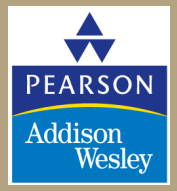
Chapter 6:
Design Principles

The Resonant Interface
HCI Foundations for Interaction Design
First Edition

by Steven Heim



Chapter 6 Design Principles

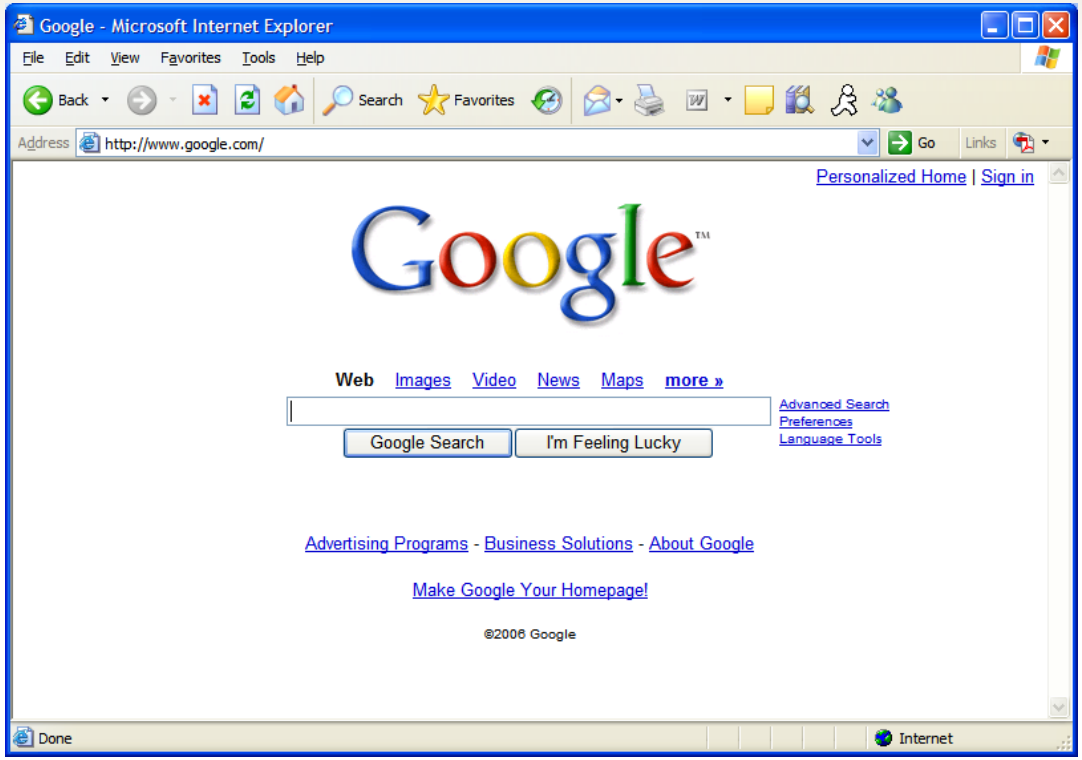
- Principles of Interaction Design
- Comprehensibility
- Learnability
- Effectiveness/Usefulness
- Efficiency/Usability
- Grouping
- Stimulus Intensity
- Proportion
- Screen Complexity
- Resolution/Closure
- Usability Goals

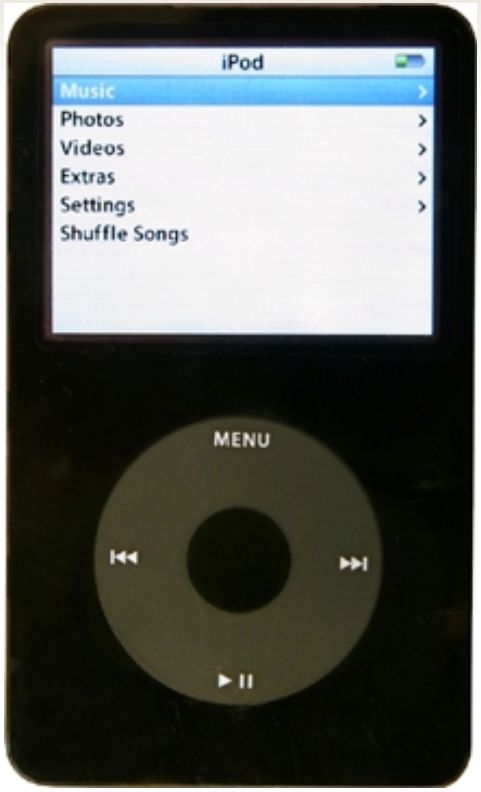
Principles of Interaction Design

- *How do we create elegant solutions to complex interaction problems?*

- *How do interaction designers succeed at creating great designs that are powerful and aesthetically appealing?*

Principles of Interaction Design





Principles of Interaction Design

Maxim

Design principles can be used to guide design decisions

- Design principles do not prescribe specific outcomes; they function within the context of a particular design project.

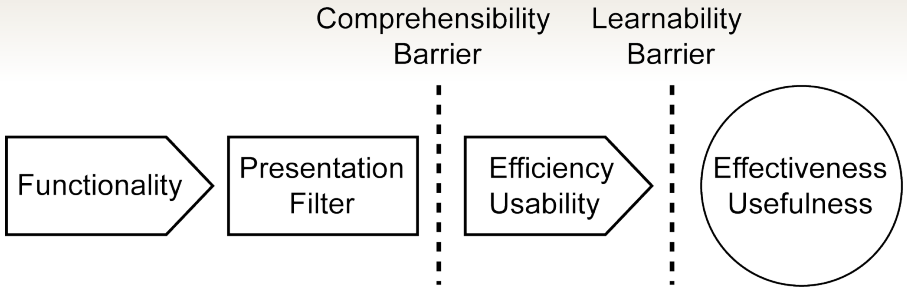
- Design principles guide interaction designers and help them make decisions that are based on established criteria

Framework for Design Principles

The framework has the following components:

- **Usability Goals**
  - There are two main usability goals in the framework; comprehensibility and learnability.
- **Design Principle Categories**
  - The framework also divides the design principles into two main groups; efficiency principles and effectiveness principles.
- **Format to Describe Design Principles**
  - The framework uses the format "serves the principle of … which promotes …" to describe the different principles.
  - *Familiarity* serves the principle of *memorability*, which promotes *usability*.

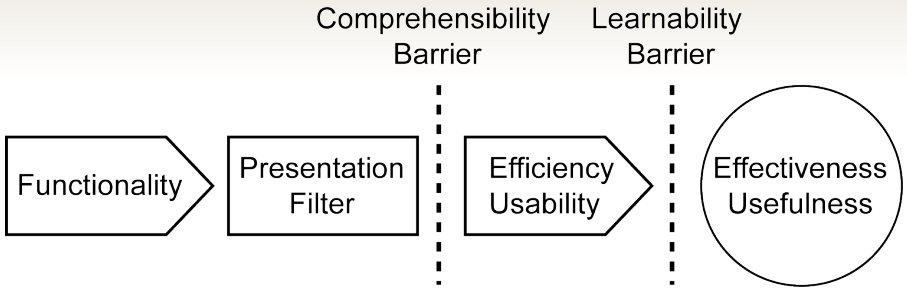
Framework for Design Principles



Functionality - The system must have adequate functionality for a particular task.

Presentation Filter - The functionality must be made accessible through the presentation filter (interface).

Framework for Design Principles



Comprehensibility Barrier - If the presentation is comprehensible, the comprehensibility barrier will be superseded. This depends on the degree of efficiency/usability in the interface design.

Learnability Barrier – If the interface is comprehensible it will be learnable, there is a direct relationship.

Effectiveness/Usefulness - If the user can learn the interface he can take advantage of the functionality and the interface will, therefore, be useful.

Comprehensibilty

MAXIM

An interface design that is easy to comprehend will be efficient and effective

- If a user does not understand the interface it will be useless

- A design's comprehensibility is highly dependent on the way in which the interface communicates its functionality to the user

Learnabilty

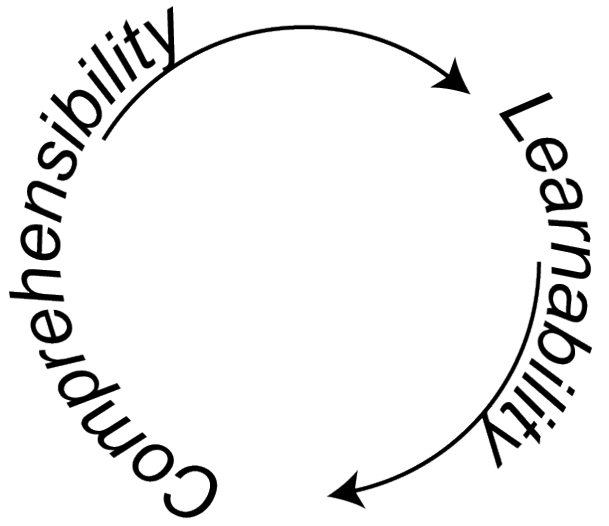
MAXIM

An interface with high usability will be easier to learn

- The learnability of a design is based on comprehensibility: if you can't understand it, you can't learn it

Comprehensibility Learnabilty

- Learnability and comprehensibility are recursive: we start with comprehensibility which affects learnability, which will in turn increase comprehensibility.



Comprehensibility/Learnability Feedback Loop

Principles of Interaction Design

- Effectiveness/Usefulness
  - Utility
  - Safety
  - Flexibility
  - Stability
- Efficiency/Usability
  - Simplicity
  - Memorability
  - Predictability
  - Visibility

Design Principle Categories

- **Effectiveness/Usefulness**

Effectiveness describes the usefulness of a design

- The effectiveness goal stipulates that a design must fulfill the user's needs by affording the required functionality

Effectiveness/Usefulness

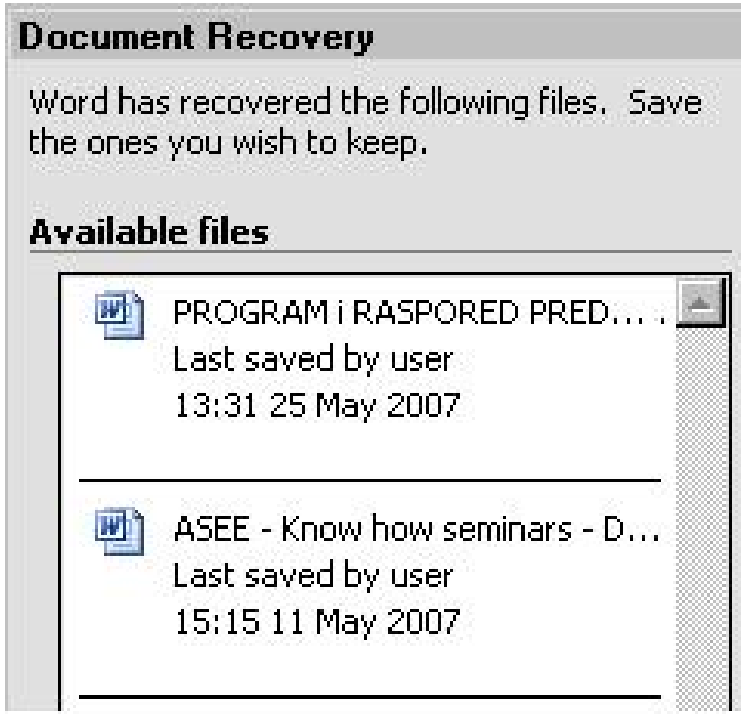
- **Utility** - The principle of utility relates to what the user can do with the system
  - In other words: To what degree does this actually help the user? How much functionality does it provide?

- **Safety** - If a design has a high degree of safety, it will prove more useful than a design that involves a high degree of risk. (crashing, precariously placed buttons)
  - For example, if a delete button was located in immediate proximity to a save button
  - **Recovery -** can be implemented in interaction designs by incorporating appropriate undo functionality and robust error recovery routines.

A computer shall not harm your work or, through inaction, allow your work to come to harm.
(Raskin, 2000)

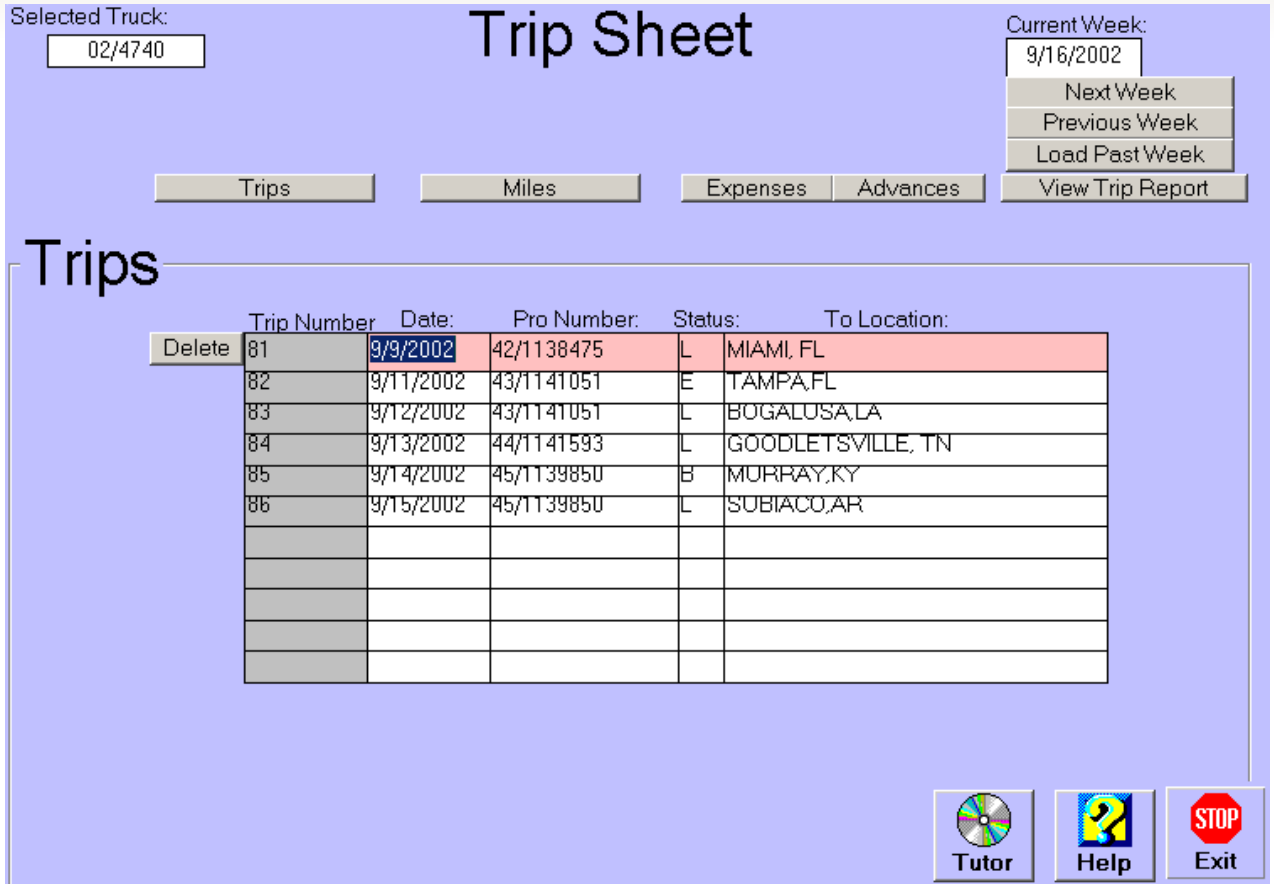
Effectiveness/Usefulness

- **Safety Example**
  - **Document Recovery in Word 2003**



Effectiveness/Usefulness

- **Safety Example (continued)**
  - **Poor Button placement**

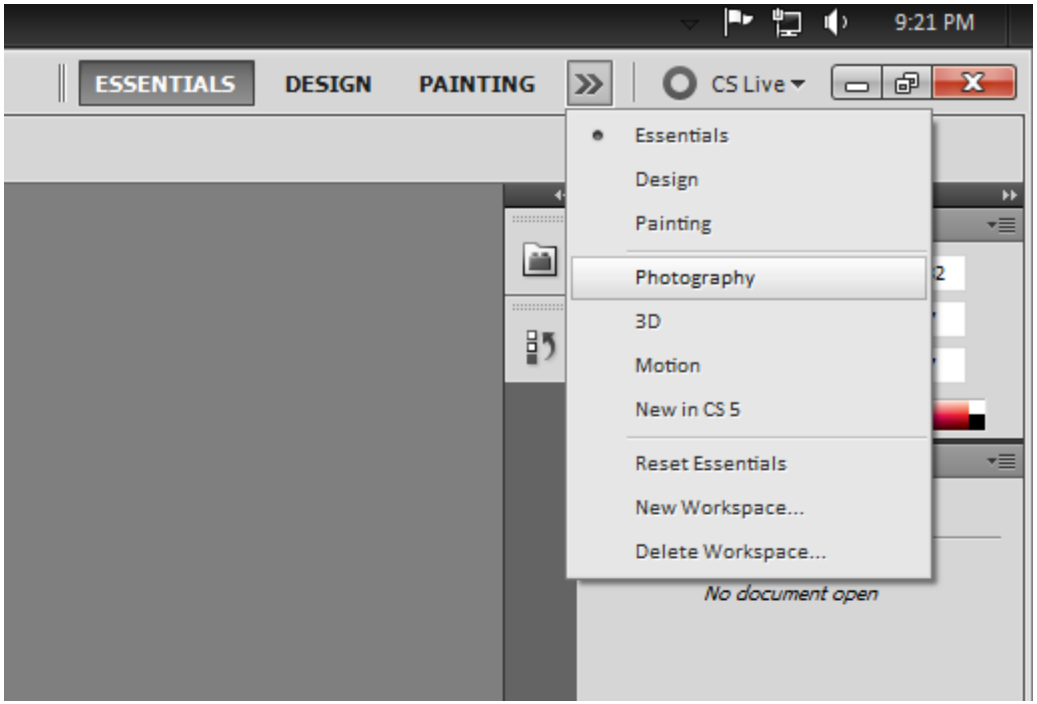


Effectiveness/Usefulness

- **Flexibility** - A tool that is flexible can be used in multiple environments and may address diverse needs
  - **Customization** - A tool would have greater flexibility if people were able to customize the interface according to their personal preferences
  - **Example:** Adobe Photoshop, used for all kinds of projects, and allows a wide range of customizations to make it as suited to the user as possible.
- **Stability** - A stable system is a robust system.
  - A system that functions consistently well will be more useful than a system that crashes frequently

Effectiveness/Usefulness

- **Flexibility Example**
  - Workspace features in Adobe Photoshop CS5



Efficiency/Usability

Efficiency describes the usability of a design

- The efficiency goal stipulates that a design should enable a user to accomplish tasks in the easiest and quickest way possible without having to do overly complex or extraneous procedures.

- **In other words, given its functionality, how easy/quick is it to do what you want it to do?**

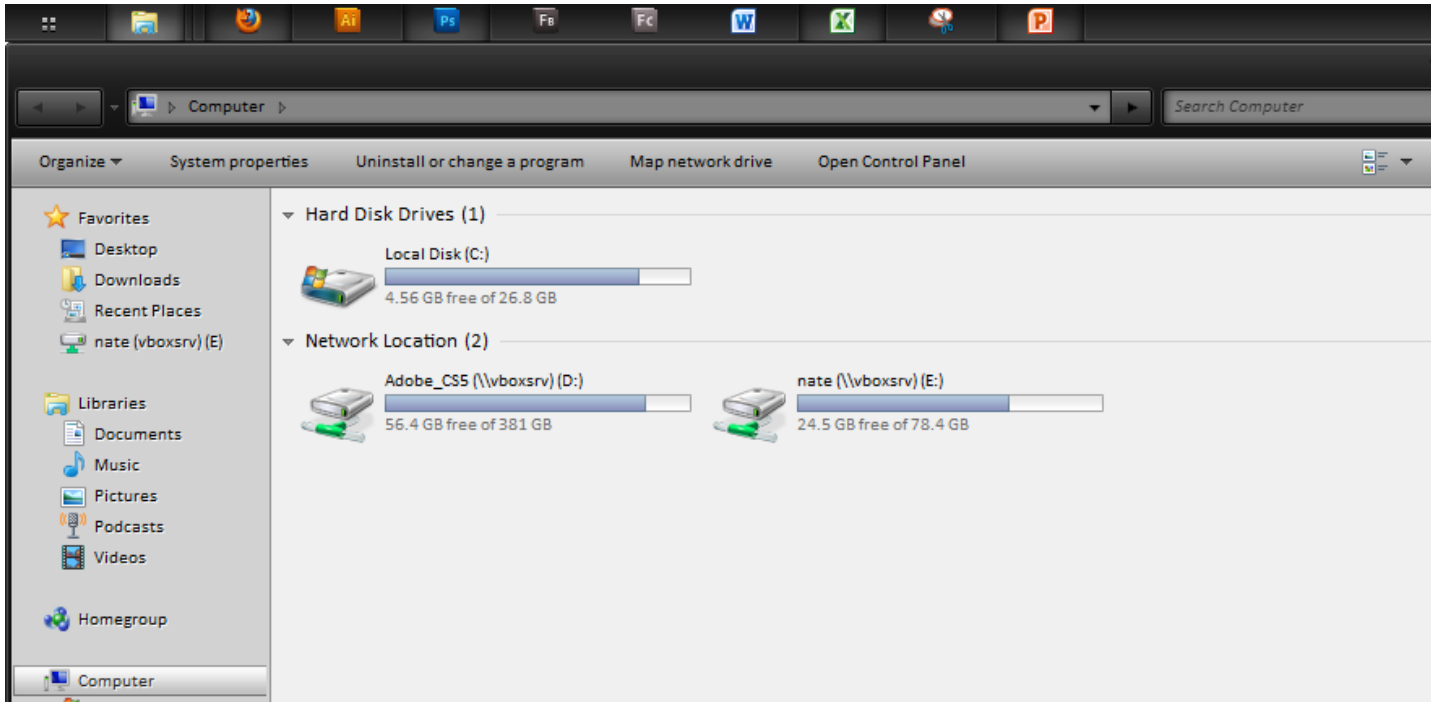
A computer shall not waste your time or require you to do more work than is strictly necessary. *(Raskin, 2000)*

Efficiency/Usability

- **Simplicity** - If things are simple they will be easy to understand and, therefore, easy to learn and remember.
  - **80/20 Rule** - The 80/20 rule implies that 80% of an application's usage involves 20% of its functionality
  - **Satisficing -** Combines the conflicting needs of finding the optimal solution that satisfies all the requirements and the need to settle on a solution that will be sufficient to proceed with the design
    - Finding the best solution that is reasonably attainable

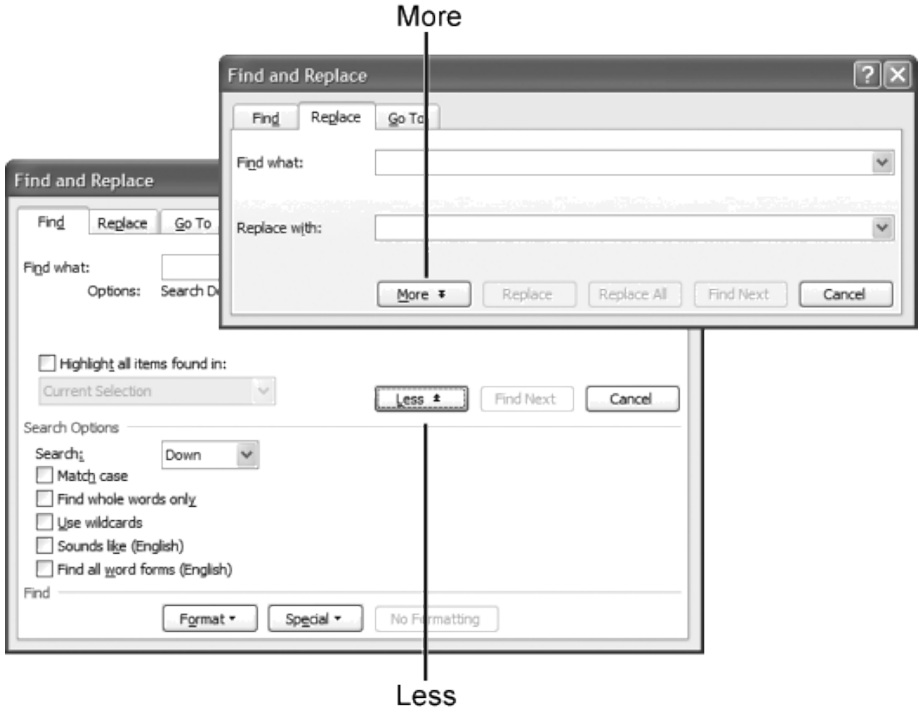
Efficiency/Usability

- **80/20 Rule Example**
  - **Windows 7**
  - **Most operations are moving files, navigating folders, starting, closing, and switching between various programs**



Efficiency/Usability

- **Simplicity**
  - **Progressive Disclosure -** Show the user only what is necessary
    - Microsoft Word 2003 Find and Replace

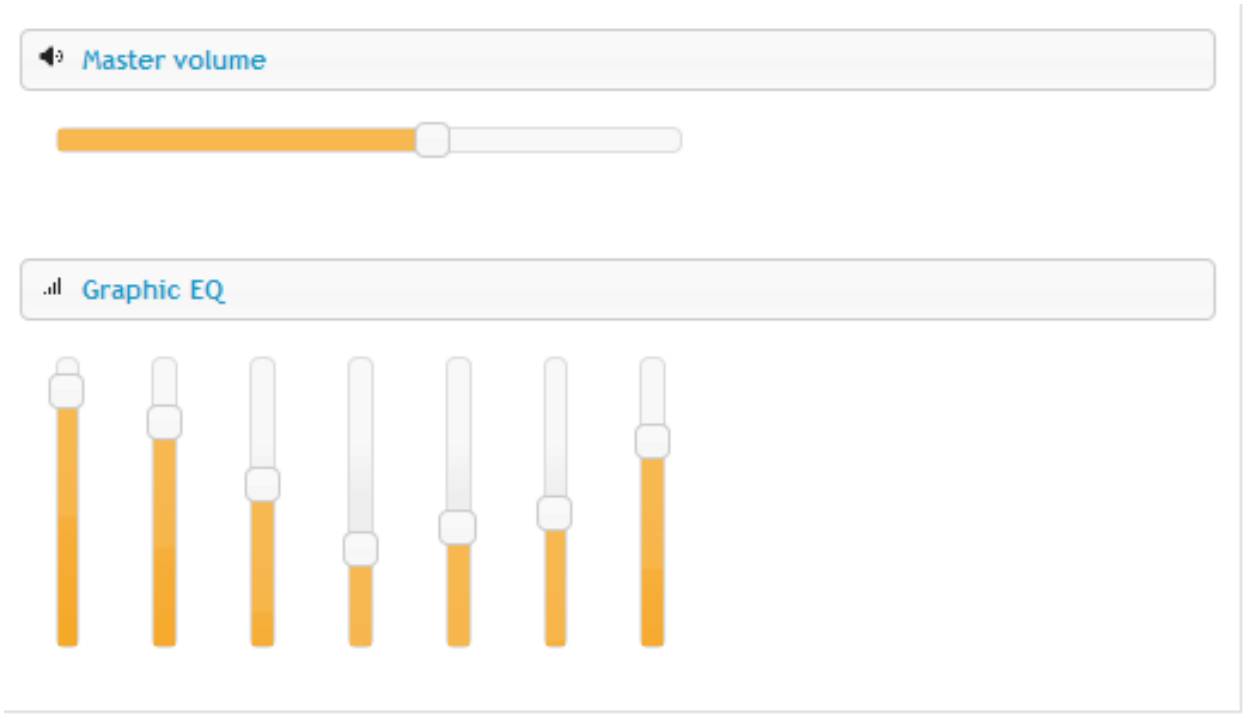


Efficiency/Usability

- **Simplicity (continued)**
  - **Constraints -** Involves limiting the actions that can be performed in a particular design
    - Controls the design's simplicity
- **Physical Constraints**
  - **Paths** - constrain movement to a designated location and direction
    - Scrollbars, Sliders
  - **Axes** - constrain the user's movement to rotation around an axis
    - Trackball
  - **Barriers** -provide spatial constraints that can confine the user's movement to the appropriate areas of the interface
    - The bounds of the computer screen

Efficiency/Usability

- **Constraints Example**
  - A graphic equalizer built with jQuery UI

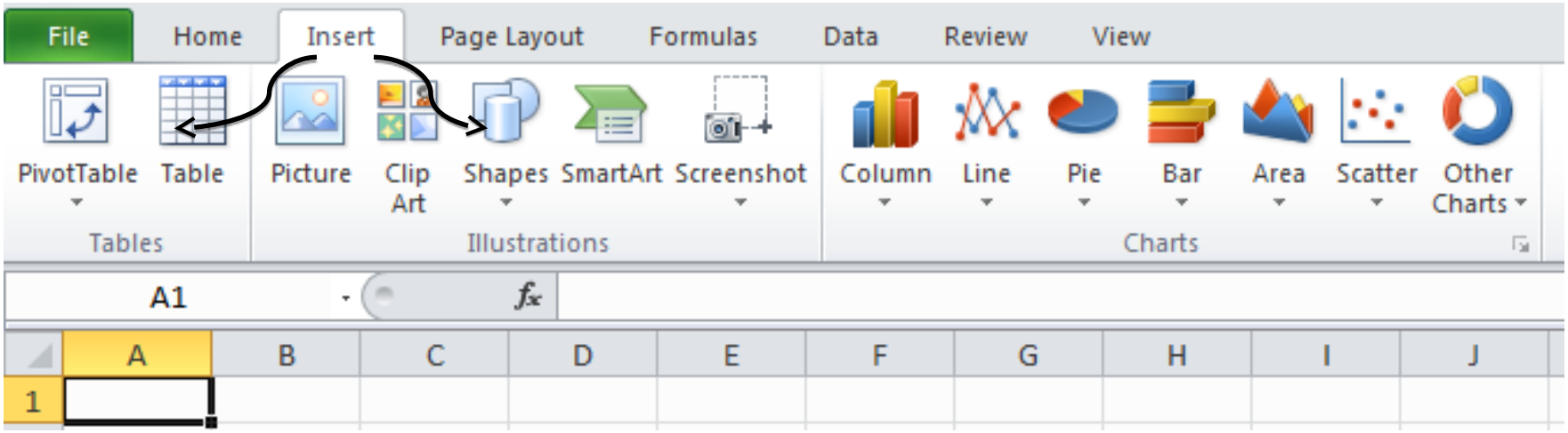


Efficiency/Usability

- **Simplicity (continued)**
- Psychological Constraints
  - **Conventions** - exploit learned behavior to influence a user's actions
    - File Menu, Edit menu
  - **Mapping** - can influence the way in which people perceive relationships between controls and effects
    - Ribbon bar in Microsoft Office 2007+
  - **Symbols** - can influence the way in which we interact with an interface by defining meaning and constraining our possible interpretations of interface elements
    - Shopping cart icon

Efficiency/Usability

- **Mapping Example**
  - **Microsoft Word 2010 Ribbon Interface**



Efficiency/Usability

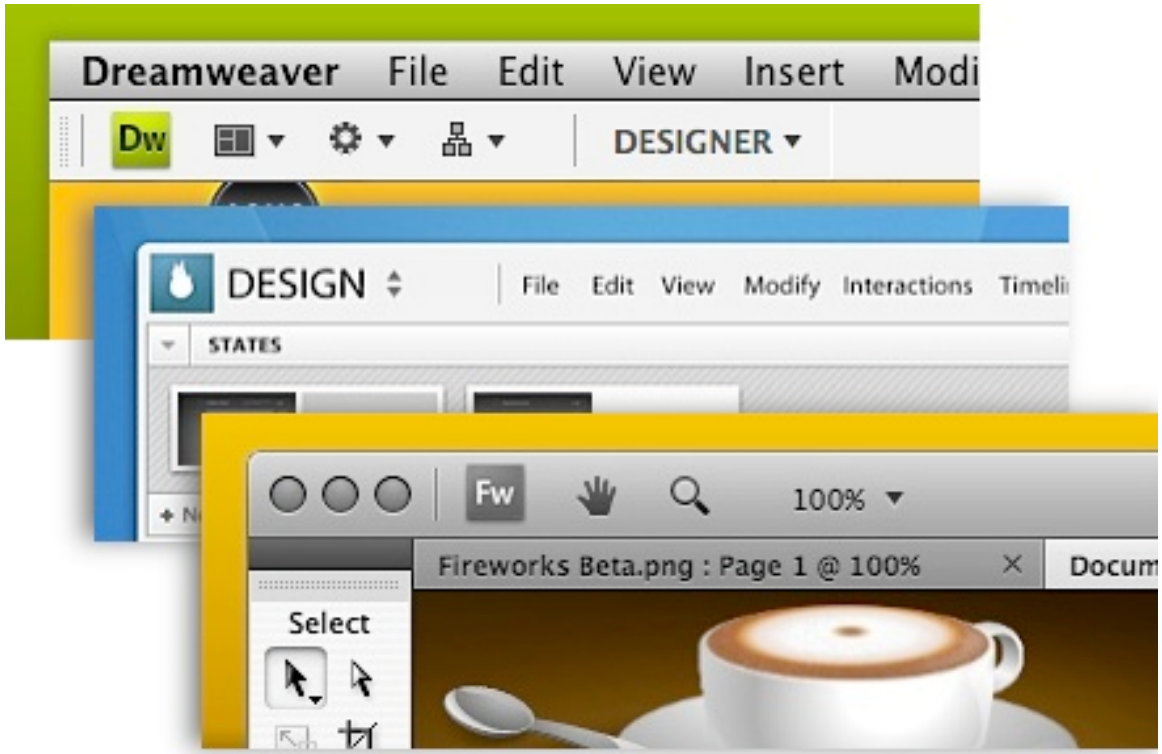
- **Memorability** - Interfaces that have high memorability will be easier to learn and use
  - Many different parameters affect memorability:
    - Location
      - Where you're used to seeing certain things
    - Logical Grouping
      - Similar things grouped together
    - Conventions
      - Things you're used to that are accepted
    - Redundancy
      - Similar user interface elements even though tasks might be different

Efficiency/Usability

- **Predictability** - Predictability involves a person's expectations and his ability to determine the results of his actions ahead of time.
  - When you click a **B** on a toolbar in a text editor, you expect the text to become bold
- Consistency-Correctness
  - Consistency reinforces our associations and, therefore, increases our ability to remember and predict outcomes and processes.
  - Before we strive to be consistent, we must make sure we are correct
    - Don't decide to make the B button do something else

Efficiency/Usability

- **UI Consistency Failure**
  - **Adobe CS4 (Dreamweaver, InDesign,Fireworks) on OSX**

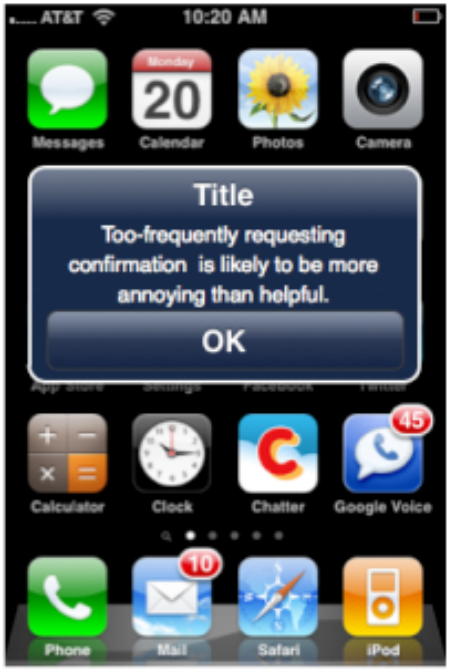


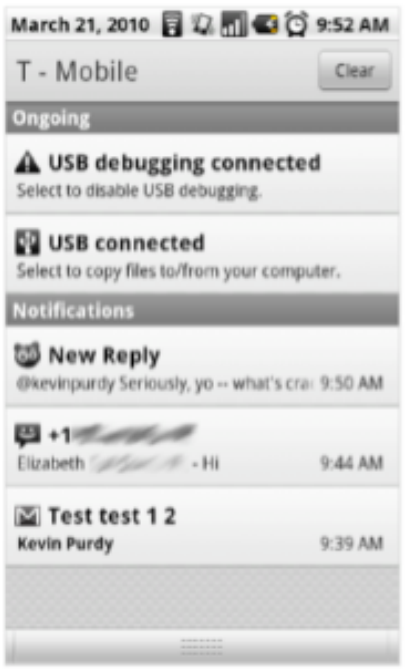
Efficiency/Usability

- **Predictability (continued)**
  - **Conventions:** allow us to use our intuitions
    - If you see a floppy icon, you usually assume its to save whatever you're working on
  - **Familiarity:** familiar menu names and options help users locate objects and functions more easily
    - File/Edit menu's, address bar in a browser
  - **Location, Location, Location:** Not all areas on the screen are created equal
    - Top of screen usually reserved for menu's and functions

Efficiency/Usability

- **UI Convention Example**
  - Notifications in iOS and Android





Efficiency/Usability

- **Predictability (continued)**
  - **Modes:** Modes create instability in mental models because they change the way objects function
    - The shift button on a keyboard changes the input mode
    - Text mode in Photoshop
    - Equation editor mode in Word

Efficiency/Usability

- **Visibility** - The principle of visibility involves making the user aware of the system's components and processes, including all possible functionality and feedback from user actions.

Show everything at once, and the result is chaos.

Don't show everything, and then stuff gets lost.

(Norman, 1998, 74)

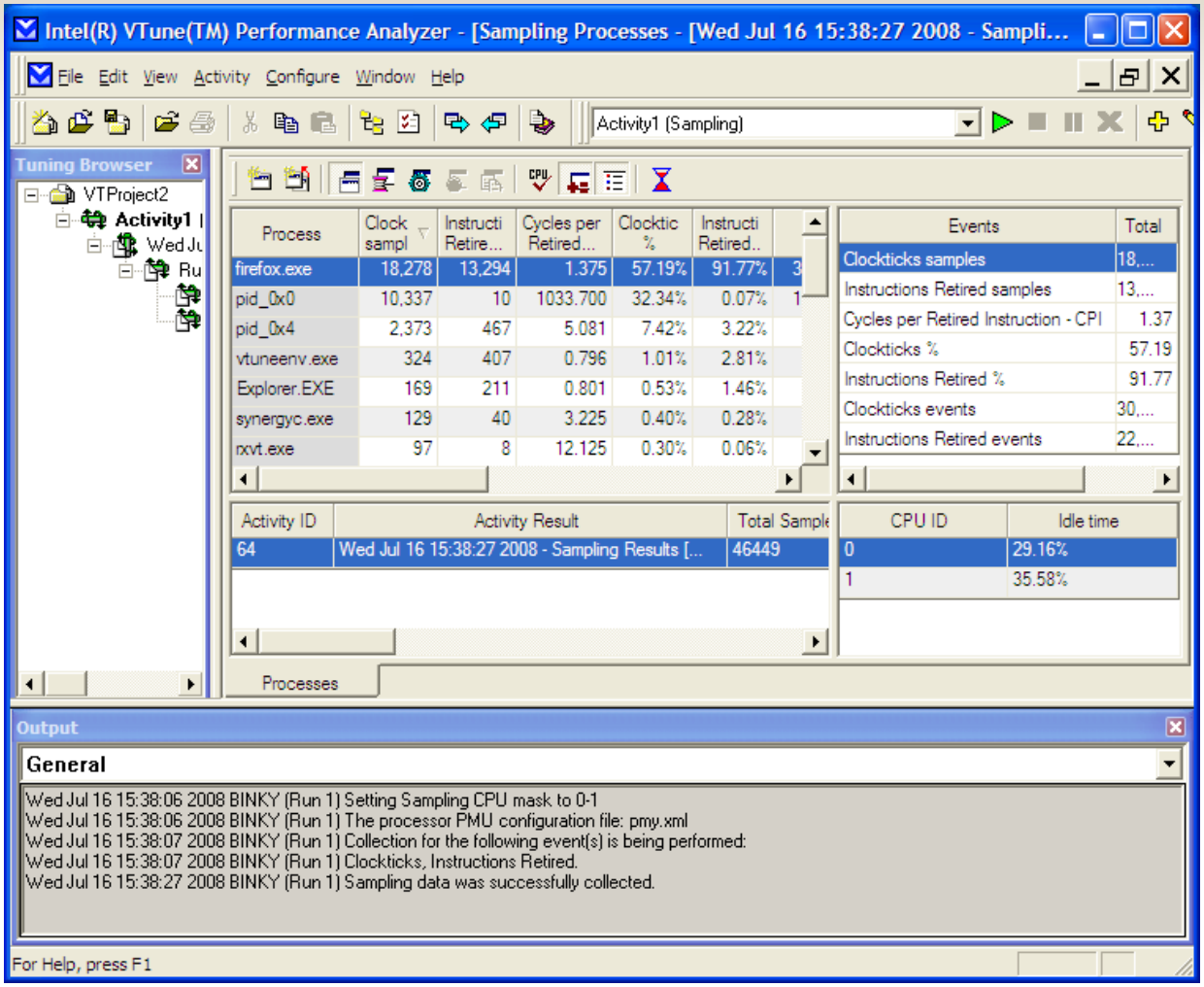
Efficiency/Usability

The principles of **progressive disclosure** and **simplicity** should be used in conjunction with the principle of visibility to avoid overload

- **Overload:** Following the principle of visibility without also applying progressive disclosure can lead to visual overload
  - Imagine if all of Words functionality were on the first ribbon
- **Feedback:** Direct Manipulation interfaces provide immediate visual feedback about user actions. It is the task of the interaction designer to decide what form that feedback takes
  - Clicking a button usually simulates pushing a button in real life, letting the user know the application has acknowledged their selection

Efficiency/Usability

- **Overload Example**



Efficiency/Usability

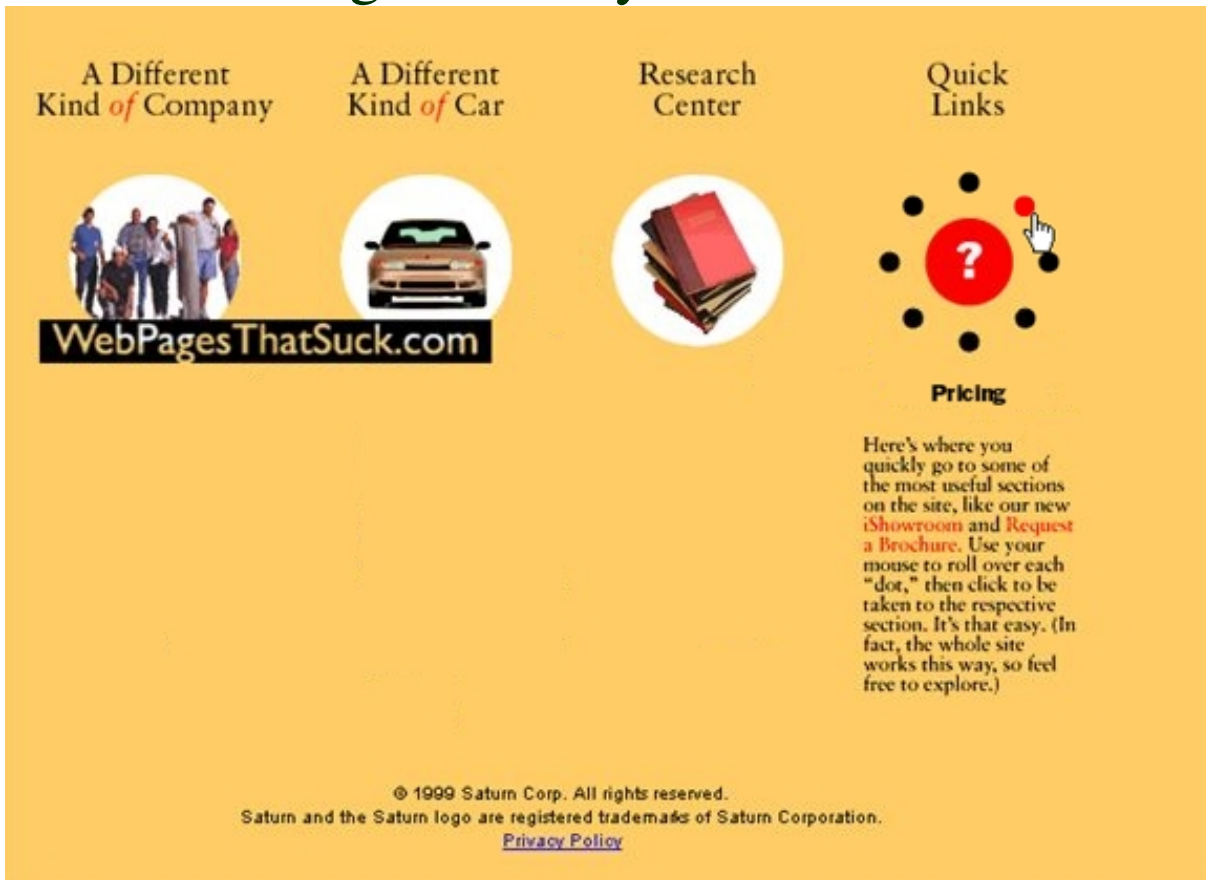
- **Feedback Example**
  - Button feedback for normal, hover and clicked states

Efficiency/Usability

- **Visibility (continued)**
  - **Recognition/Recall:** The principle of visibility is based on the fact that we are better at recognition than we are at recall
    - Recognizing is better than remembering
  - **Orientation:** People need to be able to orient themselves, especially in complex information spaces
    - Title bars and headers in a web page

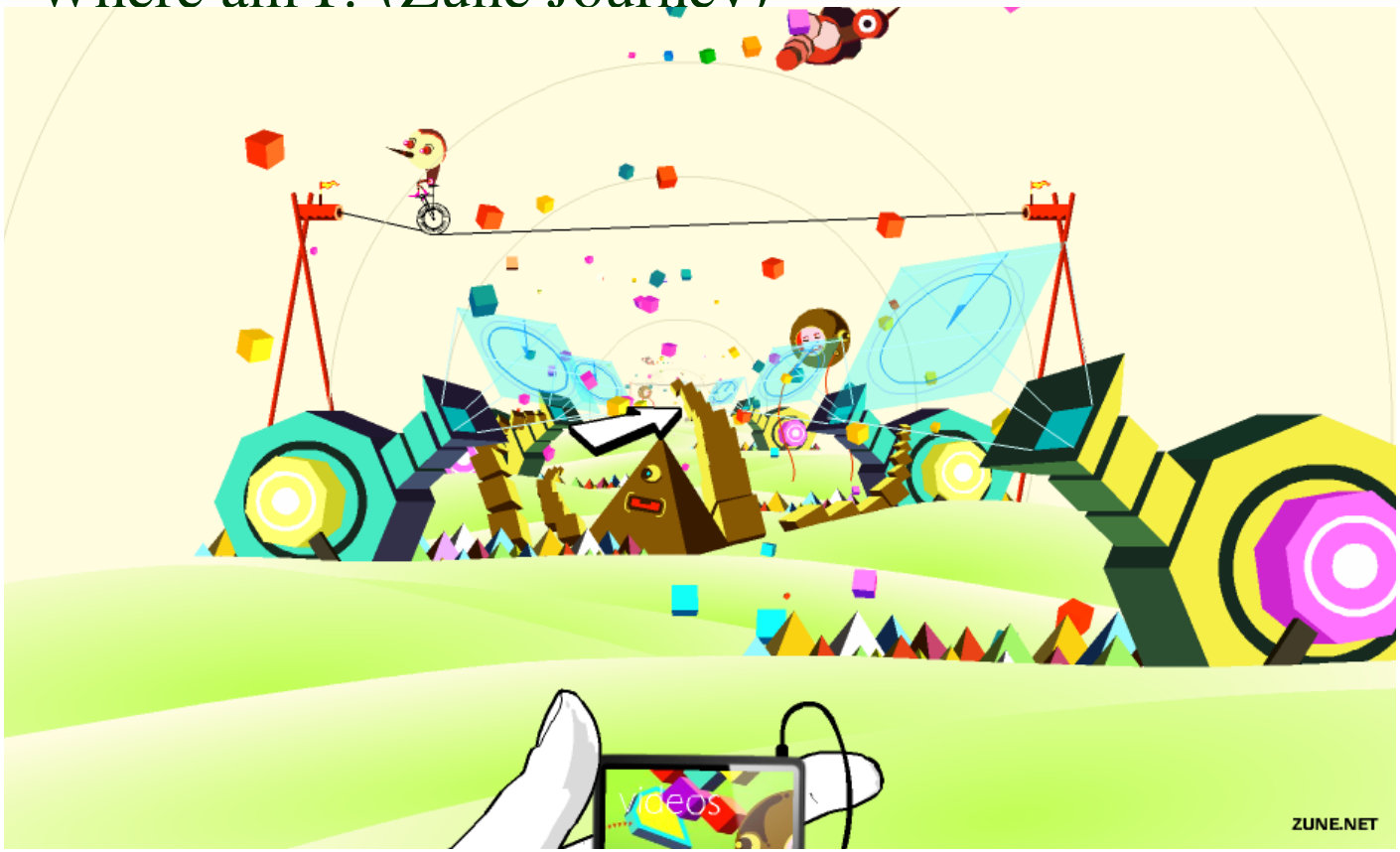
Efficiency/Usability

- **Recognition / Recall Failure**
  - Bad website design courtesy of Saturn



Efficiency/Usability

- **Orientation Failure**
  - Where am I? (Zune Journey)



Grouping

Gestalt Principles of Perception

:-)

Grouping

- **Low-level principles** - used to make decisions about specific screen controls, menus and layouts

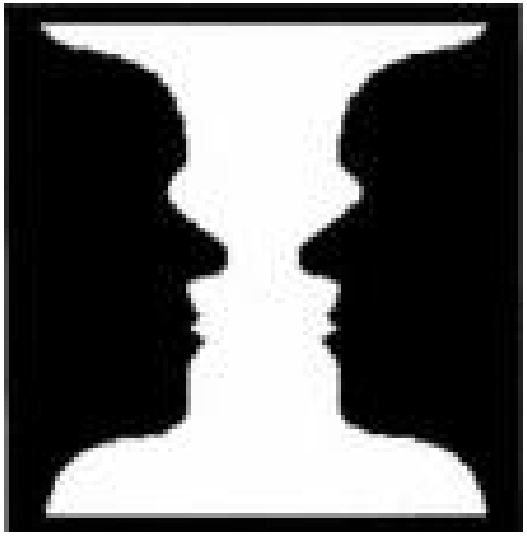
MAXIM

Use visual cues to support the logical structure of the interface

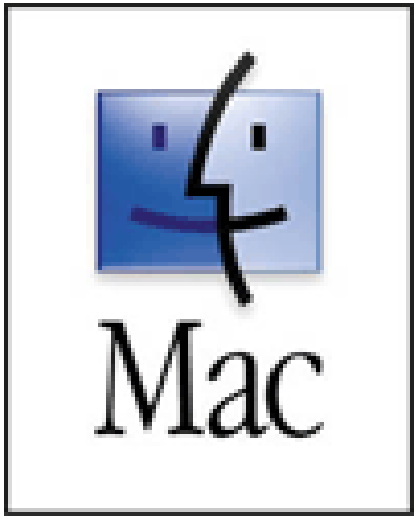
- **Gestalt Principles of Perception**
  - Gestalt psychology strives to explain the factors involved in the way we group things
  - At the heart of Gestalt psychology is the idea that we strive to find the simplest solutions to incomplete visual information

Gestalt Principles of Perception

- **Figure-Ground: Basic premise**
  - We perceive our environment by differentiating between objects and their backgrounds



The Rubin Face/Vase Illusion



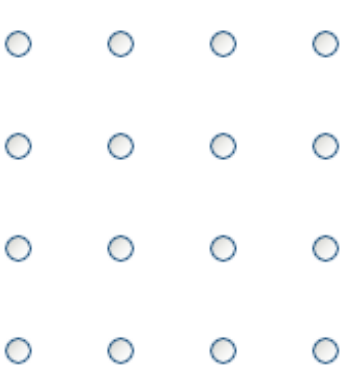
Mac Logo

Gestalt Principles of Perception

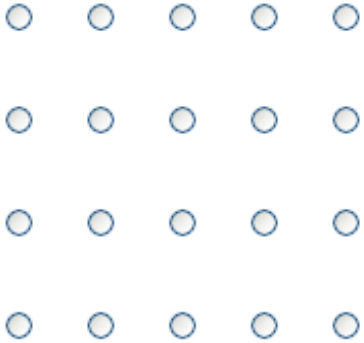
- The Gestalt Principles of Perception:
  - Proximity
  - Similarity
  - Common Fate
  - Closure
  - Good Continuity
  - Area
  - Symmetry
  - Surroundedness
  - Prägnanz

Gestalt Principles of Perception

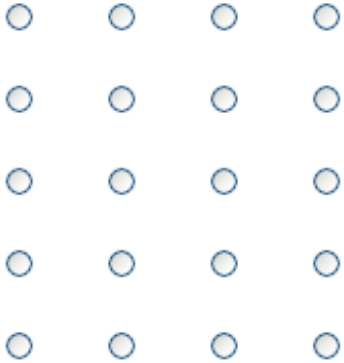
- **Proximity Principle –** Objects that are close to each other will be seen as belonging together



Equidistant



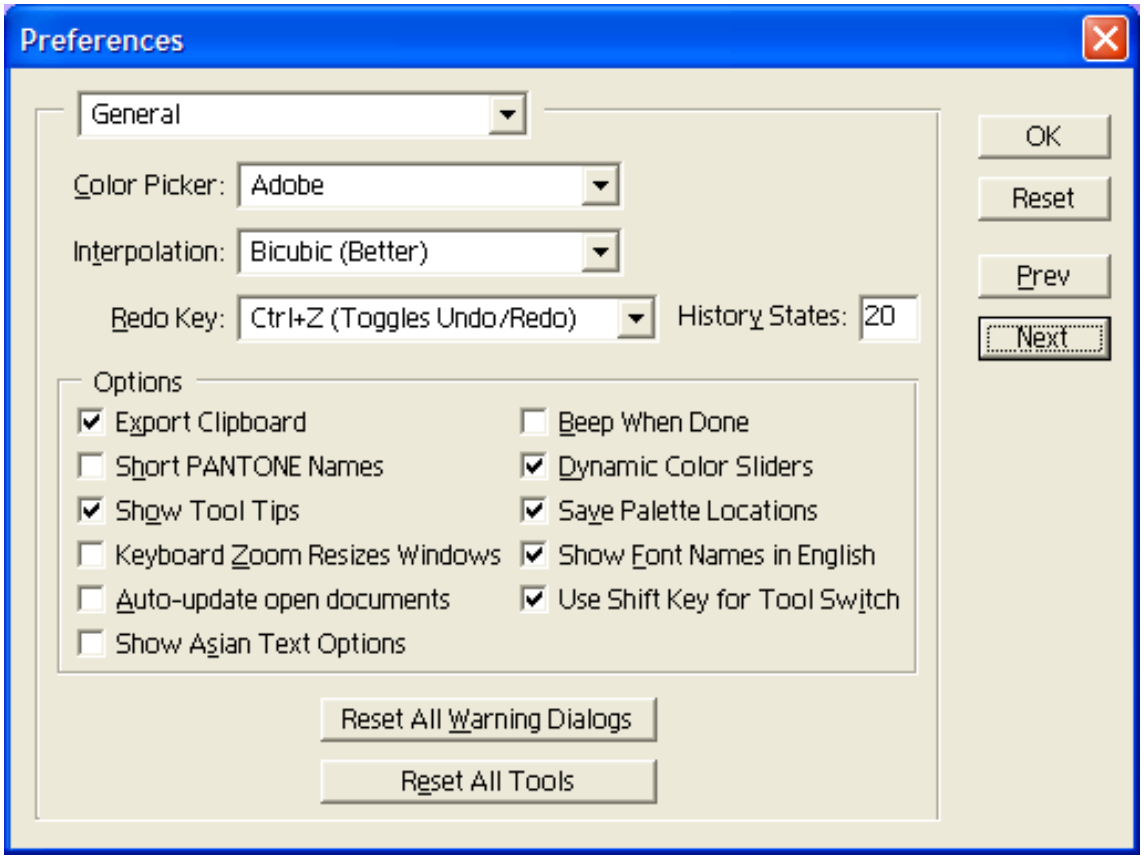
Horizontal Proximity



Vertical Proximity

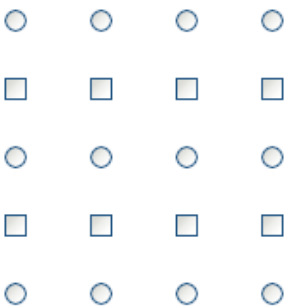
Gestalt Principles of Perception

- **Proximity** - Adobe PhotoShop Preferences Dialog

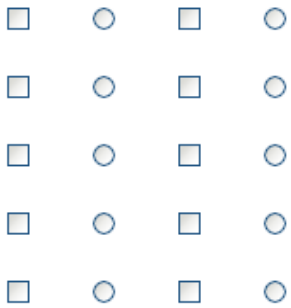


Gestalt Principles of Perception

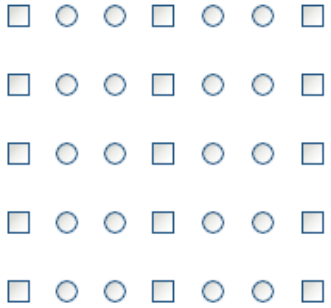
- **Similarity Principle** – Objects that have similar visual characteristics, such as size, shape or color will be seen as a group and therefore related



Rows of Similar Objects



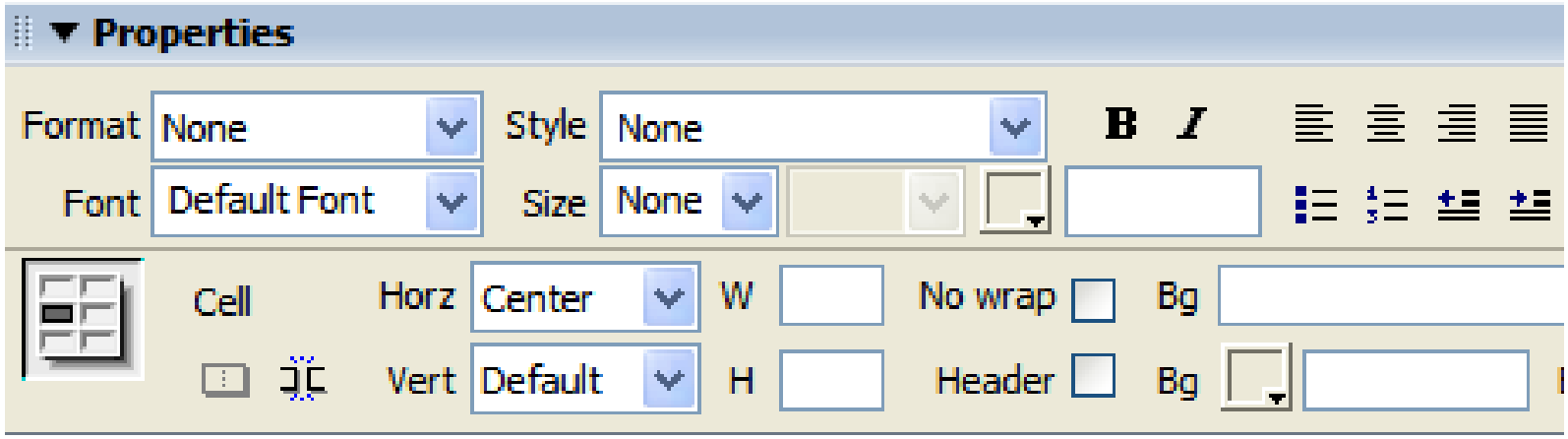
Columns of Similar Objects



Grouped Columns

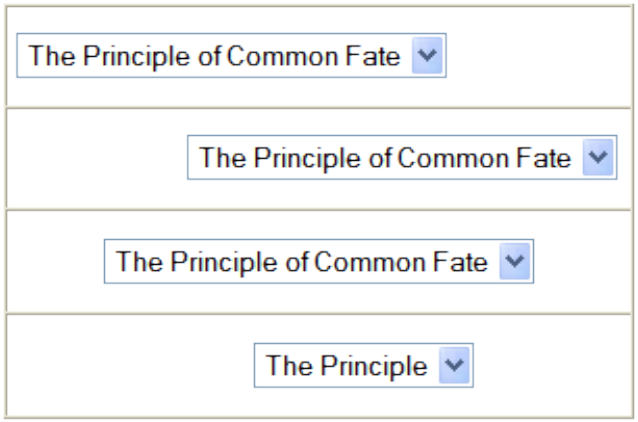
Gestalt Principles of Perception

- Property Pane from Macromedia's Dreamweaver
  - Our eyes pick up all of the text boxes because of the strong blue squares and the white areas that they have in common

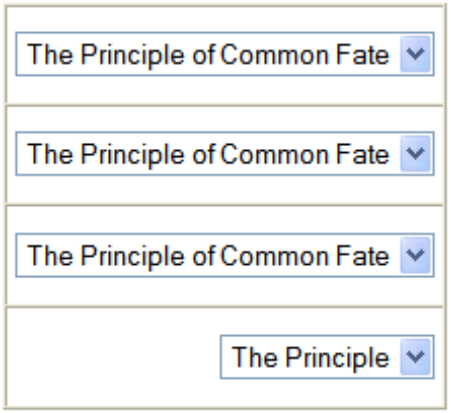


Gestalt Principles of Perception

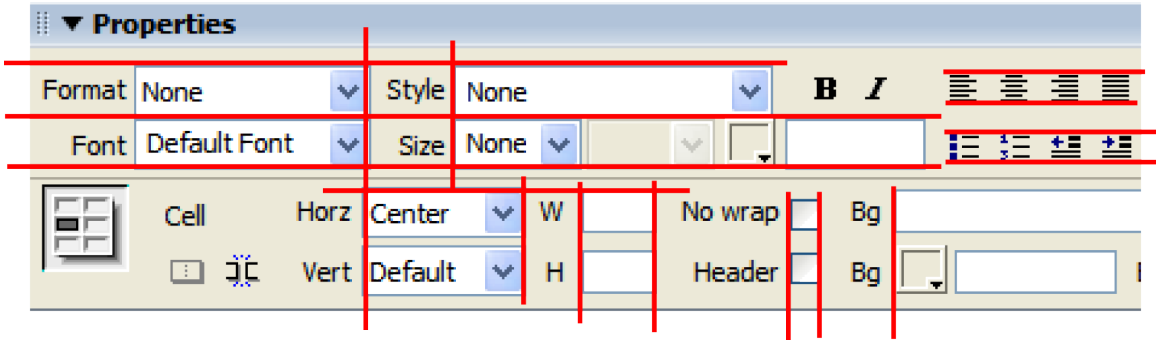
- **Common Fate Principle** – Objects that move together are seen as related



Unaligned Drop-Down Menus



Aligned Drop-Down Menus

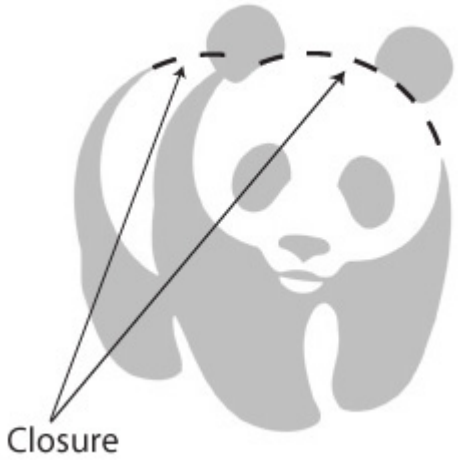


Gestalt Principles of Perception

- **Closure Principle** – We tend to see things as complete objects even though there may be gaps in the shape of the objects

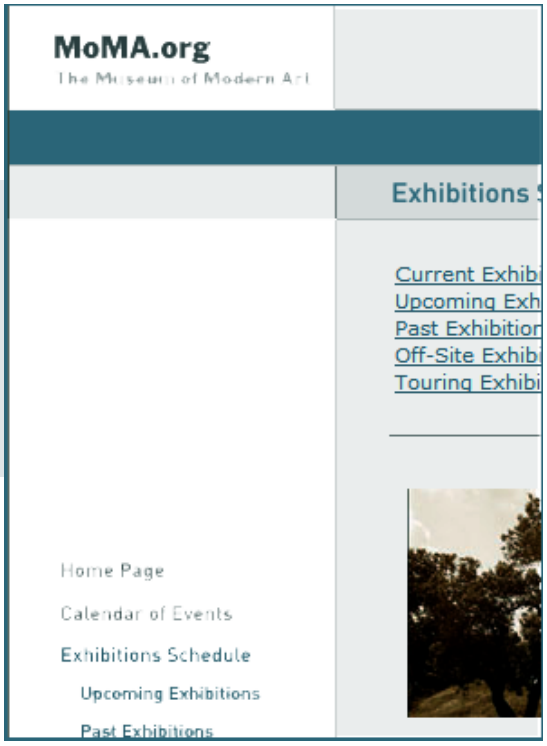
Gestalt Principles of Perception

Closure Principle

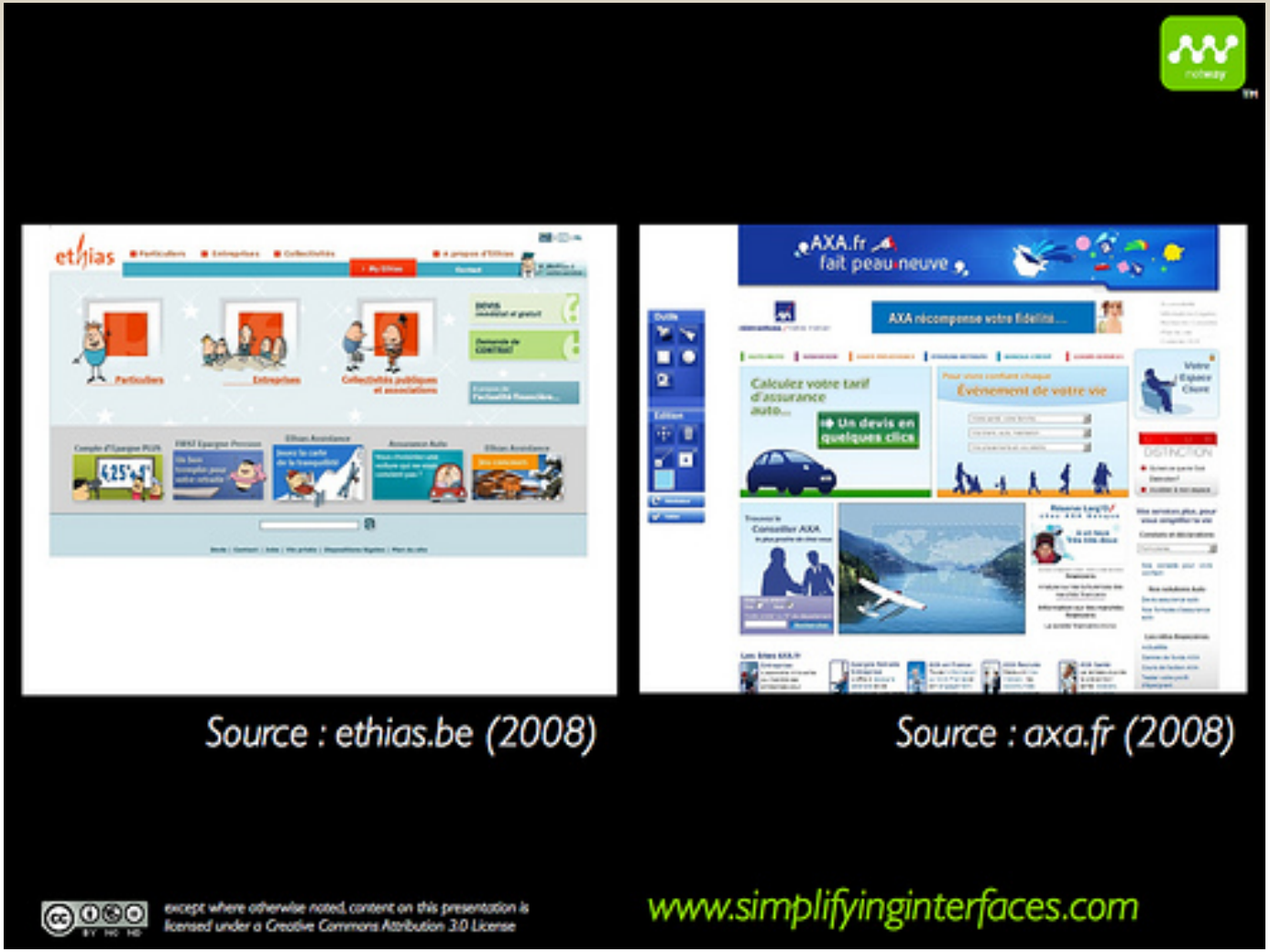


Gestalt Principles of Perception

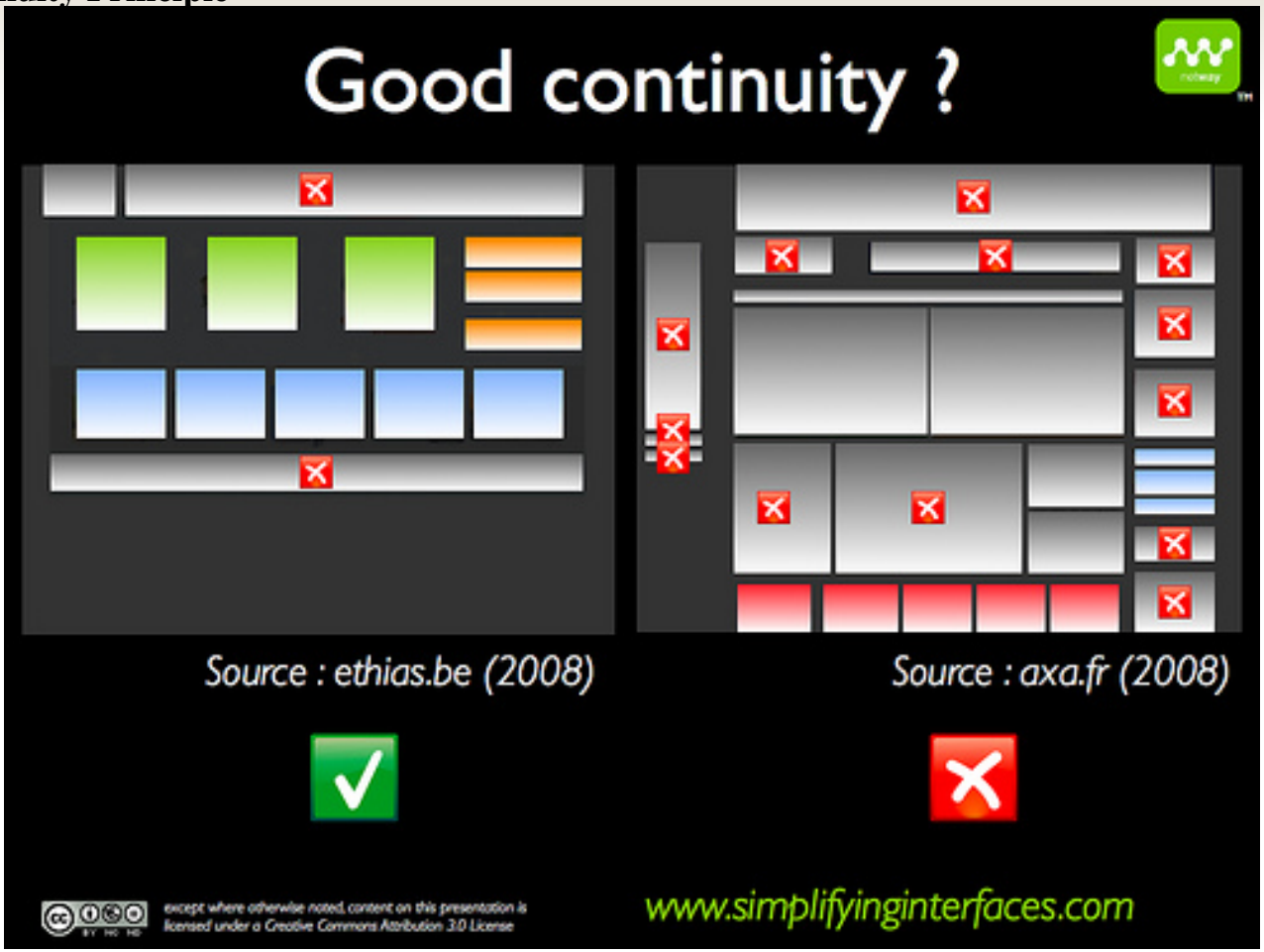
- **Good Continuity Principle** – We tend to see things as smooth, continuous representations rather than abrupt changes



Good Continuity Principle



Good Continuity Principle

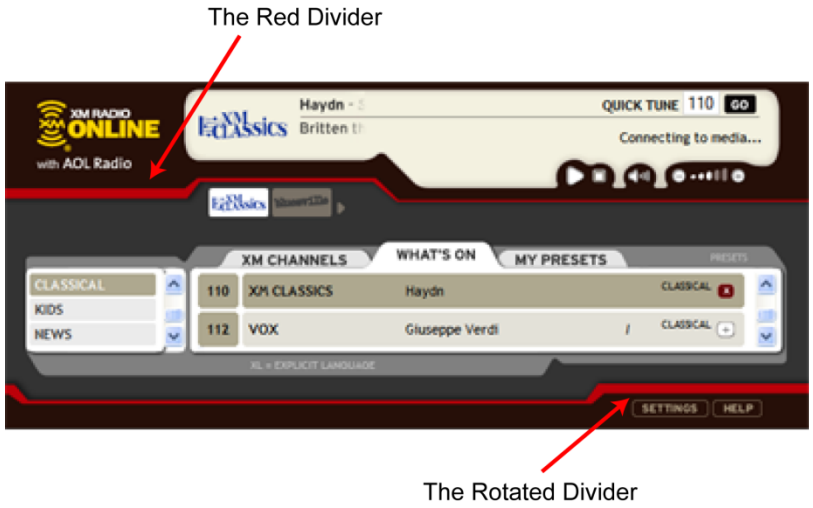


Gestalt Principles of Perception

- **The Area Principle** – Objects with small area tend to be seen as the figure, not the ground (also called the smallness principle)

Gestalt Principles of Perception

- **Symmetry Principle** – Symmetrical areas tend to be seen as complete figures that form around their middle

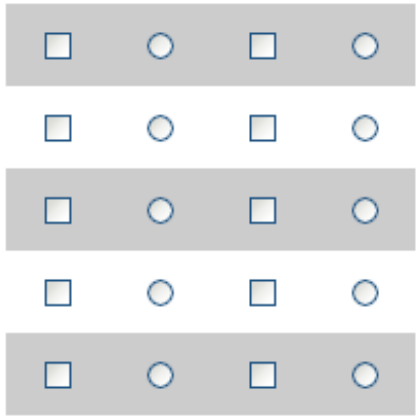


Gestalt Principles of Perception

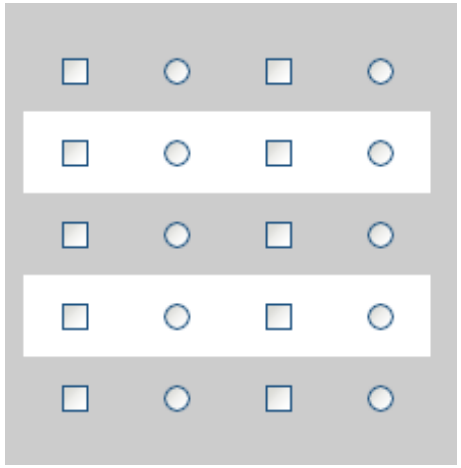
- **Surroundedness Principle –** An area that is surrounded will be seen as the figure and the area that surrounds will be seen as the ground

Gestalt Principles of Perception

- **Prägnanz Principle –** We tend to perceive things based on the simplest and most stable or complete interpretation

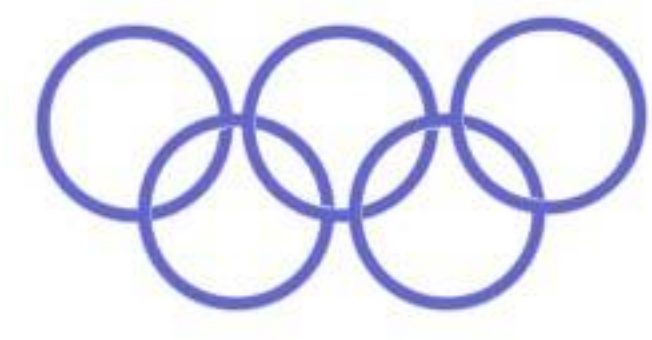


Visual Conflict with Common Fate



Visual Conflict with Surroundedness

Gestalt Principles of Perception



Law of Pragnanz:

Other Principles of Perception - *Stimulus Intensity*

- We respond first to the intensity of a stimulus and only then do we begin to process its meaning.

1 3 **9**

7

4 8 **6**

2

5 7 **1**

Other Principles of Perception – *Proportion*

- Proportion can be used to represent logical hierarchies

Heading Level 1

Heading Level 2

Heading Level 3

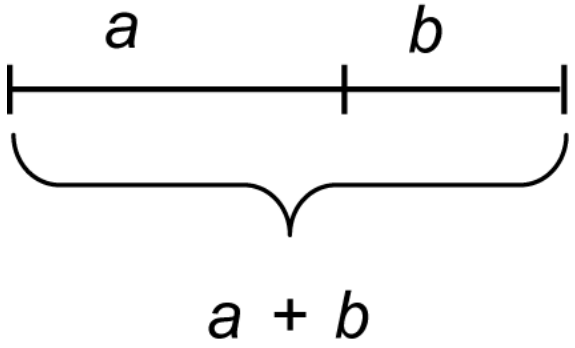
Heading Level 4

Heading Level 5

Heading Level 6

Other Principles of Perception – *Proportion*

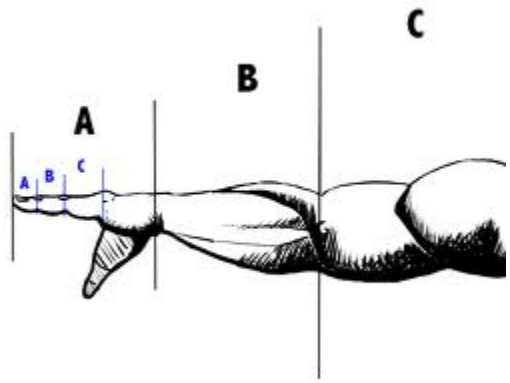
- **Golden Ratio** - The golden ratio expresses the relationship between two aspects of a form such as height to width and must equal **0.618**

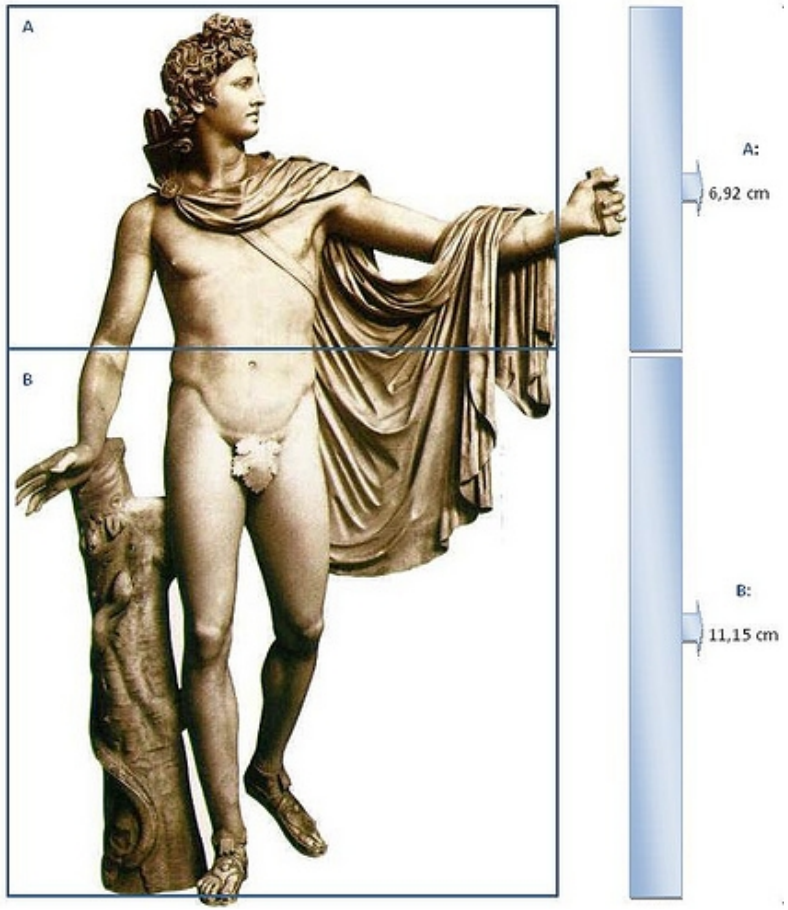


$$\frac{a + b}{a} = \frac{a}{b}$$

Other Principles of Perception – *Proportion*

- **Examples of the Golden Ratio**





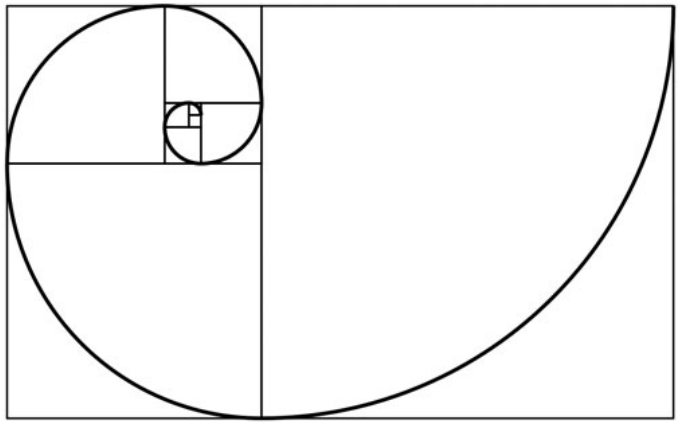
Other Principles of Perception – *Proportion*

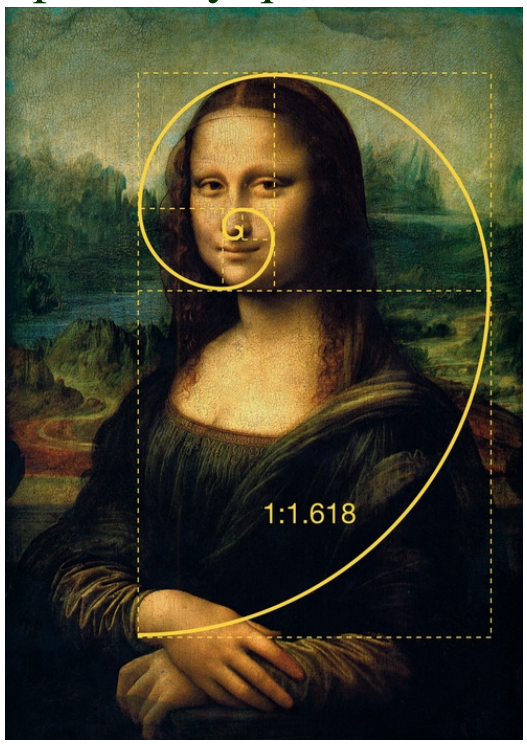
- **Fibonacci -** A sequence of numbers in which each number is the sum of the two preceding numbers.
  - The relationship between the numbers in the Fibonacci series is similar to phi.

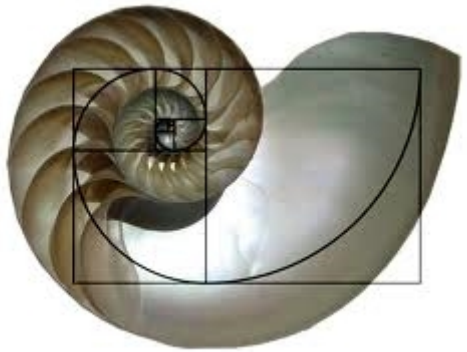
1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, …

Other Principles of Perception – *Proportion*

- **Golden Spiral -** A log spiral whose growth factor is relative to the golden ratio.
  - Gets wider by a factor phi every quarter turn.

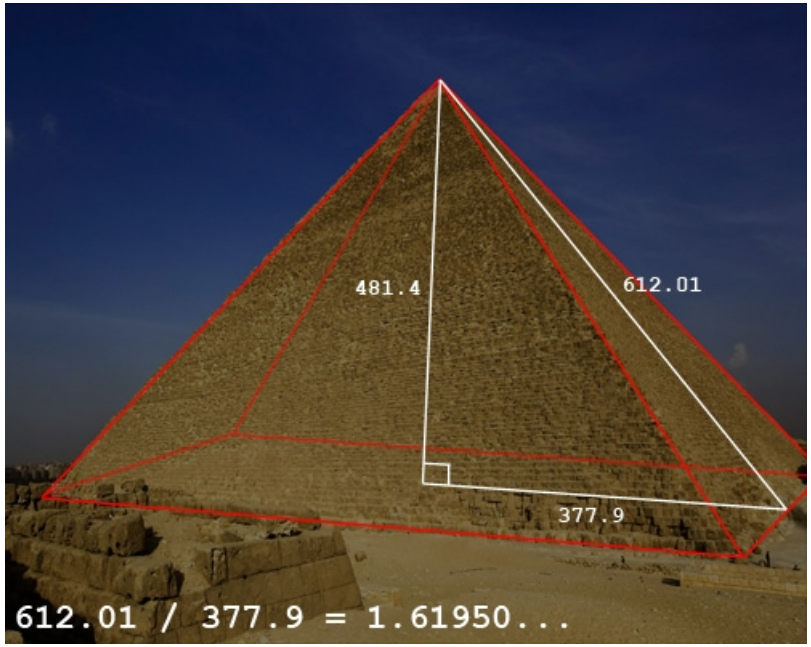


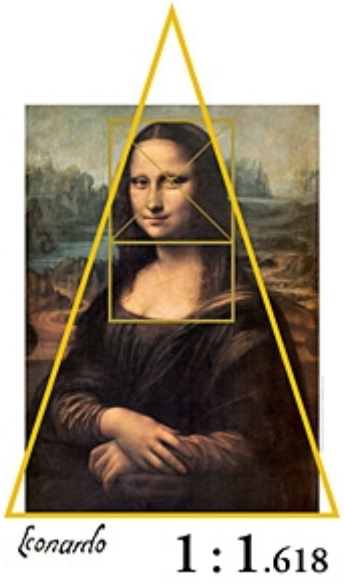




Other Principles of Perception – *Proportion*

- **Golden Triangle –** The ratio of the longest side to the smallest side is phi.





Golden Ratio Video

Other Principles of Perception - *Screen Complexity*

- The measure of complexity developed by Tullis (1984) can be used to calculate the relative complexity, and therefore the difficulty, of a design.
  - This measure of complexity uses information theory (Shannon & Weaver, 1949)

Other Principles of Perception - *Screen Complexity*

- Formula for calculating the measure of complexity

$$C = -N \sum_{n=1}^{m} p_n \log_2 p_n$$

C, complexity of the system in bits

N, total number of events (widths or heights)

m, number of event classes (number of unique widths or heights)

pn, probability of occurrence of the nth event class
(based on the frequency of events within that class)

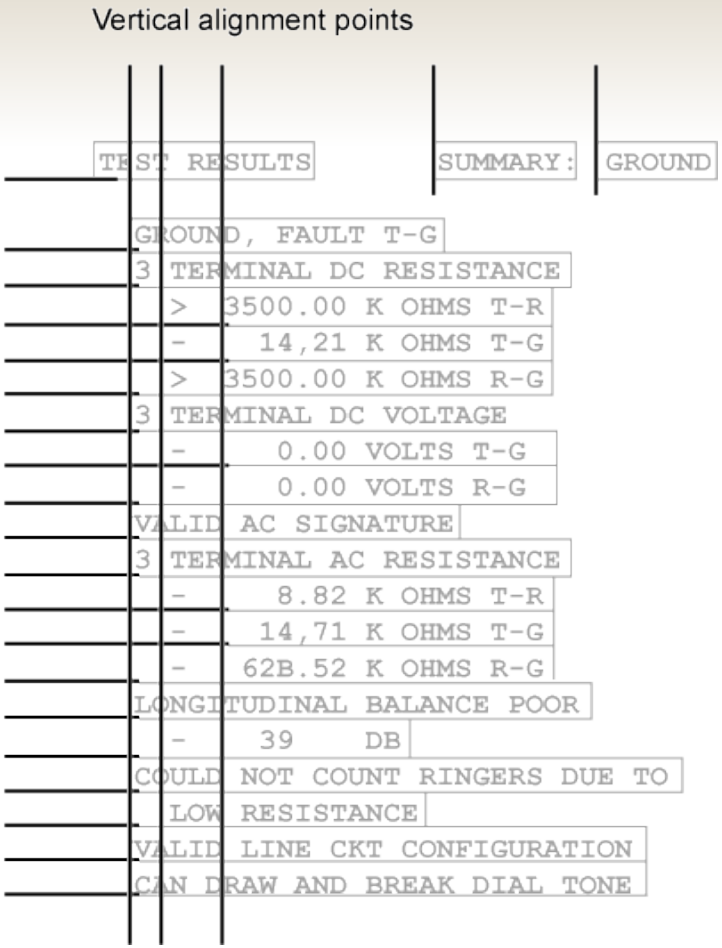
Other Principles of Perception - *Screen Complexity*

- To calculate the measure of complexity for a particular screen, do the following:
    1. Place a rectangle around every screen element
    2. Count the number of elements and the number of columns (vertical alignment points)
    3. Count the number of elements and the number of rows (horizontal alignment points)

Other Principles of Perception - *Screen Complexity*

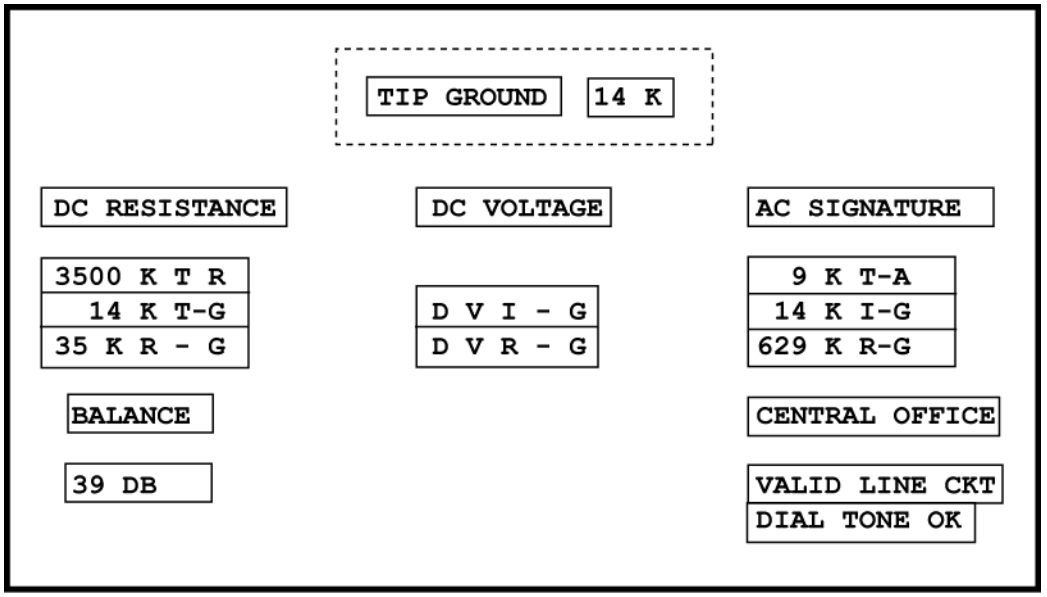
```
TEST RESULTS          SUMMARY:  GROUND

GROUND, FAULT T-G
3 TERMINAL DC RESISTANCE
   >   3500.00 K OHMS T-R
   -     14,21 K OHMS T-G
   >   3500.00 K OHMS R-G
3 TERMINAL DC VOLTAGE
   -      0.00 VOLTS T-G
   -      0.00 VOLTS R-G
VALID AC SIGNATURE
3 TERMINAL AC RESISTANCE
   -      8.82 K OHMS T-R
   -     14,71 K OHMS T-G
   -    62B.52 K OHMS R-G
LONGITUDINAL BALANCE POOR
   -     39     DB
COULD NOT COUNT RINGERS DUE TO
   LOW RESISTANCE
VALID LINE CKT CONFIGURATION
CAN DRAW AND BREAK DIAL TONE
```

Horizontal alignment points



Other Principles of Perception - *Screen Complexity*

- Redesigned screen



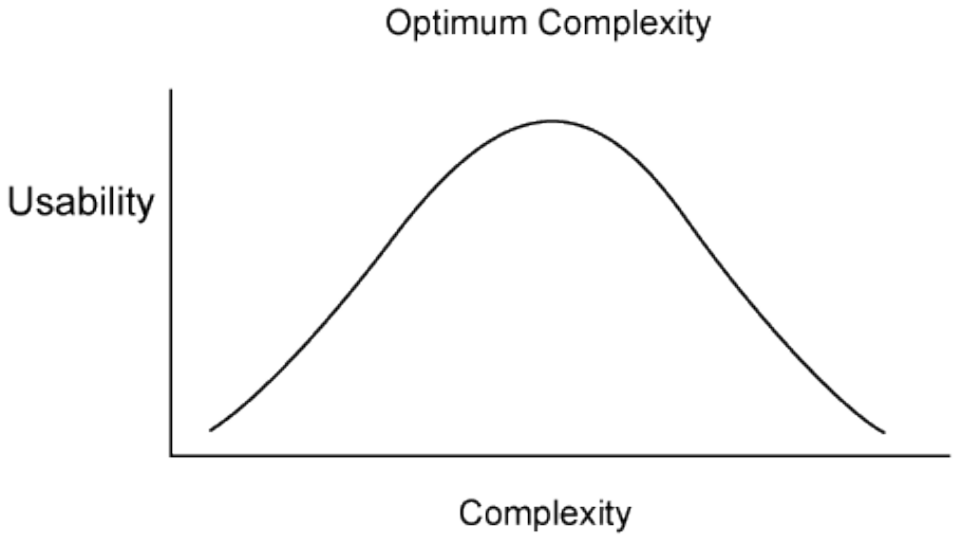
Other Principles of Perception - *Screen Complexity*

- Simplified formula by Galitz (2002):

1. Count the number of elements on the screen
2. Count the number of horizontal (column) alignment points.
3. Count the number of vertical (row) alignment points.

Other Principles of Perception - *Screen Complexity*

- **Complexity vs. Usability**
  - Comber and Maltby (1997) found that both overly simple and overly complex screens were low in usability



Other Principles of Perception - *Screen Complexity*

- **Usability**
  - Usability is defined in terms of:
    - Effectiveness (Understandable)
    - Learnability (Easy to Learn)
    - Attitude (Appearance)

Other Principles of Perception - *Screen Complexity*

- **Complexity Guidelines**
  - Optimize the number of elements on a screen within the limits of clarity and utility.
  - Minimize the alignment points. Use grid structures.

Other Principles of Perception - *Screen Complexity*

- Tradeoffs between usability and complexity:
  - As complexity decreased, predictability increased.
  - As complexity decreased, it became harder to differentiate among screen objects; the screen became artificially regular.
  - Decreased complexity meant that there were fewer ways to group objects.
  - Excessive complexity made screens look artificially irregular.
  - Increased complexity could occur from increased utility.

Other Principles of Perception - *Resolution/Closure*

- Resolution/Closure - Relates to the perceived completion of a user's tasks.
  - When the user's objective is satisfied, he or she will consider the task complete and move on to the next goal
  - Can lead to problems like with ATM machines

Usability Goals – Principles - Guidelines

- **Usability Goal—**Easy to use
  - Most people are interested in completing their tasks and do not enjoy struggling with the tools they need to use. One of the most important goals of user-centered design is to make things easy to use.

- **Design Principle—**Simplicity
  - Simple things require little effort and can often be accomplished without much thought. If interaction designs are guided by the principle of simplicity, they will be easier to use.

Usability Goals – Principles - Guidelines

- **Project Guideline—**All dialogue boxes should present only the basic functions that are most often used and that other, less used functions can be accessed using an expandable dialogue with a link for "More Options."

Videos

- Golden Ratio
  - http://www.youtube.com/watch?v=fmaVqkR0ZXg