1 and 2 at the same time
► discretionary - do any of 3.1, 3.2 or 3.3 in any order
► mixtures - most plans involve several of the above

Structure in a website

► Long scrollable pages vs. linked shorter pages
► Number of links (clicks) to get to a goal page - major cause of users abandoning a site.

\[
C_{\text{total}} = \left( \sum_{i=1}^{n} n_i \right) + 1
\]

The average number of clicks to get to the target at an unfamiliar site; 
\( n \) = the number of links per page; \( L \) = the number of levels

► Depth and breadth also have effect on time
Lee and MacGregor model (1985); \( ST = \text{search time for self-terminating search (halfway through)} \); depth = \( d \), breadth = \( b \), \( n \) = total options in the whole hierarchy, \( t \) = time to process one option, \( k \) = human response time and \( c \) = computer response time

\[
ST = \frac{(b + 1)t / 2 + k + c}{(ln b) - ln n}
\]

Wireframe

► Presents basic elements of a page and how information flow from page to page

1. Select payment

2. Select payment type

3. Press Y

4. Take ticket (and receipt)

5. Take ticket and receipt

6. Press 'Y'

7. Insert ticket

8. Press 'Y'
Wireframe: e-commerce site

Visual Design Elements
- Clarity
- Consistency
- Alignment
- Text
- Images
- Color

Clarity
- Every element in an interface should have a reason for being there → make it clear, too
- Less is more (economy of visual element)
- Consider overall and local density
  - Overall: how much information is on the screen
  - Local: how tightly packed the information is
- How? White space
  - Leads the eye
  - Provides symmetry and balance through its use
  - Strengthens impact of message
  - Allows eye to rest between elements of activity
  - Used to promote simplicity, elegance, class, refinement

Which is cleaner & clearer? This?

Or this?

Consistency
- Likeness in behavior and appearance between similar tasks/operations/situations/terminology
- Within screen and across screens
- Conceptual consistency is about ensuring the mappings are consistent, that the conceptual model remains clear.
  - Internal: within the system
  - External: in relation to other relevant things
- Physical consistency is ensuring consistent behaviours and consistent use of colours, names, layout and so on.
Consistency: Example

Home page  |  Content page 1  |  Content page 2

www.santafean.com

Alignment

► Cultural influence
  - West: top left, going right, then down
► Allows eye to parse display more easily
► How? Grids
  - (Hidden) horizontal and vertical lines to help place interface elements
  - Align related things
  - Group items logically
  - Aesthetically more pleasing

Grids for user interfaces

► Areas of the screen that automatically add emphasis to any material, graphic, or text placed there
► Tend to minimize whatever is located there
► Ideal for navigational devices such as button bars, pull down menus, or status information

Grids for user interfaces

► Neutral impact on whatever is located there
► Good for summation text or summary graphics
► Minor elements may be overwhelmed
► Tend to add minimal impact to any graphics or text located there

Inverse Pyramid Writing

Most important info
Title
Short Intro
Summaries
Overviews
Teasers

Less important info
Background Information
Supporting Details
Long Quotes

640x480
800x600
1024x768
1280x1024

Outpost.com
IBM
Dell
Web.com

Click Here

6 Things in One: The Right伪装

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Web Screen Grids

1. Inverted 7 Grid
2. L-shaped Grid
3. Double-track Grid
4. Open Grid
5. Invisible Grid
6. Visible Grid
7. Horizontal Grid
8. Vertical Grid

1. L-shaped Grid
- vertical navigation on the left side
- additional navigation on the bottom (less than optimal, don’t use for primary navigation)
- ideal for more text heavy sites

2. Inverted 7 Grid
- horizontal panel dominates the top
- vertical navigation on the left, open to the right (left-hand navigation scheme most dominant, 30% use)
- ideal grid for heavy use of images

3. Double-track Grid
- vertical navigation or secondary info on the left and right
- used for extensive navigation
- crowds the main information in one column

4. Open Grid
- navigation at the top (tab navigation - 30% use, links across top of page 18%)
- no set structure, open page
- cleanest and easiest to use
- used for sites with minimal navigation

5. Invisible Grid
- single-image screen - splash page
- page before the home page
- ideal grid for more artistic sites
- combine with other grid for main page

6. Visible Grid
- a highly visible grid with organized columns
- grid is preserved through every page of the site
- used in e-commerce site to present collections

7. Horizontal Grid
- all elements are aligned left to right and separated with ample white space
- creates a sense of openness from one side to the other
- difficult for large images

8. Vertical Grid
- popular with three-dimensional sites (navigation, advertising, other elements)
- enables clear distinctions in the grid
- not ideal for text-heavy sites, used for short bits of info

Text
- Use appropriate character size (e.g. older persons ≥12pt)
- Poorly defined font type is harder to see
- **BOLD** is more visible but tiring so use with caution
- The best for readability/salience trade-off is the Title Case, not ALL CAPITALS nor all small characters
- Sans Serif (Arial, Tahoma) is easier to read on screen than Serif (Times New Romans, Baskerville)
- **Wide kerning** (horizontal space between letters) is easier to read than **narrow kerning**
- Also take into consideration ‘leading’ (the distance between 2 baselines)
Images
► Images are the most enduring form of written communication, whether phonetic or ideographic.
► Images have been found to be:
  ▪ Recognized faster and more accurately than text
  ▪ Learned faster
  ▪ Demand less from human memory
► To make effective images, we need to:
  ▪ Know how they work
  ▪ Understand how users perceive, recognize, remember, and use

Icons
► Icon: a (simplified) picture on a screen that represents a specific file, directory, window, option, or program.
► Designed with a purpose, functional, and predictable
► From Apple’s website on designing icons:
  ▪ Perspective and shadows are the most important components
  ▪ Use universal imagery that people will easily recognize
  ▪ Simplicity - use a single object that captures the icon’s action, start from basic shapes
  ▪ Use color judiciously
  ▪ Use icon genres to help communicate what users can do with an application before they open it

Icon Recognition
► Users must first recognize what the image is
► Recognition of images is quicker and more reliable if icons are:
  ▪ Specific & concrete
  ▪ Representations of real-world objects
  ▪ Vivid and clearly depicted
  ▪ Conceptually distinct one from another
► But unless very familiar, might be affected by users’ cultural background

Icon Decoding
► The user must learn the icon’s new meaning
  ▪ What the picture represents
  ▪ Sometimes can be ambiguous. Tip: use
    ▪ analogous image to underlying concept
    ▪ a typical example of concept
► Mouse-over is always a good idea

ISO 9186: Testing graphical symbol
► When adapted for icon testing:
  1. Comprehensibility judgment test
     ▪ Give the function and several symbols, one of which has an opposite meaning
     ▪ 1 = Correct understanding is certain (≥80% population)
     ▪ 2 = Correct understanding is very probable (66-80%)
     ▪ 3 = Correct understanding is probable (50-65%)
     ▪ 4 = The meaning understood is opposite of intention
  2. Comprehension test
     ▪ Give one symbol at a time
     ▪ What do you think the symbol mean?

Icon Location
► Users must be able to quickly and accurately locate the icon
► Speed and accurate location of a visual object depends on if:
  ▪ The user has pre-established knowledge of the icon
  ▪ The icon is distinct from all other objects in its shape and color
Icon Activation

► Users must know how to use the icon
  1. How it is activated: by single or double click, only mousing over (annoying), etc → through design
  2. Appearance of activation: color change, becoming non-underlined, application launch, progress indicators, etc.
  3. Activation result: sent to a new page, open a file, open a new window, etc.

**KEY:** Be consistent in icon activation throughout interface (metaphor) and between applications

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Icon Families

► A grouping of similarly-styled icons
► Although each icon in an icon family should be distinct, a consistent style should be present in each
► If you are creating a family or grouping of icons, do not design any icon in isolation

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Designing with Color

► Color is emotional
  - Psychological and cultural
  - Physiological: some colors excite neurons in the brain more than others (red)

► Color is good for segmentation (grouping)
  - Reduce the amount of time to search for information
  - Too many colors can increase search time

► Color is good for drawing attention

► Color should be used as redundant coding
  - 10% of the male population has some form of color deficiency or color confusion

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2.1 Vision: the eyes

► Lens focuses light to the retina
  - Light passes through the lens
  - Focused on the retina
  - Rod cells (periphery)
  - Cone cells (fovea)

► Central 1-2° gives foveal vision
► Remaining 180° gives peripheral vision

► Cone cells
  - Detect color and hi-res images
  - X-ganglia (wires from the cell to the brain) provide early pattern detection.

► Rod cells
  - Good for low levels of luminance
  - Y-ganglia permit early movement detection
  - Sense shades of grey but can’t detect colors.

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How we see the world

► Cone cells detect color (hue, saturation, value) through photo-pigments.
  - mainly reds (64%) & very few blues (4%).
  - Center of retina (high acuity) has no blue.
  - Means disappearance of small blue objects you fixate on.

► Brightness is determined mainly by R+G

► Shapes are detected by finding edges
  - combine brightness & color differences for sharpness
  - harder to deal with blue edges & blue shapes

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Vision: color
Vision: color

► Different wavelengths of light focused at different distances behind eye’s lens
  ▪ need for constant refocusing → fatigue
  ▪ be careful about color combinations
► More saturated colors = more focusing
  ▪ don’t use saturated colors in UIs unless you really need something to stand out (warning)
  ▪ pastel colors are cleaner
► Stereoscopic vision (slightly different image to each eye) gives excellent depth perception
► Color picker: http://www.visibone.com/colorlab/

Designing with color

► http://websitetips.com/colortools/sitepro/
► Use contrast for structure & hierarchy
► Color palettes
  ▪ Monochromatic
  ▪ Complementary
  ▪ Analogous

Color Palette Examples

- Monochromatic - http://www.pbs.org/wgbh/amex/romans/
- Complementary - http://www.pbs.org/animateddogs/
- Analogous - http://www.pbs.org/empires/romans/

Color Meanings: Culturally Specific

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<th>China</th>
<th>Japan</th>
<th>Egypt</th>
<th>France</th>
<th>U.S.A.</th>
</tr>
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<td>Joy</td>
<td>DANGER</td>
<td>Death</td>
<td>Aristocracy</td>
<td>Danger, Stop</td>
</tr>
<tr>
<td>White</td>
<td>Luck</td>
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<td>Peace</td>
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<td>Wealth</td>
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<td>Victory</td>
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<tr>
<td>Green</td>
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<td>Death</td>
<td>Death</td>
<td>Death</td>
<td>Death</td>
<td>Death</td>
</tr>
</tbody>
</table>

More on: http://www.princetonol.com/groups/iad/lessons/middle/color2.htm

Kansei’s colors

► Invented by Nagamachi in Japan in 1970
► KANSEI study seeks the structure of emotions, which exists beneath human behaviors
► Used a lot in customer product (first used in the US by Mazda)
► Not just colors
Searching and Color

- Search for a particular item on a display
- Color generally faster than character (but shapes are fastest)
  - Shapes (60%)
  - Size (40%)
  - Color (40%)
  - Alpha characters (40%) → %, >, <, ?
  - Characters (10%) → vary by character (A is faster)

Find the Red Letter; Find the ‘A’, Find the triangle

Designing with Sounds

Audition (hearing)

- Receiving vibrations and perceiving sounds
  - Outer ear protects inner/middle ear and amplifies sound
  - Middle ear transmits sound waves as vibrations to inner ear
  - Pinna → canal → ear drum → ossicles (amplifier) → cochlea (detection)
- Hearing without awareness
  - cocktail party phenomenon: the effect of not being aware of the content of other people’s conversations until your name is mentioned
  - dichotic listening task: different stimuli delivered to 2 ears via headphones; still aware of ignored signal

Auditory Characteristics

- Pitch
  - 20Hz – 15KHz frequency
  - Human is less accurate in distinguishing high frequencies than low ones
  - Tuned to 3KHz by shape of outer ear
- Timbre
  - ‘signature’ of sound source
  - Complex set of resonance overlaying the fundamental frequency
- Amplitude and loudness
  - Loudness is a psychological property of sound
  - Our ears are capable to cope with 0 to 160db (pain at 130db!)
  - Prolonged exposure above 85 dB can cause hearing damage → noise-induced hearing loss (NIHL)

Auditory characteristics

- Sound filtering
  - Can attend to sounds over background noise
  - Reduces with aging → speech discrimination problem
- Location
  - Horizontal plane
  - Pinnae separation and acoustic delay
Designing with Sounds

► Earcons
  - Synthetic sounds used to convey information
  - Structured combinations of notes (motives) represent actions and objects

► Auditory icons
  - Natural sounds with associated semantics which can be mapped onto similar meanings in the interaction e.g. throwing something away ~ the sound of smashing glass

Haptics (touch)

► Receiving thermomechanical forces and perceiving physical properties of things
► Three kinds of cutaneous receptor (skin)
  - Thermoreceptors (temperature)
  - Mechanoreceptors (pressure)
  - Nocioceptors (pain)
► Kinaesthetic sense - body pose
  - Two kinds of proprioceptor in joints
► Reaction times depend on fitness
  - Practice improves
  - Deteriorate with age

Motor subsystem: Fitts’ Law

► Fitts’ Law predicts that the time to point at an object using a device is a function of the distance from the target object & the object’s size.
► The further away & the smaller the object, the longer the time to click on it.
► Fitts’ Law is useful for designing systems for which the time to click on an object is important

Motor subsystem

Fitts’ Law

\[ MT = a + b \log_2 \left( \frac{2A}{W + c} \right) \]

- \( MT \) is the movement time
- \( a \) and \( b \) are empirically determined constants, that are device dependent.
- \( c \) is a constant of 0, 0.5 or 1
- \( A \) is the distance of movement from start to target centre
- \( W \) is the width of the target, which corresponds to “accuracy”
- It has an assumption that the most time used is for homing (i.e. better to locate objects on the edges of the screen even if it’s further)
- BUT, only accounts for direct line movements

Understanding Humans: Model Human Processor

► Based on years of basic psychology experiments found in the literature
► Models the information processes of a user interacting with a computer
  - the higher level: identified with consciousness and working memory
  - the lower level: processed in parallel with the higher level without conscious effort
  - Skilled performance differs from novice performance
► Enables calculations to be made of how long a user will take to carry out a task
► Focus on a single user interacting with some entity
  - Neglects effect of other people and the environmental support

MHP Diagram
Cognition
► Interacting with technology is mostly cognitive
► We need to take into account cognitive processes involved and cognitive limitations of users
► We can provide knowledge about what users can and cannot be expected to do
► Identify and explain the nature and causes of problems users encounter
► Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive products
► A raft of theories, from fine grained to high level
► Most relevant to HCI are attention, perception and recognition, and memory

Attention
► Sternberg (1999): A means of focusing limited mental resources on the information and cognitive processes that are most salient at a given moment
► Two states:
  • Focused attention: ability to attend to stimulus in presence of distracters
  • Divided attention: ability to attend simultaneously to lots of things
► Driven by meaning (top-down) and by change (bottom-up)
  • Captured by salience and grouping: spatial, intensity, color, size, timbre, pitch, convention
  • Involuntary capture and movement: Perceptual filters “trigger” attention capture (cocktail party effect, buzzing light)

Designing for Attention
► Design to assist attentional focus in the right place and at the right time
► Help user to.
  • attend their task not the interface.
  • decide what to focus on, based on their tasks, interest, etc.
  • to stay focused, do not provide unnecessary distractions → clippy, anybody?
  • structure their task.
► Use alerts (only) when appropriate!
► Avoid using too many changes/functions just because the system allows it

Designing for attention
► Make things salient: use colour, larger font, white space, underlining, animation, noises
► Presenting information that is relevant to goal (google’s advertisement)

Sensation and Perception
► Sensation = sensing our environment through touch, taste, sight, sound, and smell
► Perception = the way we interpret these sensations and therefore make sense of everything around us

Perception: “knowing”
► Gestalt psychology
  • Perceptions are formed by grouping of stimuli based on prior knowledge
► Object constancy
  • When landing, you just “know” that the houses are real
► Depth perception
  • Motion parallax, interposition, perspective
Gestalt Psychology – Law of Perceptual Organization

1) Proximity (grouping)
2) Similarity (color/shape)
3) Closure

But Gestalt perception is also affected by:
- Stimulus factors: color and contrast, size, intensity, position, distance
- Individual response factors: interest, involvement, needs, values
- Affect “perceptual judgement”

Sensory buffers/memory
- Very brief, but accurate representation of what was perceived
  - Details decay quickly (70 - 1000 ms visual; 0.9 - 3.5 s auditory)
  - Limited capacity (7 - 17 letters visual; 4 - 6 auditory)

Short-term memory
- Limited capacity
  - 7 ± 2 chunks (Miller) – often misinterpreted
  - A chunk is a meaningful grouping of information – allows assistance from LTM (individual differences)
- Early and late best
- Applies to ‘raw’ content (strategies & meaning affect memory)
- Can you memorize these?
  - HEC ATR ANU PTH ETR EET
  - 746335892147530
- Easier when grouped
  - THE CAT RAN UP THE TREE
  - 746 335 892 147 530

Long-term memory
- The sum of all we know
  - Slow access (100ms to days) – tip-of-the-tongue
  - Limitless capacity, stable content
- Semantic memory: Memory for meaning
  - Facts and skills
  - Relationships between things
- Built up by association → Hebbian learning
  - Experience and exposure
  - Intermittent exposure best
  - More associations the better for recall
### Long-term memory

- **Link strength**
  - Affects ease of access
  - Function of usage frequency

### Episodic memory: story memory
- Reconstruction rather than replay
- Built on ‘key events’
- Filling in the gaps
- Scripts and frames for concepts
  - Typical sequences of events
  - Part of semantic memory, used by episodic memory
- Forgetting: Destruction or inaccessibility?
  - Both e.g. concussion and stroke damage
  - Interference: referential confusion
  - Lack of use: connection partly overwritten

### Designing for Memory

- **Recall**
  - Info reproduced from memory
- **Recognition**
  - Presentation of info provides knowledge that info has been seen before
  - Easier because of cues to retrieval
- **Recognition is easier than recall**

### Perceptual Processor: 100ms/cycle

- Light blinks appearing within 100ms
  - Look like a single brighter light
- Light blinks in two locations within 100ms
  - Look like motion of a single light
- Auditory clicks occurring within 100ms
  - Sound like one louder tone
- Multiple taps occurring within 100ms
  - Feel like one tap of greater pressure
- SRT (press space bar when anything flashes on the screen)
  - 1 perceptual cycle + 1 cognitive cycle + 1 motor cycle = 100ms + 70ms + 70ms = 240ms

### A raft of cognitive models

- **KLM (Keystroke Level Model)**: Assumes that routine cognitive skills can be decomposed into a serial sequence of basic cognitive operations and motor activities, which are:
  - **K**: A keystroke (280 ms)
  - **M**: A single mental operator (1350 ms)
  - **P**: Pointing to a target on a small display (1100 ms)
  - **H**: Moving hands from the keyboard to a mouse (400 ms)
- **GOMS (Goal Operator Method Selection Rules)**
  - **Goals**: What the user wants to do.
  - **Operators**: Specific steps a user is able to take and assigned a specific execution time.
  - **Methods**: Well-learned sequences of subgoals and operators that can accomplish a goal.
  - **Selection Rules**: Guidelines for deciding between multiple methods.
Designing for reasoning

► Affordance: the properties that things (are perceived to) have and how these relate to how the things could be used

► Metaphor: describing a first object as being or equal to a second object in some way

► Mapping: the set of possible relations between objects ➔ spatial & semantic

Let’s check this metaphor

Mathematics Education on the Web: MEOW

Mental model

► A person’s understanding of the world
  ▪ Partial, informal, unstable

► Properties, interactions, forces, effects
  ▪ E.g. cooking with a gas oven, way a can opener works

► Forged by experience
  ▪ Trial and error
  ▪ Consistent with model ➔ believe in model

► Deep versus shallow models (e.g. how to drive a car and how it works)

Case 1: You arrive home hungry, frozen pizza instruction says heat in 350F oven. Set oven to max to speed up?
Case 2: In desperate need hot shower, open tap to the max to speed up hot water?
User’s Mental model
► Execution-Evaluation (Norman) Cycle

Establishing goal
Specifying action sequence
Executing action
Forming intention
Perceiving system state
Interpreting system state
Evaluating system state wrt goals and intentions

http://www.youtube.com/watch?v=l8IsTYRBkr4

Designing for mental model
► People have preconceived models that you may not be able to change – so adapt
  ▪ Disconnecting = pulling the wire out, not eject
► Interface must communicate model
  ▪ Help/documentation to communicate your model
  ▪ Visibility – don’t let users guess
  ▪ Constraint – restrict what is irrelevant

Error
► Mistakes
  ▪ Wrong intention caused by “wrong” model
► Action slips
  ▪ Right intention but failed to do it right
► We should design to minimize error
► Error messages are a big thing!

Design Theories, Principles, Guidelines
► Theories – high level (includes models)
  ▪ Describe systems, objects, actions with consistent terminology for teaching, education, and communication
  ▪ Help predict or explain performance and behavior
► Principles – mid-level
  ▪ Useful for analyzing and comparing competing designs
► Guidelines – specific and practical
  ▪ Cures for design problems
  ▪ Cautions for potential danger
  ▪ Reminders based on experience
► Why use them?
  ▪ Make efficient, proven decisions
  ▪ Not to repeat mistakes of the past

Design Theories and Guidelines
► Theories – high level (include models)
  ▪ Descriptive and explanatory
  ▪ Describe and explain why certain actions or phenomena happen
  ▪ Predictive
  ▪ Predict human performance, satisfaction etc by interpolating previous knowledge
  ▪ Ex: Model Human Processor, Fitts’ Law
► Guidelines – examples
  ▪ Ensure that embedded links are descriptive
  ▪ Use unique and descriptive headings
  ▪ Use radio buttons for binary choices
  ▪ Use thumbnail images to preview larger images

Design Principles
► Rules of thumb to help with the design process
► There are many of them, borrowed from computer graphics, software engineering, HCI
► No “cookbooks”, no universal checklists
► Become obvious to user of poorly-designed UIs
► Are easy to ignore
► Apply at multiple levels of design
► Are neither complete nor orthogonal
  ▪ Can all be “broken”, often to satisfy another rule
► Have underpinnings in psychology or experience or common sense

Mac OS X
Usability Principles from Dix et al.

► Learnability: Ease with which new users can begin effective interaction and achieve maximal performance
  ▪ Predictability, Synthesizability, Familiarity, Generalizability, Consistency
► Flexibility: Support for multiple ways of doing tasks
  ▪ Dialog Initiative, Multithreading, Task migratability, Substitutivity, Customizability
► Robustness: Supporting user in determining successful achievement and assessment of goals
  ▪ Observability, Error Prevention, Recoverability, Responsiveness, Task Conformance

Usability principles: Learnability

► Predictability: can users predict what happens if they perform an action?
► Synthesizability: can users know what had happened looking at the current state of the system?
► Generalizability: can users generalize their knowledge from one system to another?
► Familiarity: does the system employ familiar representation of information?
► Consistency: does the system maintain consistent representation of similar concepts?

Usability principles: Flexibility

► Dialogue initiative
  ▪ System pre-emptive: system prompts, user responds
  ▪ User pre-emptive: user-initiated dialogue
► Multi-threading
  ▪ Concurrent: Input goes to multiple tasks simultaneously
  ▪ Interleaved: Many tasks, but input goes to one at a time
► Task migratability
  ▪ Ability to move performance of task to the entity (user or system) that can do it better
► Substitutivity for Input and Output
► Customizability
  ▪ Adaptability: Ability for users to adapt the interface
  ▪ Adaptivity: Ability for system to adapt the interface (based on user/task model)

Usability principles: Robustness

► Observability: can user know what’s happening with the system?
  ▪ Browsability: ability to monitor without changing state → mouse-over reveals what’s waiting
  ▪ Persistence: duration of observable state
  ▪ Feedback: an important element to support observability (let users know what to expect)
► Recoveryability from task prosecution
  ▪ Backward and forward error recovery (undo and redo)
  ▪ Abort operation underway (only if it’s slower than cognitive processing)
  ▪ What to do if action cannot be undone?

Usability principles: Robustness

► Responsiveness: user’s perception of what’s acceptable speed
  ▪ Depends on the task demand (ATC vs. ship navigation)
  ▪ Depends on the nature of the operation (games vs. OS installation)
  ▪ Depends on the MHP elements that are involved (drag-and-drop vs. observing google’s search results)
  ▪ Consistency is important (users remember the bad experience)
► Task conformance: Does system support all tasks user wishes to perform in expected ways?
  ▪ Task completeness: Can system do all tasks of interest?
  ▪ Task adequacy: Can user understand how to do tasks?
  ▪ Extensibility: Does it allow user to define new tasks?

User Interface Design Principles*

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User familiarity</td>
<td>Use terms and concepts familiar to the user as it helps reasoning.</td>
</tr>
<tr>
<td>Consistency</td>
<td>Comparable operations should be activated in the same way. Commands and menus should have the same format, etc.</td>
</tr>
<tr>
<td>Minimal surprise</td>
<td>If a command operates in a known way, the user should be able to predict the operation of comparable commands.</td>
</tr>
<tr>
<td>Feedback</td>
<td>Update users on what’s going on, maintain two-way communication.</td>
</tr>
</tbody>
</table>

* From software engineering
### User Interface Design Principles

<table>
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<tbody>
<tr>
<td>Memory load</td>
<td>Reduce the amount of information that must be remembered between actions.</td>
</tr>
<tr>
<td></td>
<td><strong>Minimize</strong> the memory load.</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Seek efficiency in dialogue, motion and thought. <strong>Minimize keystrokes and</strong></td>
</tr>
<tr>
<td></td>
<td><strong>movements.</strong></td>
</tr>
<tr>
<td>Recoverability</td>
<td>Allow users to <strong>recover from their errors</strong>. Include undo facilities, <strong>con</strong></td>
</tr>
<tr>
<td></td>
<td><strong>firmation of destructive actions, 'soft' deletes, etc.</strong></td>
</tr>
<tr>
<td>User guidance</td>
<td>Incorporate some form of <strong>context-sensitive user guidance</strong> and assistance.</td>
</tr>
</tbody>
</table>

### Principles of Good HCI Design*

<table>
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<tbody>
<tr>
<td>Learnability</td>
<td>Visibility, consistency, familiarity, affordance (heard those before)</td>
</tr>
<tr>
<td>Ease of use</td>
<td>Navigation, control, feedback (heard those before). Navigation = providing support for users to move around the system.</td>
</tr>
<tr>
<td>Safety</td>
<td>Recovery from error, constraint (heard those before)</td>
</tr>
<tr>
<td>Accommodation</td>
<td>Flexibility, style (aesthetic design), conviviality (polite, friendly, and pleasant)</td>
</tr>
</tbody>
</table>

* Benyon et al., Designing Interactive Systems