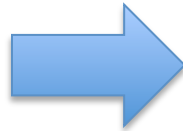# User Interface Fundamentals

Tony Scarlatos

Director, Multimedia Lab
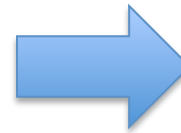
GUI Elements and Principles

Elements

- Windows
- Icons
- Menus
- Pointers
- Color
- Text
- Graphics
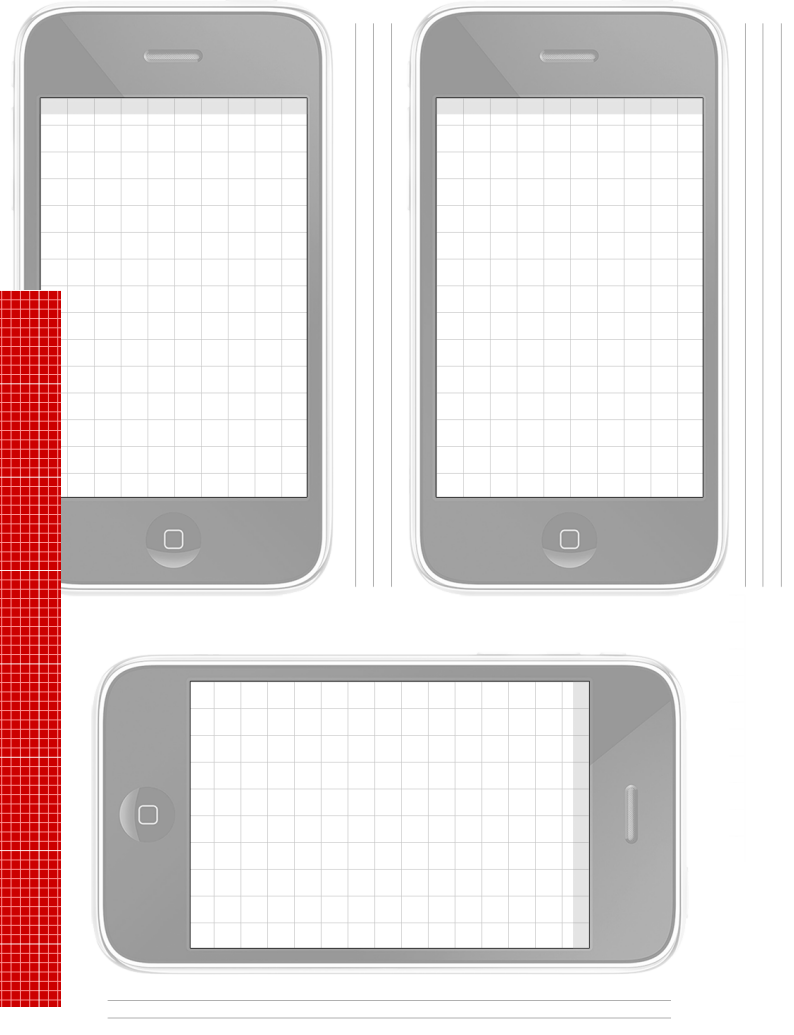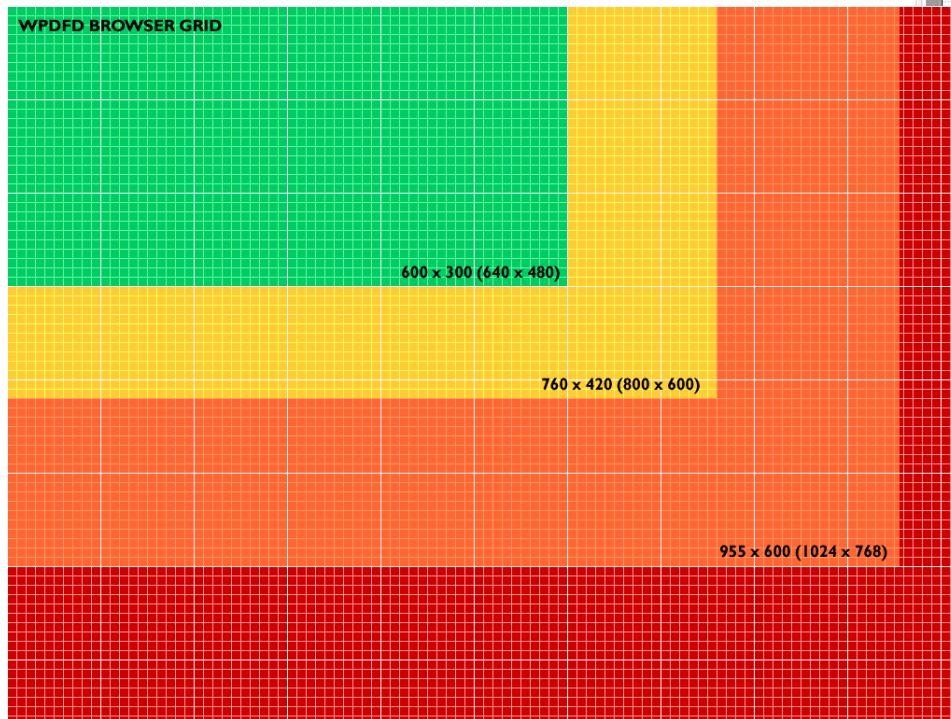- Audio
- Animation
- Video

Principles

- *Consistency*
- *Clarity*
- *Predictability*
- *Economy*
- *Transparency*
- *Modality*
- *Sensitivity*
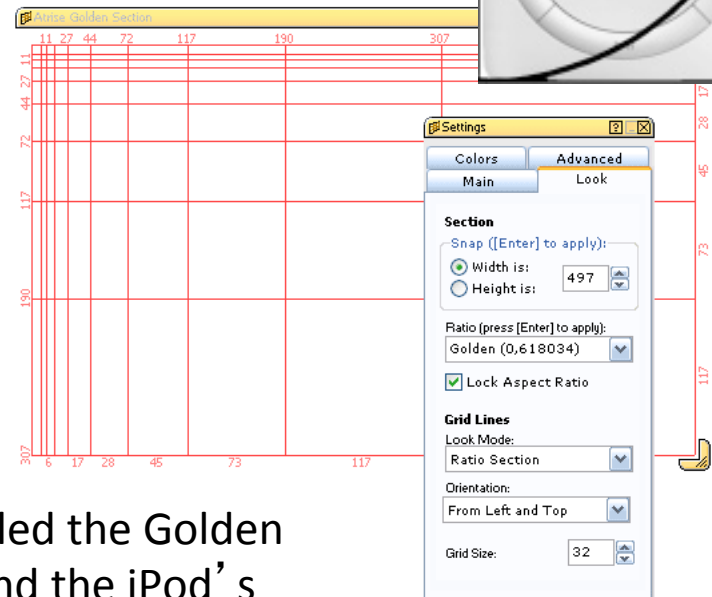- *Understandability*
- *Conviviality*

Product

Screen Layout

- Aspect Ratio & Orientation
    - The web and mobile devices make this challenging

WPDFD BROWSER GRID

600 x 300 (640 x 480)

760 x 420 (800 x 600)

955 x 600 (1024 x 768)

The Golden Rectangle (Phi)
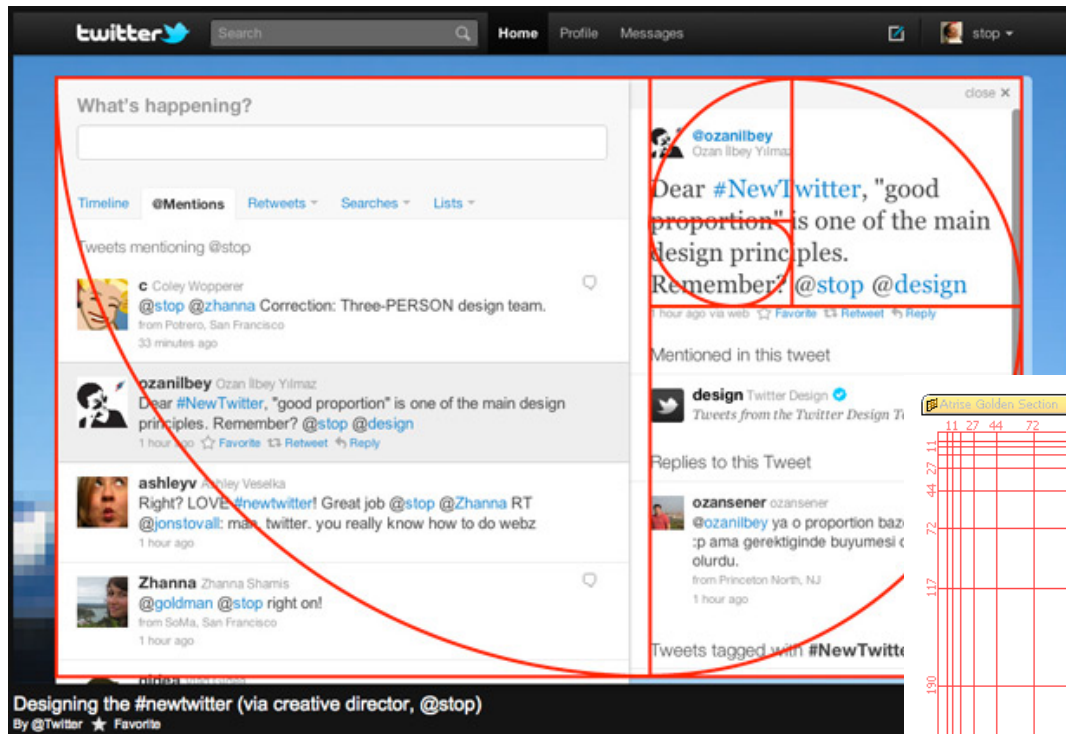
The Fibonacci Series yields a ratio of 1:1.61 (Phi) which is found throughout natural forms. The rectangle based on that ratio is called the Golden Rectangle. Above, the Twitter screen layout and the iPod's proportions are based on Phi. Software tools now help designers use the Golden Mean.

The Rule of Thirds
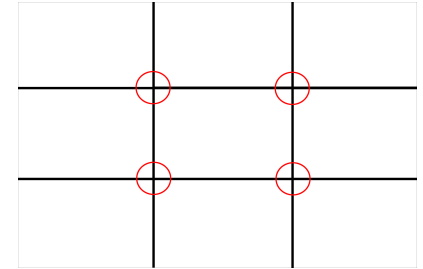
The Rule of Thirds helps designers to find the points of emphasis in their interfaces and to balance their screen layouts.

Screen Prominence
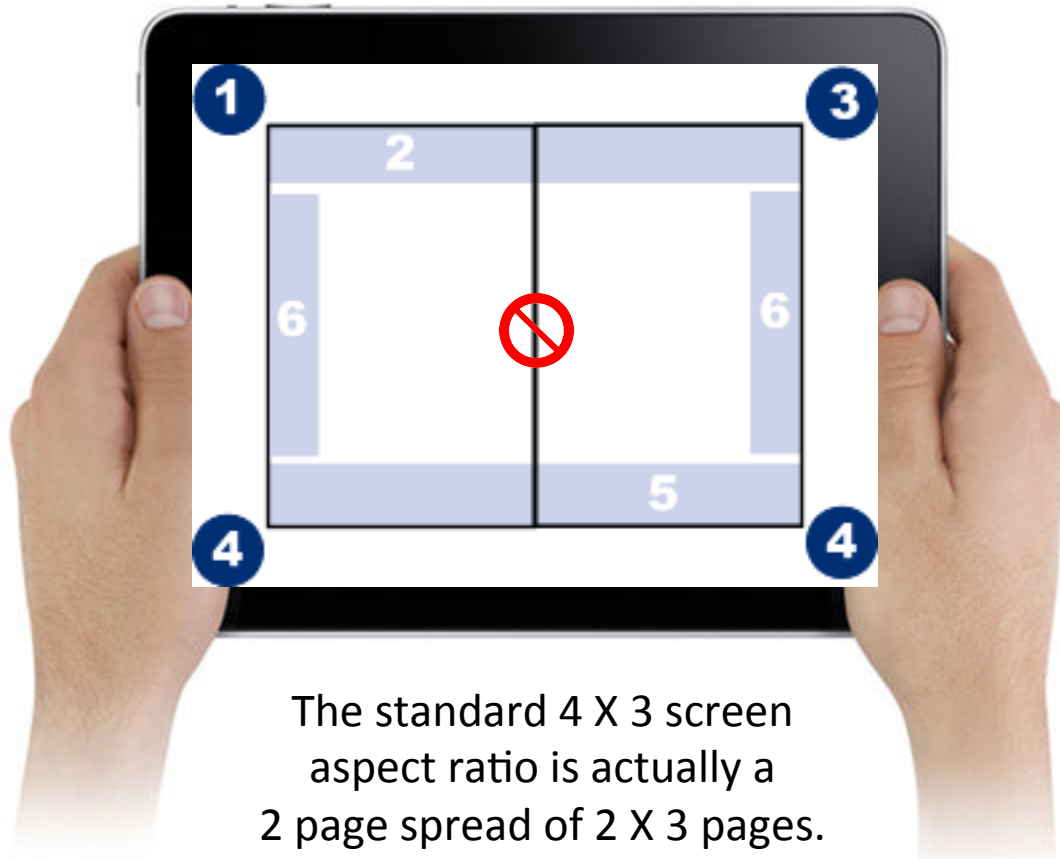
The standard 4 X 3 screen
aspect ratio is actually a
2 page spread of 2 X 3 pages.

For cultures that read left to right, the upper left corner of the screen is the most prominent part of the screen, followed by the upper right, and the two lower corners. The center of the screen actually has the least prominence (it's the gutter of the book).

Capturing the User's Attention

- Where the eye is drawn:
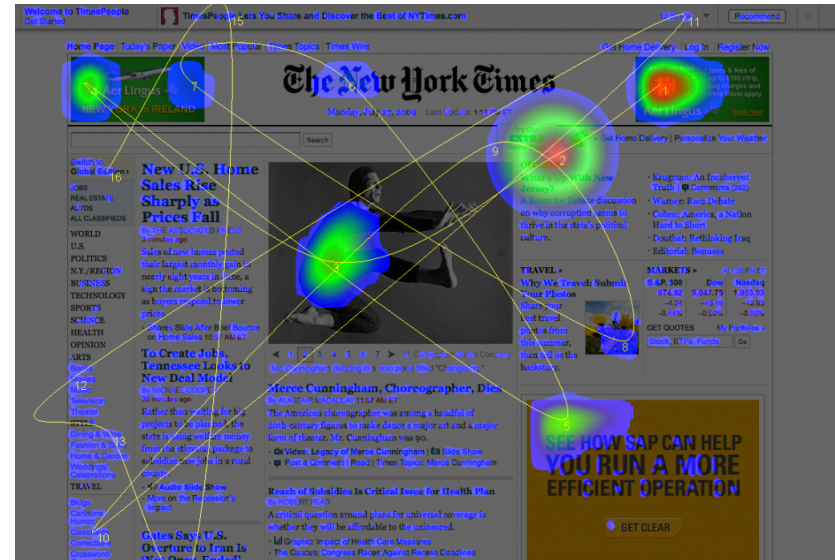 - Moving pictures (video, animation)
  - Pictures (photos, graphics, illustrations)
  - Headlines (large, bold, or differently-colored text)
  - Body copy
- Visual prominence accrues to:
  - Larger regions of positive and negative space
  - Regions with greater contrast
  - Higher saturations of color
  - Warmer colors

An eye-tracking heat map of the NY Times online indicates where a user's gaze has been directed.

Use of the Grid
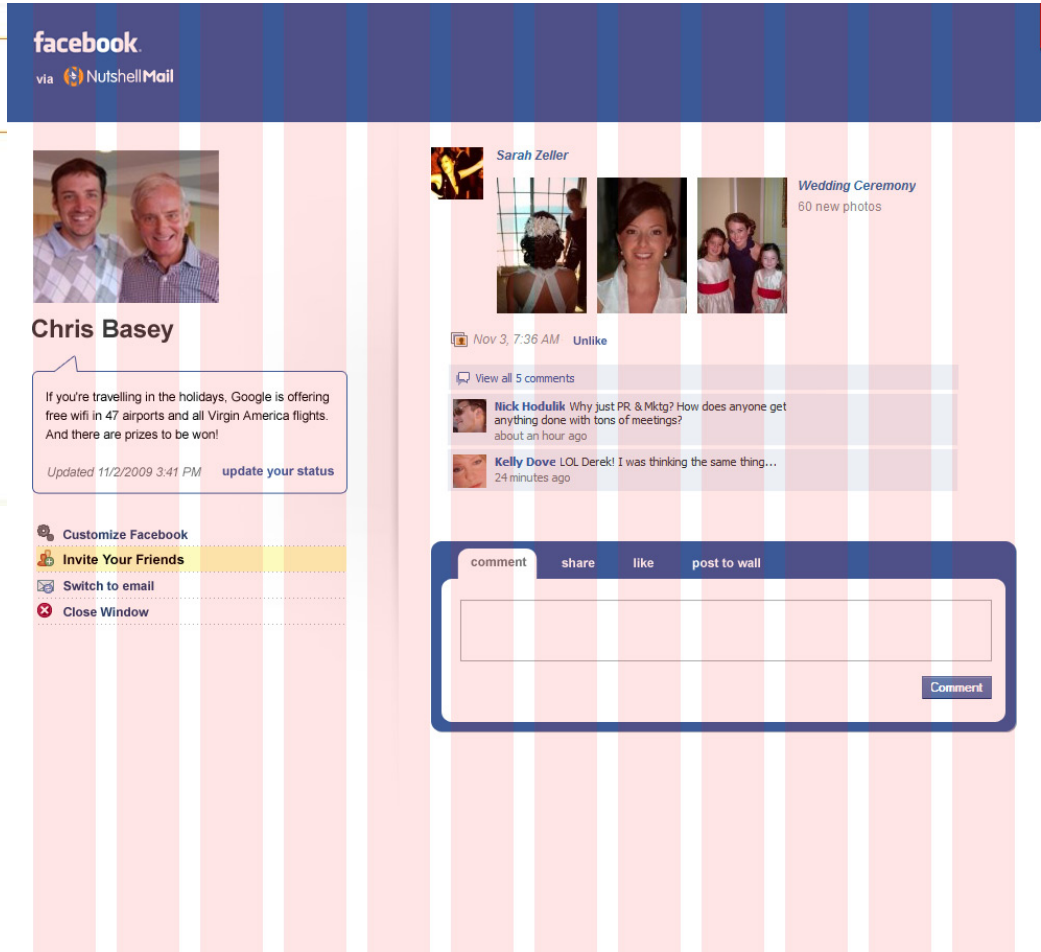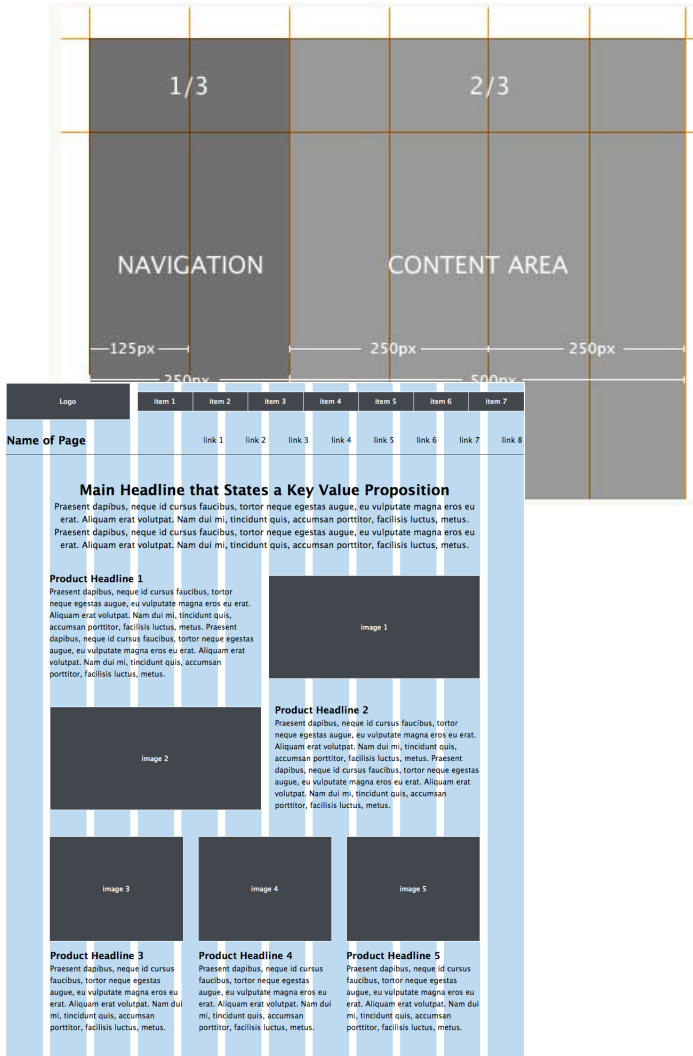
Grids organize the presentation of a variety of data, especially dynamic data.

Color

- Layers and Separates
  - Distinguishes different types of information
- Sets the context for graphs and tables
- Emphasizes important items
  - Saturated colors are "active", neutral grey is "disabled"
- Labels
  - Groups similar functions by color
- Contributes to the "mood" of the application
- Color is never perceived in isolation. Use strong colors in small quantities, against large areas of quiet colors. More saturated colors draw our attention immediately. Use them sparingly.

Color perception stems from natural phenomena, like atmospheric distortion and the blue shift. Warmer, more saturated colors advance, and cooler, less saturated colors recede.

UI Color Guidelines

- Use a limited palette of complementary colors

- Make sure your background *is* the background

- Don't use light blue for text, but it's great for backgrounds

- Older users need brighter colors to recognize them, and 10% of males have some form of color blindness

- Don't use highly saturated colors from opposite ends of the spectrum in close proximity

Use Complementary Colors

Warm colors move forward

Cool backgrounds recede

This is very hard to read.

Don't Do This!

Color Palettes
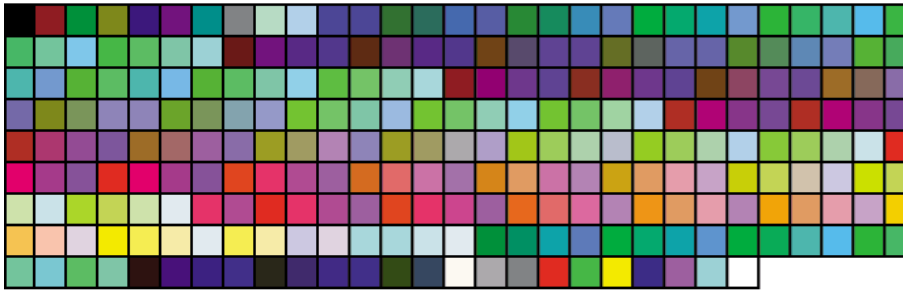
Windows palette
(256 colors)

Macintosh palette
(256 colors)

Web-safe palette
(216 colors)

Color Psychology: Warmer Colors

- Red
  - Rare in the natural world
  - Associated with fire, blood, danger
  - Commands attention
- Orange and Yellow
  - Color of the sun
  - Motivator, makes people happy and decide rapidly
- Green
  - Pastoral
  - Puts people at ease

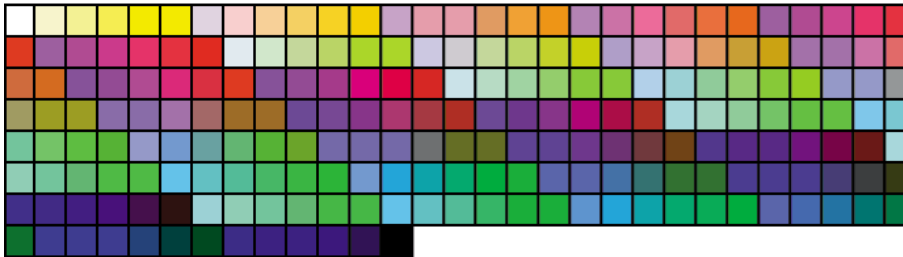# Color Psychology: Cooler Colors

- Blue
  - Most common color in the natural world
  - Color of the sky and the ocean
  - Light blue conveys access and assistance
  - Dark blue conveys authority
- Violet
  - Infrequent color in nature
  - It's unusual and exceptional
  - The color of royalty, intrigue and mystery

Color Psychology: Neutral Colors

- Brown
  - Color of the earth
  - Dependable and full of promise
- Black
  - Color of night
  - Formality (and fear)
  - Judicial
  - Funerals in western cultures
- White
  - Color of clouds
  - Purity
  - Weddings in western cultures

Icons

- Graphic icons are quickly recognized and remembered.
- Help overcome language barriers and literacy issues.
- Simple and consistent in style – they should be recognizable at a distance, and should scale well.
- Color palette is limited, and ability to show detail is low.
- A 50/50 balance of positive to negative space is usually the best design for readability.
- Abstract ideas are difficult to represent.
- Text aids, like cursor "tooltips" can be used.
- Icon size is dependent upon the input used (i.e. touch screen), and also the age of the user.
- Consideration of cultural differences in interpreting icons is important.
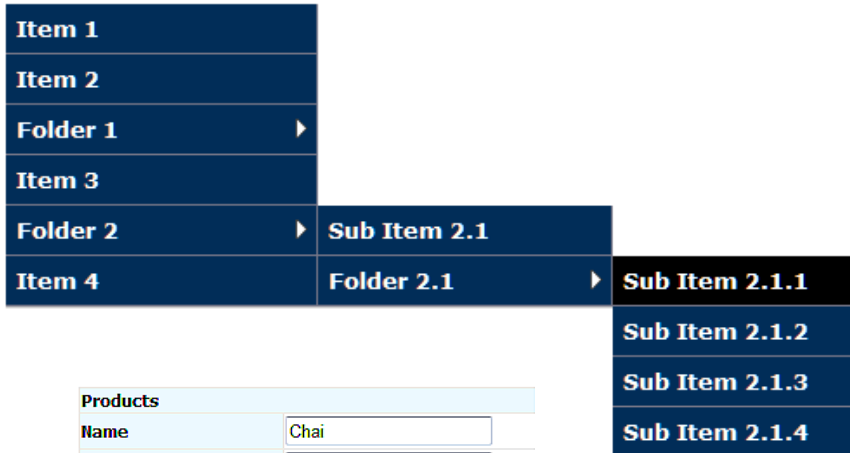- Icon sets can be converted to web fonts using a number of free services.

Literal   **Abstract**   **Arbitrary**

Menus

Minimize the number of nested menus to three, and the number of menu items to nine or less. Order the items semantically and in descending priority (i.e. frequency of use). Limit the number of icons used. Avoid cognitive overload.

Pointers

Cursors provide feedback to the user about the mode the application is in – editing, processing, etc. Cursors can have color, and can be animated to show that a process is taking place. But complex pointer icons can also confuse users. N/A for mobile devices.

Pointer Shapes

Normal Select		Vertical Resize	
Help Select		Horizontal Resize	
Working In Background		Diagonal Resize 1	
Busy		Diagonal Resize 2	
Precision Select		Move	
Text Select		Alternate Select	
Handwriting		Drag- make copy	
Unavailable		Drag - make shortcut	

Common Cursor Types

(default) arrow cursor   (open) hand cursor   (closed) drag cursor   (text) selection cursor   resize cursor   (wait) busy cursor

Widgets

Widgets are standardized mini- utilities such as calendars; but also include scroll bars, progress bars, sliders, etc. Scroll boxes in particular are over used, and often reflect a failure of design more than a useful feature.
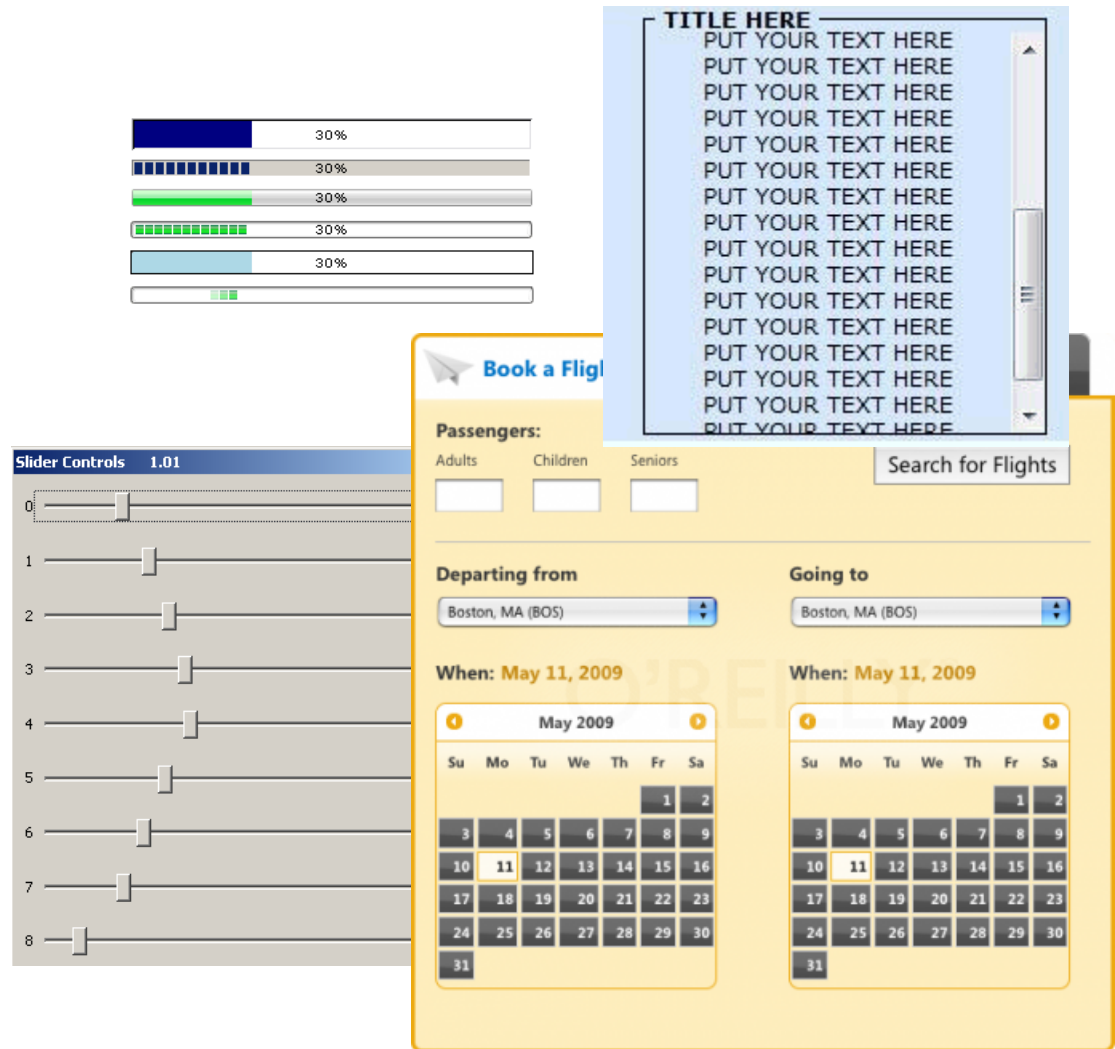
Controls

Interface controls are modeled after an actual artifact, like a switch or a knob. In practice controls like dials may be harder to use in a computer interface than their actual counterparts, since there is no tactile feedback. Buttons with multiple states can be a distraction in the interface.

Avoid complication and clutter

With dialogs, alerts, and tool bars, avoid complexity and too many choices. Tools should be semantically organized.

Use dialogs and alerts sparingly. Dialogs and alerts can interrupt the flow of interaction and make users lose their place.
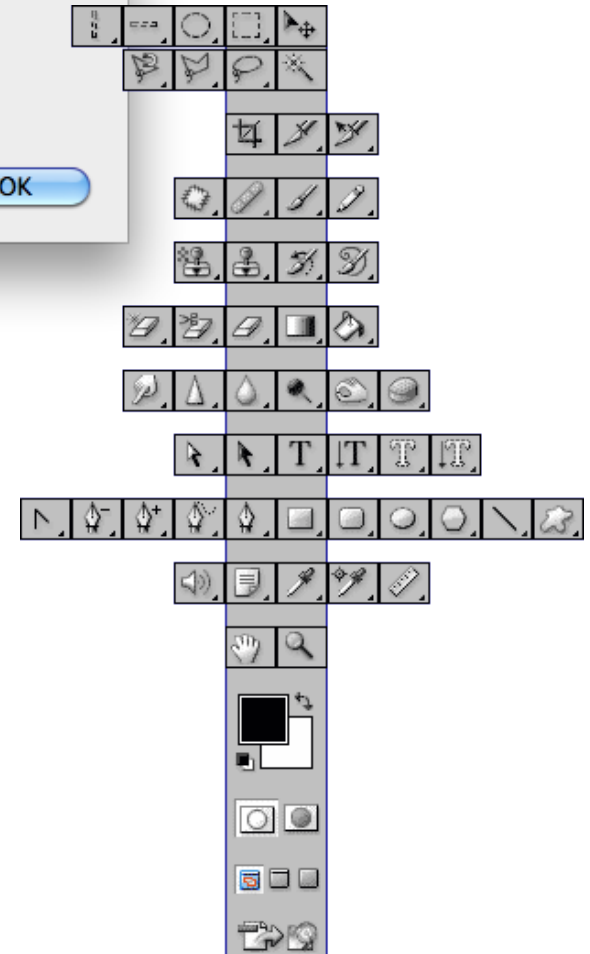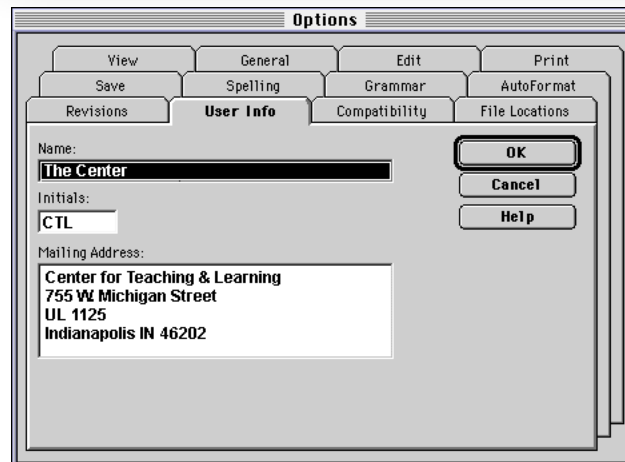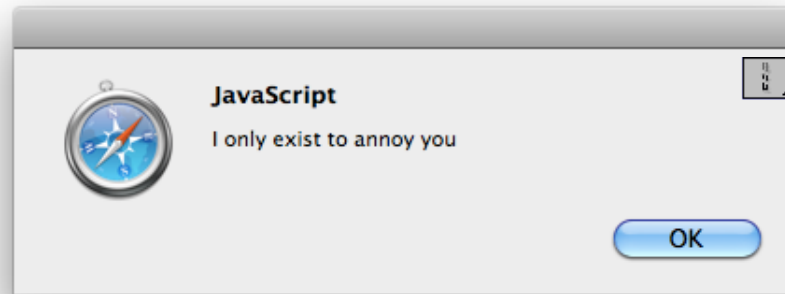
Text

- Legibility and quick comprehension are the primary goals.

- Screen resolution is much lower than print, and reading a lot of text can strain the user's eyes. Keep the use of text to a minimum.

- Users scan more than they read, so use text in readily "consumable" chunks.

- The minimum point size for text should be no less than 12 point. Older users and children require larger font sizes.

- With few exceptions, DO NOT USE all capital letters. Capitals are harder to read (and may imply impatience with the user).

12 point   24 point   48 point

96 point

Color Use in Design

While there is little hard evidence for many conventions that have grown around color use in publicationst, there is one area in which color use does follow hard-and-first rules: cultural color psychology. The high visiblity of red might make it appealing in the West, but in South Africa, where it is associated with mourning, it would not be seen on a cover about as often as black would be in the West. Blue is generally appealing to all of us irrespective of culture becase of its calming influence, but is a turnoff when used for food. It's all about context. So while it may be somewhat useless to tell a designer how to use color, here's a helpful guide on how NOT to use it.

Black
Black is complex; it can be sexy, authoritative, powerful, menacing, intriguing, righ, depressing, dull, glossy,textural, timeless...on many occasions it will be at least two of these at the same time. Avoid using black on the cover, where it can be too widely associated with death and tradefy, but on the inside pages of a magazine its use can be striking. In color psychology,many people thing that it implies submission.

White
White is almost complex as black. Innocence, cleanli-ness, wealth, and purity are some of the associations we make with white, but it can also be sterile and neutral to the point of blandness.

Red
The extreme vibrancy of red has both good and bad points. It is aconfrontational and can render other elements on a page almost invisible. But it will definitely attract the eye and has been proved to create a strong emotional response in a viewer, stimulation faster heartbeats and breathing.

Blue
Peaceful and tranquil, blue causes the body to produce calming chemicals. But choose it carefully - it can also be cold and depressing.

There is one area in which color use does follow hard-and-first rules: cultural color psychology... it's all about context.

Green
Green is the easiest color on the eye and is calming and refreshing. As the color of nature, most associations viewers make are positive ones. Additionally, dark green implies wealth and power.

Yellow
Yellow is the most difficult color for the eye to take in, and thus is potentially overpowering - possibly why it's seen as an unpopular color choice for covers.

Purple
Used in the right way, purple has associations of luxury, wealth, romance, and sophistication, but it can also apear overtly feminine or gauche.

Orange
Our associations with orange are good: exciting, vibrant, and joyous. But it can be a difficult color to use - too red can overpower; too yellow is anemic.

Brown
Another nature color with good associations. Light brown implies genuinenes, while dark brown suggests wood or leather. The combination of these makes them appealing for men's subjects.

A good balanced text layout in Helvetica, but…

Typography

- Limit the use of styles to at most four: headlines, subheads, body copy, and captions.
- The use of **bold** and *italic* fonts should be consistent and limited.
- Choose fonts that support the theme of the interface.
    - Serif fonts (e.g. **Times**) are classical and formal. They are more legible than sans-serif fonts and are good for body copy.
    - Sans-Serif fonts (e.g. **Arial**) are modern and informal. Usually best for headlines.
- Specialty fonts and typographic designs (e.g. logos) might have to be rasterized for distribution. Some applications, such as Flash, allow developers to embed fonts in their executable files (.swf).
- Web fonts and SVG graphics are a good solution to the installed fonts problem.

Arial

Arial Black

Comic Sans MS

Courier New

Georgia

Impact

Times New Roman

Trebuchet MS

Verdana

Above, the "core nine" cross-platform (web-safe) fonts.

Media Formats for HTML 5

- Raster file formats: PNG, JPEG, and GIF
  - PNG supports transparency*
  - JPEG is a lossy compression format that does not support transparency
  - GIF is an 8 bit format that supports transparency and animation*
- SVG is a vector format that is scalable and device resolution independent*
- Video formats supported by HTML 5 are
  - MP4 *
  - OGG
  - WebM
- Audio formats supported by HTML 5 are
  - MP3 *
  - OGG
  - WAV
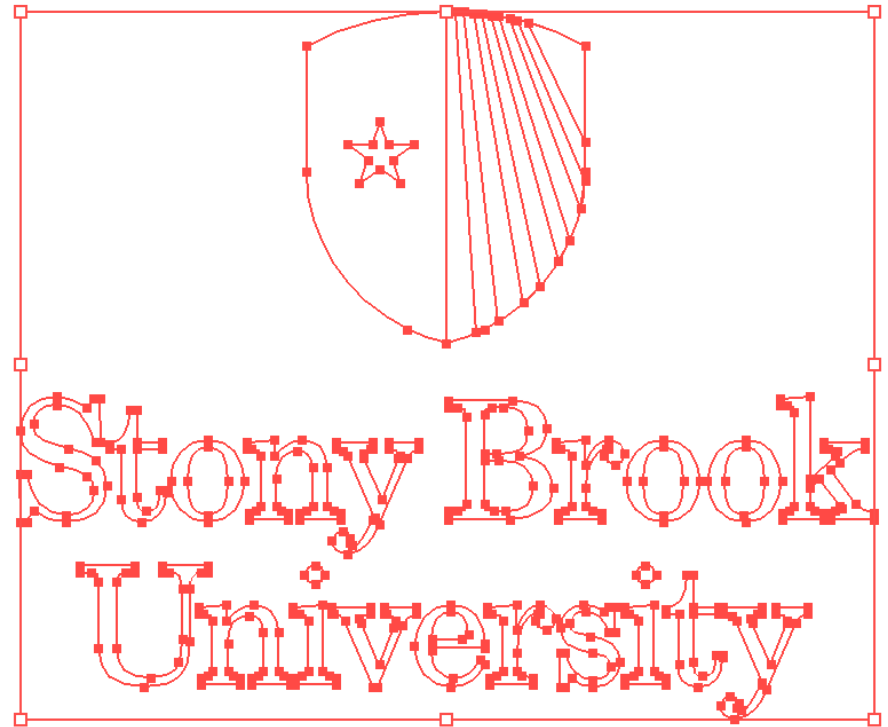
Digital Media

- Richard E. Mayer (Prof. of Psychology, UC Santa Barbara): *Multimedia Learning*, Cambridge University Press, 2001

- **People learn better when multimedia messages are designed in ways that are consistent with how perception and cognition work, and with research-based principles**
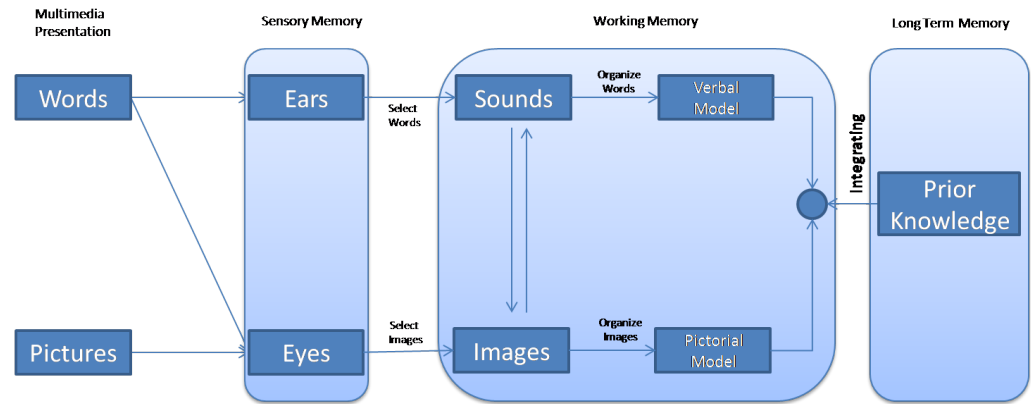
Cognitive Theory of Multimedia Learning; Nine Ways to Reduce Cognitive Load in Multimedia Learning; Mayer and Moreno, Educational Psychologist, 2003
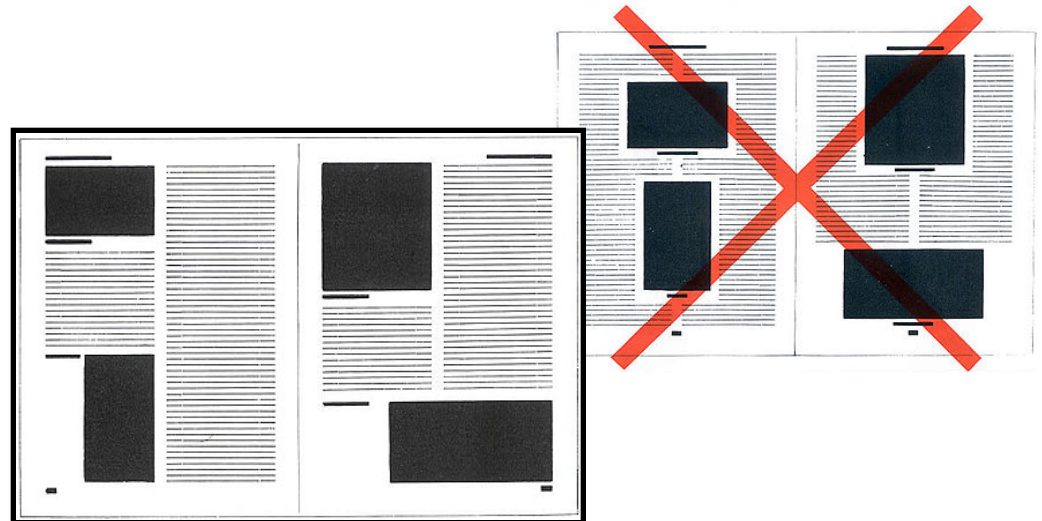
Principles for managing essential processing

- **Multimedia principle**: People learn better from words and pictures than from words alone.

- **Segmenting principle**: People learn better when a multimedia lesson is presented in learner-paced segments rather than as a continuous unit.

- **Pre-training principle**: People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.

- **Modality principle**: People learn better from animation and narration than from animation and on-screen text.

Principles for reducing extraneous processing

- **Coherence principle**: People learn better when extraneous words, pictures, and sounds are excluded rather than included.

- **Redundancy principle**: People learn better from animation and narration than from animation, narration, and on on-screen text.

- **Signaling principle**: People learn better when the words include cues about the organization of the presentation.

- **Spatial contiguity principle**: People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.

- **Temporal contiguity principle**: People learn better when corresponding words and pictures are presented simultaneously rather than successively.

Principles based on social cues

- **Personalization principle:** People learn better when the words are in conversational style rather than formal style.

- **Voice principle:** People learn better when words are spoken in a standard-accented human voice than in a machine voice or foreign-accented human voice.

- **Image principle:** People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen

Mayer᾽s final principle

- **Individual differences principle**: Design effects are stronger for low-knowledge learners than for high-knowledge learners. Design effects are stronger for high-spatial learners than for low-spatial learners.

One view of diversity:
Multiple Intelligences

Ben Shneiderman's
8 Golden Rules of HCI Design (1 – 4)

- **Strive for consistency**
  - Consistent actions should be required in similar situations.
  - Identical terminology should be used in prompts, menus, and help screens.
  - Consistent color, layout, capitalization, and fonts should be employed throughout.
- **Enable frequent users to use shortcuts**
  - To increase the pace of interaction use abbreviations, special keys, and macros.
- **Offer informative feedback**
  - For every user action, the system should respond in some way.
  - Report on the state of the system.
- **Design dialogs to yield closure**
  - Sequences of actions should be organized into groups with a beginning, middle, and end. Feedback at the completion of a group of actions shows the user their activity has completed successfully.

Ben Shneiderman's
8 Golden Rules of HCI Design (5 - 8)

- **Offer error prevention and simple error handling**
  - Design forms so that users cannot make a serious error; for example, prefer menu selection to form fill-in, and do not allow alphabetic characters in numeric entry fields.
  - If users make an error, instructions should be written to detect the error and offer simple, constructive, and specific instructions for recovery.
- **Permit easy reversal of actions**
- **Support internal locus of control**
  - Surprising system actions, tedious sequences of data entries, inability or difficulty in obtaining necessary information, and inability to produce the action desired all build anxiety and dissatisfaction.
- **Reduce short-term memory load**
  - Reduce short term memory load by designing screens where options are clearly visible, or using pull-down menus and icons.

Six other laws (1 – 3)

- **Moore's Law:** (1950) Every 18 months, the number of transistors on integrated circuits will double. Designers can expect devices to become smaller, faster, cheaper and more powerful. *Design for the future... not for the now.*

- **Fitts Law:** (1954) The time it takes to move from a starting position to the final target is determined by the distance to the target and the size of the target. *Relates to icon size (bigger), button placement (edges of the screen) and contextual (pop-up) menus.*

- **Hick's Law:** (1952) The time it takes for users to make decisions is based on the number of choices they have. *Users will make choices more quickly from one menu of 10 items than two menus of 5 items.* Speed is also determined by familiarity of choices, and format of choices.

Six other laws (4 – 6)

- **Miller's Magical Number 7:** (1956) The human mind is able to remember information best in chunks of 7 (plus or minus 2). *For short-term memory, information is best presented in chunks of 5 to 9 pieces.*

- **Tesler's Law:** There is a point beyond which a process cannot be simplified further, and the complexity can only be transferred from one place to another. *Designers should strive to distribute complexity broadly.*

- **Poka-Yoke Principle:** From the Japanese (Toyota)- avoiding (yokeru) inadvertent errors (poka). *Designers put constraints on devices or products to prevent errors.*

Top 2 Principles

- **Recognize Diversity**
  - "The average computer user" is a fiction
  - Age, Gender, Culture, Abilities and Disabilities, Education, Socioeconomic Status, and many other factors distinguish one user from another
- **Prevent Error**
  - Using a computer should always make a task easier than not using one
  - Productivity gains and satisfaction come from optimal design, losses and frustration come from inferior design