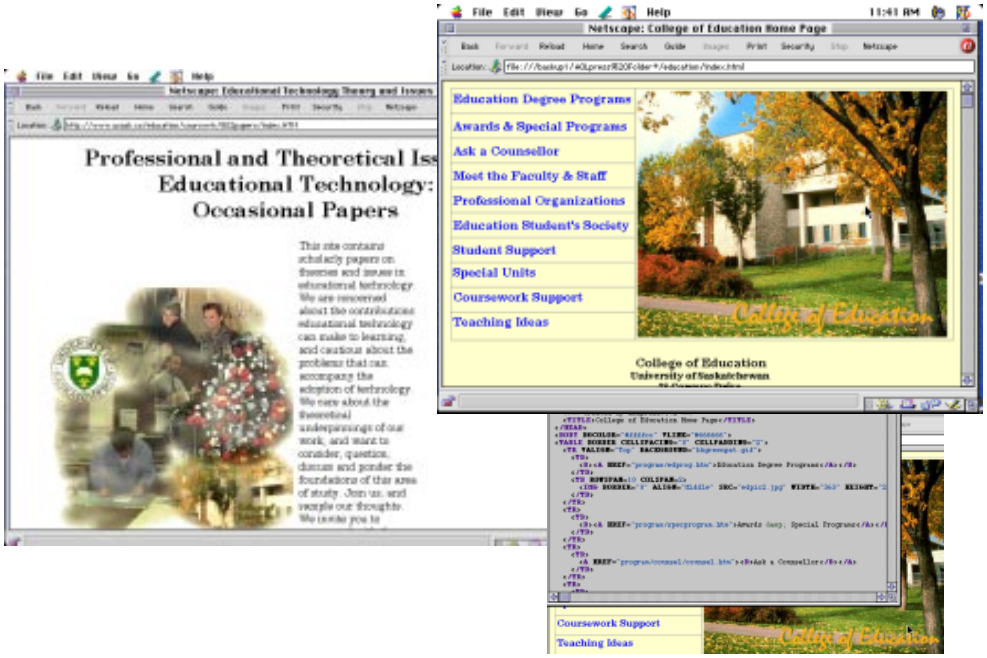
A Compilation of Guidelines for the Design of Web Pages and Sites



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Introduction to Web Design

The World Wide Web is growing exponentially with new sites appearing daily. Some of these sites are designed by graphic or instructional design professionals, but many are designed by people who have little experience or training in either graphic or instructional design. A plethora of recommendations abound concerning web design but few are based on research (Boling, Bichelmeyer, Squire and Kirkley, 1997). Some of the literature about graphic design for computer screen layout is adapted from paper-based recommendations, while other conclusions are based on dated research into computer screen design carried out on 40 column monochrome or 4 color screens (Schwier & Misanchuk, 1993). Any newer research available about screen design is based on studies of Computer Based Instruction (Hannafin & Hooper, 1989; Heines, 1984) or computer based multimedia (Moore, Burton & Myers, 1996), systems which are based on a fixed screen size. It might be argued that there are enough similarities amoung paper design, CBI or multimedia screen design and web page design that the lack of research specific to web design is unimportant. But there are also some very significant differences in design between this medium and those mentioned previously. Web page layout contains aspects of page layout, it contains aspects of screen design and it contains some unique features such as the limitations of HTML and bandwidth which make generalizations from these other media problematic. This research paper will examine the literature available from research into instructional screen design, human interface design, hypertext navigation and multimedia design with the objective of identifying guidelines which can be used in the design of aesthetic as well as easily usable web sites. This paper is

delimited to identifying research-based guidelines applicable for web sites which provide instruction or information for educational purposes. No attempt will be made to incorporate guidelines which pertain to sites intended to be used for advertising purposes or other functions unrelated to education.

What are the salient aspects of a web page? Web pages typically include the following elements: text, graphics and navigation elements. Web pages may also include sound files, animated graphics or movies. Web pages can be highly graphics intensive or almost completely text-based. Web pages can be designed to fit on one screen, or extend down many screens beyond the top of a page by scrolling. Web pages may also be interactive, with the addition of hypertext links which move the user from one page to another within a site, or from one site to another (Lynch and Horton, 1997).

Design Principles

Because of the similarities between computer-based multimedia and web sites, it seems useful to include guidelines for design which have been developed for multimedia. Some general principles derived from multimedia design include simplicity, consistency, clarity of design as well as aesthetic concerns such as balance, harmony and unity (Schwier and Misanchuk, 1993). Further design principles derived from the gestalt theory of perception include figure and ground, similarity, proximity, continuity, closure, area, and symmetry.

Simplicity

Although gaining attention is an important part of any communication act, it is important to try to keep your message as simple as possible (Schwier and Misanchuk, 1993). Use only the amount of text and graphics as is absolutely necessary to get your point across - superfluous graphics can interfere with understanding (Anglin, Towers & Levie, 1996; Levie & Lentz, 1982) and an overabundance of fonts or colors can distract rather than assist learning.

Consistency

Keep the layout of pages consistent - inconsistencies force people to spend extra time trying to figure out how to navigate, or where to find the answers to questions they have - it increases cognitive overhead (Norman, 1988) Schwier and Misanchuk (1993) suggest that you should strive for consistency in:

- level of discourse and style of presentation from one section of the sequence to another;
- placement of various items (e.g., orientation information, navigation devices, student input, feedback, operating instructions);
- use of color (including "grays" in black and white);
- access structure (e.g., use of headings);
- use of cues (font, including size and style; bolding, italics, and color);
- style of graphics;
- terminology (directions, prompts, menus, and help screens);
- names of commands and manner of evoking them;
- interaction behavior required in similar situations (e.g. don't require a learner to click on a button one time and to type a character another time, if the situations are highly similar). (page 214)

Clarity

Pare the message down to the absolute essentials the learner needs to know and consider the following rules for improving clarity:

- Keep the instruction at a language level compatible with the intended learners.
- Avoid jargon and overly-scholarly language. (editor's note: unless that is your audience)
- Present ideas succinctly; keep your prose lean.
- Keep sentences short.
- Use "point form" (bulleted lists, like this one) whenever possible.
- Use the active, rather than the passive voice.
- Stay away from negative statements if possible; avoid double negatives entirely
- Use informal language....
- Use personal pronouns....
- Use examples that learners will find familiar. And do use lots of examples.
- Use inclusive (i.e., non-sexist, non-racial) language. (Schwier and Misanchuk, 1993, page 215)

Balance

To understand balance, think of the balance beam. When objects are of equal weight, they are in balance. If you have several small items on one side, they can be balanced by a large object on the other side. Screen balance works in much the same way. It can be affected not only by the size of objects, but also their value (ie. lightness or darkness, termed visual weight).

You can have formal or informal balance. Formal balance is symmetrical, with the items on one side of the screen being similar in shape, size and color to the items on the other side of the screen. Formal balance is usually much easier to design. Informal balance is usually asymmetrical, with several smaller items on one side being balanced by a large item on the other side, or smaller items being placed further away from the center of the screen than larger items. One

darker item may need to be balanced by several lighter items. When a screen is not balanced, it creates a feeling of tension, as if the screen might tip, or things might slide off the side, just as the unbalanced beam would tip to one side. As Mullet and Sano (1995) discuss, many 20th Century typographic designers " discovered the greater vitality and inherent visual interest provided by active, asymmetric layouts" (p. 103). But they caution that creating asymmetric layouts is much more difficult to do, and depends on careful placement to compensate for the differences in size, position and value of the major elements of a design.

Harmony and Unity

In order to create harmony and unity, you must design a page or site using consistency and repetition. Similar fonts and colors, pictures which match the topic, and graphics which are similar in tone used within a site will make that site appear harmonious. Unity can be fostered by ensuring that all the items which are present on a page appear to belong together and different pages in the site are similar in content and design. Visual identity can be very important in a unified site design - similarity amongst pages ties a site together and gives it a feeling of wholeness.

Gestalt Principles of Perception

Gestalt theorists were intrigued by way our mind perceives wholes out of incomplete elements (Mullet & Sano, 1995, Behrens, 1984). "To the Gestaltists, things are affected by where they are and by what surrounds them" (Behrens, 1984, p. 49). The terms figure and ground explain how we use elements of the scene which are similar in appearance and shape and group them together as a whole. Similar elements (figure) are contrasted with dissimilar elements

(ground) to give the impression of a whole. A breakdown of figure and ground occurs with camouflage, where the objective is to make the figure so much like the ground that it disappears from view.

According to Mullet and Sano (1995) the following Gestalt principles apply in design: the principle of similarity states that things which share visual characteristics such as shape, size, color, texture, value or orientation will be seen as belonging together; the principle of proximity or contiguity states that things which are closer together will be seen as belonging together; the principle of continuity predicts the preference for continuous figures (two crossed lines instead of four joined lines); the principle of closure applies when we tend to see complete figures even when part of the information is missing; the principle of area states that the smaller of two overlapping figures is perceived as figure while the larger is regarded as ground; and, the principle of symmetry describes the instance where the whole of a figure is perceived rather than the individual parts which make up the figure.

Screen Design Research

Screen design in an educational context is defined as "the coordination of textual and graphic elements to present sequenced content, in order to facilitate learning" (Mukherjee and Edmonds, 1993). Good screen design should fulfil the following expectations: focus users' attention on important information; attract and maintain interest; promote the integration of information with past learnings (deep processing, schema development); promote engagement with content; and, help users find and organize information easily by facilitating navigation through the information (Hannafin & Hooper, 1989). Some topics which are important to consider in screen design include screen grid and layout (including white

space and length of text on the screen), screen density, font selection, leading, text justification, color, icons and buttons((Schwier & Misanchuk, 1993; Lynch & Horton, 1997).

Screen grid and layout

The screen grid can be used as a way of ensuring consistency between pages in a site(Lynch & Horton, 1997). The grid can be used to establish that certain areas of the screen are to be used for specific purposes (eg. navigation buttons or hyperlinks are found on the top and bottom of the page, text information is placed in the center half of the screen with white space found on either side). Since HTML makes no allowances for margins or white space, other means such as tables with invisible borders are used to provide designers with the means of implementing their ideas (Siegel, 1996). Implementing a screen grid using tables can cause problems if the designer is unaware of the limitations.

Line Length

According to Schwier & Misanchuk (1993), research on line length is contradictory, with recommendations (emanating from the print medium) ranging from 35 - 75 characters per line. In terms of CRT research, two studies reported that longer lines were better (Grabinger, 1989; Kolers, P., Duchnicky, R. & Ferguson, D., 1981), while Hooper and Hannafin (1986) suggest that a rule of thumb is "text is read more efficiently when presented in a dense manner" (p. 26). Misanchuk, Schwier & Boling (in press) suggest that worrying about line length may be a moot point in terms of the web since users have the opportunity themselves to regulate the length of lines.

Screen density

Recommendations as to the amount of text to place on a computer screen are very contradictory. Most of the research on text density was carried out previous to 1990. This means that much of the research used computers with monochrome monitors or monitors with 16 colors at most. Some of the research was even based on 40 column screens. Some studies found subjects preferred high density screens (Morrison, Ross, Schultz & O'Dell, 1989) while others recommended lower density (Ross, Morrison & O"Dell, 1988). Formats for testing screen density varied widely; from screenfuls of X's and O's representing text, to nonsensical text, to actual instruction - it is unclear whether these methodological differences have an effect on the actual outcomes. Many experts in computer-based instruction have recommended "minimal amounts of text with lots of white space and double-spaced lines" (Schwier and Misanchuk, 1993, p. 234) while others suggest that "text is read more efficiently when presented in a dense manner" (Hooper & Hannafin, 1986, p. 26). Since the environment for computers has changed dramatically since the majority of these recommendations were made and no new research studies are forthcoming, it is impossible to determine any instructionally based research guidelines about screen density.

A conference presentation by Jared Spool profiling his recent internet research found that users rated sites with large amounts of white space and sparse text as "too complicated, over-detailed, visually confusing, unclear and "not enticing". Mistrustful of the results, the researchers tested the effects of white space five

different ways, only to come up with similar results." (Festa, 1998)

Font Selection & Leading

Chen, Jackson, Parsons, Sindt, Summerville, Tharp, Ullrich & Caffarella (1996) conducted research on the optimal font size for CBI using a Macintosh Centris, 14 inch monitor and Times Truetype font and discovered a preference for 14 to 16 point font over 10 to 12 point font. As this contravenes many findings from print-based research, they concluded "font size recommendations based on print media are inadequate" (p. 143).

Misanchuk, et al. (in press) offer the following guidelines for font selection:

> For body text on-screen, you would do well to choose a font with these characteristics:
>
> - minimum 12- or 14-point size (if the font has relatively small characters compared to other fonts of that size (e.g., Times), choose 14; if the characters are relatively large (e.g., Bookman), you can choose 12)
> - plain (roman) style, rather than bold, italic, outline, shadow, or other style sans-serif or with serifs that are not too fine to render well on-screen
> - bitmap font rather than outline font
> - proportional font (unless it is necessary to choose a non- proportional font for some reason)
> - not anti-aliased
> - system-resident font (preferred but not mandatory)
>
> For headings and titles on-screen, you should generally choose a font with these characteristics:
>
> - 18-36 point size (assuming 12- or 14-point body text)
> - plain (roman) or bold style is acceptable; italics may be used if the font size is large enough to render well on-screen
> - either sans-serif or serif font is acceptable (it often

works well to have the opposite of body text--i.e., if body text is sans-serif, make titles/headings serif, and vice versa)
- due to the size of titles/headings, outline fonts may render well enough on-screen to be usable
- proportional font
- anti-aliased titles/headings generally look more pleasing
- system-resident font (preferred but not mandatory) Misanchuk, et al. (in press)

Misanchuk (1989) conducted research which seemed to indicate that subjects preferred Geneva font on a Macintosh. However, Misanchuk, et al. (in press) caution against taking these previous results too seriously, as many variables were not controlled. They further suggest: "rapid advances in technology (new fonts; higher-resolution displays) may make the generalizability of the existing research questionable." Indeed, there are typefaces being designed specifically for web use which are completely designed to be used on a computer. Microsoft's home page includes a section on "Typography on the Web" which includes several of these fonts which are freely distributed. With the advent of Cascading Style Sheets, designers can specify that these fonts be used on web pages to increase readability (Veen, 1998) Below are examples of two fonts recommended for use on web pages:

This is an example of Verdana 9 point

This is an example of Verdana 14 point

This is an example of Georgia 9 point

This is an example of Georgia 14 point

These fonts are specifically designed to be legible in both small and large font sizes on the screen.

Text Justification

Typographic convention in magazines and newspapers usually requires that text be full justified; however, research indicates that ragged right text justification is the easiest to read (Muncer, S. J., Gorman, B. S., Gorman, S., and Bibel, D. ,1986; Trollip, S. R., & Sales, G., 1986, as cited in Schwier and Misanchuk, 1993). Full justification requires that both margins be aligned - methods to accomplish this alignment include leaving spaces between letters or words, or hyphenating words. Hyphenation of words makes decoding more difficult. For comprehension purposes, don't use full justification of text on the screen.

Color

Misanchuk, et al. (in press) suggest a cautious approach to the use of color and suggest that materials should be designed in shades of gray, black and white first, with color added later in a fashion which adds to instructional effectiveness. There are several reasons why this is good advice. There are many people who suffer from some type of color deficiency ranging from weakness in certain colors, mainly red and green, to full loss of color (it is estimated that 8% of the population experience some type of color deficiency - Schaeffer & Bateman, 1996). Aging also affects the perception of colors. It is also possible that users are accessing your design via monochrome monitors - if important distinctions are shown by varying colors, this information will not be available to these users. Shneiderman warned that "...excessive or inappropriate use of color can inhibit performance and confuse the user" (Shneiderman, 1998, p. 265). Horton (1991, p. 164 cited in Misanchuk et al (in press)) warns that

"Unless used carefully and sparingly, color can make the tasks of reading text and interpreting small objects slower, less accurate, and more painful...color reduces legibility...color produces fuzzy edges...[and] color tires the eyes". Marcus (1995) suggests " Color can be a powerful tool for communication if used correctly... use appropriate highlighting and deemphasis techniques to convey meaningful semantic distinctions" (p. 429). If used incorrectly, however, color can interfere with functionality.

Schaeffer & Bateman (1996) discuss color in terms of its affective role, its structural uses and its cognitive uses. The affective role of color concerns how color can be used to motivate or generate an emotional response. Structural uses for color involve assigning functional meanings to various colors (ie. menu items in one color, instructions in another color and error messages in a third color). In this way, color can help the user to differentiate between the functions of various text messages. Color can also be used to attract the user's attention to convey messages which must be addressed quickly. The cognitive uses of color involve: highlighting salient features; color coding, which may help with retrieval of information; decreasing the cognitive load by using colors with accepted meanings (ie. red - stop, yellow - caution, green - go); and simplifying complex information (ie. using color to organize information by differences or relationships).

Based on literature reviews, Pett and Wilson (1996), Schwier & Misanchuk (1995) and Murch (1995) have contributed lengthy lists of guidelines for the use of color. These guidelines can be found in Appendix A. The bottom line on color: design conservatively, possibly starting with black and white; do not make color the only way to

discriminate between choices; and,use it appropriately to serve the purposes of clarity and functionality.

Icons, Buttons, Radio Buttons, Check Boxes and Pull-down Menus

In both multimedia and web design, great attention is paid to the navigation interface, the means by which users are able to navigate from one location to another. In many treatments, navigation is initiated by using icons, buttons or menus. Where buttons or menus are not terribly difficult to design, icon design is much more complicated.

The main requirement for buttons, radio buttons, check boxes and menus is that they have the appropriate affordance, that is, they look like something you would normally press, click, put x's in, or pull down (Shneiderman, 1998; Norman, 1988). This is not too difficult to achieve on the web since HTML includes special routines which draw radio buttons, check boxes and pull down buttons for you. The design of buttons is a bit trickier, since you have to draw your own graphic and make it look like a button (bevelled edges give the 3D effect which makes a graphic look like something you would press). The second requirement, which is harder to achieve, is to give the user some feedback that execution is occurring after a button is pressed. This was much harder in the past, but with the addition of Javascript to the newer web browsers, icons will flash or change color when pressed, giving the user the sense that something may happen.

Icons can be very useful when designing navigation aids, but they also have their pitfalls. Advantages of icons include: to help users work

smarter by improving productivity and reliability (road signs can read at twice the distance and half the time as word signs (Horton, 1994)); to represent visual and spatial concepts such as shape, color, position, angle, size, texture, and pattern; to save space in crowded screen displays; to speed search (we can recognize icons much more quickly that reading a list of words); for better recall and immediate recognition (Both Braden (1996, p.498) and Horton (1994, p.5) cite studies where graphic recall is close to 100% accurate); to allow illiterate or semi-literate users to function in the system; and, to increase global access to your web page or multimedia product. On the downside, it is very challenging to design icons - the constraints of a very small space make it difficult to convey a message (especially a concept as opposed to a concrete operation). As Horton (1994, p. 15) states: " Obscure icons make computer screens look like the control panel of an alien spaceship. Gaudy, garish icons make them look like a piece of "refrigerator art." "

Shneiderman (1998) includes the following guidelines for the use of icons:

- represent the object or action in a familiar and recognizable manner
- limit the number of different icons
- make the icon stand out from its background
- consider three dimensional icons; they are eye-catching but also can be distracting
- ensure that a single selected icon is clearly visible when surrounded by unselected icons
- make each icon distinctive from every other icon
- ensure the harmoniousness of each icon as a member of a family of icons. (p. 208)

Screen Resolution and Access Issues

Many of the recommendations for layout discussed above pertain to either paper page layout or fixed screen layout for CAI or multimedia. The web presents a unique challenge to designers for several reasons. Since the web can be used on multiple platforms, with varying screen resolutions (from 640 x 480 up to 1048 x 760) and with color depths varying from black and white all the way to 32 bit color, a designer needs to be very careful in the way they design their layout. Many recommendations suggest designing for the lowest common denominator. In terms of the majority of web users, this requires designing for a Macintosh (Macintosh screen area is smaller than Wintel machines) with a 14 inch monitor (640- x 480 pixel area) and 256 colors (although 16 color machines are still used, and many users still access the web with text-only browsers such as Lynx). Further suggestions include starting your design in black and white to ensure readability for persons with color deficiency and including ALT tags on all image files to ensure that people using text-only browsers or special readers (ie blind or sight deficient users) are still able to access the information provided in your pages (Lynch & Horton, 1997). Appendix B includes a ruler which can be used to design pages which will fit on all machines (Gillespie, 1998).

Writing Style

After conducting 3 studies on web reading styles, Morkes and Nielsen (1997) have published the following conclusions: 1) users like summaries and the inverted pyramid style used by journalists, where the most important information

is presented first in an article; 2) users appreciate headings which help them to scan and locate the information they are interested in 3) users do not appreciate flowery or "marketese" writing and want web pages to be concise and 4) simple and informal writing is preferred over formal writing styles.

Use of Graphics in Design

Research into static and dynamic illustrations in text and computer based instruction adds another dimension to the consideration of elements of web screen design (Anglin, Towers & Levie, 1996; Levie & Lentz, 1982). This research examines how graphics are used and indicates when a graphic is useful or distracting.

Functions of Graphics

Various authors have categorized the role of graphics within the instructional context (Duchastel, 1978; Levin, 1981; Levie and Lentz, 1982; Brody, 1984 as discussed in Misanchuk et al. (in press); Alesandrini (1984) as discussed in Anglin, Towers & Levie, (1996)) These authors have categorized the role of graphics in different ways; from a low of three functions (Duchastel, 1978) to a high of twenty functions (Brody, 1984). As Misanchuk et al. (in press) state: "While their conclusions are not in complete agreement, neither are they contradictory. Rather, they usually emphasize slightly different things." For this review, we will look at one of the categorizations, that of Levie & Lentz (1982) as an example of the different ways graphics can be used to aid instruction.

Levie and Lentz (1982) identified four functions for graphics: attentional; affective; cognitive and compensatory. Pictures attract

attention to the material or direct attention within the material - hopefully using graphics in this way will heighten the likelihood that a user will remember the material. Pictures also enhance enjoyment or affect emotions and attitudes. The cognitive use of graphics involves using pictures to increase comprehension (for example, providing elaboration for a text explanation), to improve recollection and retention, or to provide information that is not otherwise available. The compensatory use of pictures involves helping poor readers by adding pictorial clues to decode text.

Alesandrini (1984) expanded the functions for graphics by discussing three types of graphics: representational; analogical and arbitrary. Representational pictures resemble the concept being discussed. Photos, drawings and models are examples of representational graphics. Analogical graphics show meaning by acting as a substitute and suggesting a similarity to the topic being discussed. Arbitrary graphics are schematized pictures which bear a logical relationship to the topic being discussed. Charts, diagrams, flowcharts and schematic diagrams of computer or electrical circuits are examples of arbitrary graphics.

Proper Use of Graphics

After reviewing numerous studies of the use of static graphics as an adjunct to text instruction, Anglin, Towers, and Levie (1996) reached the following conclusions:

> static visual illustrations can facilitate the acquisition of knowledge when they are presented with text materials. However, the facilitative effects of illustrations are not present across all learning situations....Illustrated visuals used in the context of learning to read

> are not very helpful; illustrated visuals that contain text-redundant information can facilitate learning; illustrated visuals that are not text- redundant neither help nor hinder learning; illustration variables (cueing) such as size, page position, style, color, and degree of realism may direct attention but may not act as a significant aid in learning; and, there is a curvilinear relationship between the degree of realism in illustrations and the subsequent learning that takes place (p. 766)"

Misanchuk et al. (in press) suggest that there are various issues which need to be addressed in considering how to use graphics or whether to use graphics at all. These issues include germaneness, realism, complexity/simplicity, size and cultural factors.

Germaneness - Germaneness means that a picture is not only relevant to the discussion, but essential. It cannot be removed without harming comprehension.

Realism - although it would seem evident that high quality, realistic pictures would be most effective, research has not verified this understanding. In many instances, "the detail of a photograph may also overwhelm the learner with irrelevant information so that instructionally salient features are difficult to discern" (Lowe, (1995) p. 294, as cited in Misanchuk et al. (in press)). In many instances, simplified drawings will prove better instructional aids since they focus attention on the salient points under construction. (Houseman, 1997)

Complexity/Simplicity - Misanchuk et al. (in press) suggest: " The general rule of thumb is to use graphics that are as simple as possible. Complexity should be added only where

absolutely required."

Size - Reeves and Nass (1996) discovered that larger pictures caused more arousal, were better remembered and were better liked than smaller ones. Since larger pictures are more memorable, it would seem important to include the largest pictures you could possibly use on your page. As Misanchuk et al. (in press) point out, however, the larger the picture, the longer the download time and the more likelihood that your user will become frustrated and leave your site. It is necessary to balance the need to have a graphic which is large enough to be comprehensible with the need to have the page download quickly before users move on. It is also important that you design graphics which are not too large for the user's screen. Lynch and Horton (1997) have included recommendations for maximum width which would be viewable across platforms (see Appendix C for recommendations).

Cultural factors - Since it is possible that users from other cultures will be viewing our sites, it is important that care is taken to ensure that the use of certain colors or graphics does not offend users from other cultures. Horton (1993) gives recommendations about using graphics in culturally sensitive ways. See Appendix D for his recommendations.

Visuals that complement the text information being presented increase the likelihood for retention of that information, but visuals which are not related to the text have no effect on retention. When bandwidth is a problem, gratuitous visuals would seem to be unnecessary in page design.

Further Screen Design Issues

Hannafin and Hooper (1989) term the above mentioned aspects of screen design the behavioral aspects of screen design. While important factors to consider, in terms of actual instructional outcomes, sometimes these graphic elements become less important than other considerations for an instructional setting. For example, where guidelines may indicate that spaciousness and legibility should be considered,

> image quality may be important when details must be presented, but techniques that intentionally obscure image quality, or increase the vividness of an image, may actually deepen processing....a single detailed screen that helps to contrast critical differences between examples and non-examples ... may be more effective than several, spacious screens that fail to illustrate important relational differences (Hannafin & Hooper, 1989, p. 157)

Hannafin and Rieber (1989) have developed a model of instructional design termed **ROPES** (**R**etrieving, **O**rienting, **P**resenting, **E**ncoding, **S**equencing) which can be used to made decisions about screen design. Below are guidelines pertaining to some of the aspects of this model.

Retrieving -According to cognitive theory, new information will be remembered and understood better if it is integrated within the framework of past knowledge. Retrieval of past knowledge is important in the processing of new information. One guideline suggests that learners should create notes on the computer as information is being read in order to link the old with the new. Another guideline related to retrieval involves the representation of graphics. In some instances, the literal fidelity of an image is very important (eg.

high quality representation of a human heart) while in others the functional fidelity takes precedence (eg. a diagram of the actual paths in an electronic circuit as opposed to the photographic image of a chip) (Hannafin & Hooper, 1989).

Orienting - Orienting activities show the learner which information is essential; they act to focus attention on aspects of the information. These activities can include graphic organizers, lesson or content maps, summaries or objectives, even cuing devices such as headings or highlighting which point out important points. Another orienting activity is consistent frame design. Consistency in the design of the navigation and text elements allows the learner to focus all his/her attention on learning without the distraction of trying to figure out where they are, how to move, or where the information is located (Misanchuk et al., in press).

Encoding - The process of encoding takes transitory information stored in working memory and transfers it to long term memory (LTM). The more meaningful this information is, the more likely it will be stored in a retrievable form in LTM. Aids to the organization of new information such as text outlines and headings, will promote this transfer. Segmenting text into meaningful units will aid in encoding. Combine text and graphics only when redundancy exists between them. Watch that motivational screen designs are not too stimulating; they may interfere with learning by overloading working memory with extraneous information (Hannafin & Hooper, 1989).

Multimedia research

Because of the ability to link animation, sound, and pictures together on a web page, studies of multimedia may add to our understanding of web page design. One such review, which cited research on perception, animation, and multiple-channel communication (Moore, Burton and Myers, 1996), contains findings which may be important for page design. The finding that pictorial information is remembered much more easily than text (Anglin, et al.,1966; Braden, 1996; Horton, 1994) led researchers to propose the dual code theory (Paivio, 1971, 1986, as cited in Moore et al.,1996) which states that people store information in two ways depending on whether it is verbal or pictorial information. Because text accompanied by pictures was actually saving information in two separate ways, (encoded verbally and as a picture) there is more likelihood that people will remember the information if it is presented in both formats. This is the rationale for multimedia presentations, whether the pictures are static illustrations or dynamic animations. The same is somewhat true when combining pictures with audio. However, combining audio with text appears to overload the channels, and once our information-processing channels are overloaded, no learning takes place. It is important when designing a multimedia web site that you do not throw too many different modalities (picture, text, audio, animation) simultaneously at the user or you will overload his(her) capacity to process and store the information you are presenting.

Jakob Nielsen (Dec., 1995) has provided guidelines for the use of animation, video and audio on the web. These guidelines are useful for deciding when to include multi-media elements on a site and when to forego their use. The

deciding factor, as for most web elements, is that of response time.

Animation

Moving images focus attention. A study by Reeves and Nass (1996) using an EEG to measure brain waves showed that attention increased every time motion appeared on the screen. Needless to say, it is hard to concentrate on reading a message if you brain is attending to the spinning logo or the cycling advertisement at the top of the screen. Rieber states that " designers...must resist incorporating special effects, like animation when no rationale exists" (Rieber, 1990, p. 84, as quoted in Anglin, et al., 1996). Appropriate uses for animation include showing continuity in transitions, indicating dimensionality in transitions, illustrating change over time, multiplexing the display and enriching graphical representations (Nielsen, Dec. 1995).

Video

Due to the restrictions of bandwidth, use of video is not recommended to any large extent. When video is used, production values are typically low and disappointing to the user. Video windows are very small resulting in poor video since it is difficult to discern detail. Nielsen (Dec. 1995) suggests video be used in a limited way to promote television shows, give users an impression of a speaker's personality and demonstrate things that move such as ballet clips or demos of products which need to show movement. It is very important that, if you include a video on your site, you also include information about its size so that users can decide whether or not they want to wait. Never incorporate the automatic downloading of a video into the loading of a page.

Audio

"The main benefit of audio is that it provides a channel that is separate from that of the display. Speech can be used to offer commentary or help without obscuring information on the screen." (Nielsen, Dec. 1995) Audio can add music to your site, evoking a mood or giving you a sample of what something sounds like. It can promote an artist, add interest to a text site by humanizing the author, or teach you how to pronounce words in another language. If audio is included, it should be produced on the best quality sound equipment you can obtain. Reeves and Nass (1996) found that people will put up with poor video but are very affected by poor audio.

Response Times

Research on response times for stand-alone computer operations have been established for a long period of time (Shneiderman, 1998; Nielsen, 1993). According to Nielsen:

Research on a wide variety of hypertext systems has shown that users need response times of less than one second when moving from one page to another if they are to navigate freely through an information space...Currently the minimum goal for response times should therefore be to get pages to users in no more than ten seconds, since that's the limit of people's ability to keep their attention focused while waiting....speed must be the overriding design criterion. To keep page sizes small, graphics should be kept to a minimum and multimedia effects should only be used when they truly add to the user's understanding of the information. (March, 1997, online)

Human Interface Design

Another area of inquiry relevant to web page design is the research on human-computer interaction, also called human interface design, which seeks to discover the most efficient way to design understandable electronic messages (Shneiderman, 1998; Norman, 1988; Nielsen, 1993). Research in this area is voluminous - a complete branch of computer science is devoted to this topic. Shneiderman (1998) discusses guidelines for menu use, icons, form fill-in, data display and entry, and color use. He elaborates three principles of human computer interface design as follows: 1) recognize the diversity; 2) Use the Eight Golden Rules of interface design; and, 3) prevent errors. These principles will be discussed below.

Recognize Diversity: In order to recognize the diversity, the designer must take into account the type of user frequenting his system, ranging from novice user, knowledgeable but intermittent user and expert frequent user. Each type of user expects the screen layout to accommodate their desires, novices needing extensive help, experts wanting to get where they want to go as quickly as possible. Accommodating both styles on the same page can be quite challenging. Approaches to address the differences in users involve such things as including both menu or icon choices as well as commands (ie. Command or Control P for Print as well as an icon or menu entry), or providing an option for both full descriptive menus and single letter commands.

Eight Golden Rules of Interface Design: The Eight Golden Rules of Interface Design include the following: 1) strive for consistency; 2) enable frequent users to use shortcuts; 3) offer informative feedback; 4) design dialogs to yield closure; 5) offer error prevention and simple error

handling; 6) permit easy reversal of actions; 7) support internal locus of control; and, 8) reduce short-term memory load. A detailed explanation of these elements can be found in Appendix E.

Prevent Errors: The third principle is to prevent errors whenever possible. Steps can be taken to design so that errors are less likely to occur, using methods such as organizing screens and menus functionally, designing screens to be distinctive and making it difficult for users to commit irreversible actions. Expect users to make errors, try to anticipate where they will go wrong and design with those actions in mind.

Human Factors Research

One researcher who has contributed extensively to the field of human-computer interface design is Donald Norman. This psychologist has taken insights from the field of industrial design and applied them to the design of user interfaces.

According to Norman (1988):

Design should:

use both knowledge in the world and knowledge in the head. Knowledge in the world is overt - we don't have to overload our short term memory by having to remember too many things (icons, buttons and menus provide us with knowledge in the world - we don't have to remember the command for printing, it's there in front of us). On the other hand, while knowledge in the head may be harder to retrieve and involves learning, it is more efficient for tasks which are used over and over again (providing command key sequences like Control P for Print are an example of this).

"make it easy to determine what actions are possible at any moment (make use of constraints)"

(p. 188). For example, well- designed things can only be put together certain ways (the trapezoidal SCSI cable is an example), and menus only display the actions which can be carried out at that time (other options are dimmed).

"Make things visible, including the conceptual model of the system, the alternative actions and the results of actions" (p. 188). Provide an overview map of your site so that your user can design their own mental map of how things work.

"Make it easy to evaluate the current state of the system" (p. 188). You can do that by providing feedback in the form of messages or flashing buttons.

"Follow natural mappings between intentions and the required actions, between actions and the resulting effect; and between the information that is visible and the interpretation of the system state" (p. 188). It should be obvious what the function of a button or menu is - use conventions already established for the web, don't try to design something which changes what people are familiar with.

"In other words, make sure that (1) the user can figure out what to do, and (2) the user can tell what is going on." (Norman, 1988, p. 188)

Metaphors, Conceptual Models, Mental Models

One of the ways to make a web site understandable and easier to use involves the use of metaphor. A good metaphor makes it much easier to anticipate actions. Two of the metaphors which have made the web experience easier to understand involve the ideas of browsing and searching. Both of these metaphors have been

transferred from our understanding of how you find things in a library. Browsing occurs when you wander around looking for something interesting while searching involves designing an active plan to find some information. Time spent in front-end analysis will often result in dividends if a useful metaphor can be developed to help navigation.

The designer analyzes the content to be taught, the task to be performed or the information to be displayed, and defines its structure and functionality. This structure in the designer's mind is called a conceptual model (Bielenberg, 1993, p. 14)

The user also has a model, a mental model which he has built up according to his experiences in a site. For example, a designer may have in mind an online catalogue, with feature screens describing products and an online ordering system (here again, we use the metaphor of the catalogue to make things easier to understand). The user may be familiar with the paper version of a catalogue but may be unsure how the online version corresponds to his understanding. After trying options, the user will begin to develop his own mental map, based on his experiences. However, if his mental model is different from the designer's conceptual model, errors will occur and the user will become confused or frustrated. In designing a conceptual model, the closer your design matches familiar situations, the easier your system will be to use.

Usability Research

Jakob Nielsen has been conducting web usability research since its inception. As with any kind of design activity, it is very important that several types of evaluation occur early on in the

design of a web site. One method of testing involves asking typical users to work through paper mockups of screens, using talk-aloud protocols to show what they are thinking about. A second method involves working through a design using heuristics (see Appendix F for a list of 10 usability heuristics plus Keith Instone's adaptation of these heuristics for the web). A third method involves setting users down in front of a rough prototype of a system and watching them as they work through the design (this method also utilizes the think-aloud protocol as well as video-taping the user). Nielsen (Dec. 1997, online) has published a list of guidelines for web design (see Appendix G) based on usability tests run since 1994. Some significant findings from this report include: most users don't read, they scan for information; the author's personality makes a site more attractive; web users are impatient, they don't want to be slowed down by cool features or self-promotion; search capability is very important; download factors are critical; animation is almost always annoying; frames are disliked; wild backgrounds disrupt a user's reading; more users are scrolling (pages no longer than 3 screens are recommended) but many still don't go beyond the first screen; image maps are more usable now, especially if they are broken up into smaller sections that load more quickly than one large graphic; and, users want sites to work and are no longer tolerant of those that don't.

Microsoft Network has also been conducting usability research and has produced a checklist which designers can use to ensure their web pages are effective (Keeker, 1997). See Appendix H for this checklist.

Hypertext and Hypermedia

> The name hypertext, or hypermedia, has been applied to networks of nodes (also called articles, documents, files, cards, pages, frames, screens) containing information (in text, graphics, video, sound, and so on) that are connected by links (also called pointers, cross-references, citations). Hypertext is more commonly applied to text-only applications whereas hypermedia is used to convey the inclusion of other media, especially sound and video (Shneiderman, 1988, p. 553).
>
> The intrigue of hypertext is that it extends traditional linear text with the opportunity for jumping to multiple related articles. Convenient backtracking, clickable indexes and tables of contents, string searching, bookmarks, and other navigation tools profoundly alter the reader's experience....hypertext authors need to choose appropriate projects, to organize their articles suitably, and to adjust their writing style to make the best use of this new medium (Shneiderman, 1988, p. 556).

Research on Learning with Hypermedia

In a review of hypermedia-based learning, Ayersman (1996) discussed four strands of research into learning and hypermedia: research based on perceptions or attitudes about hypermedia; research based on individual differences or learning styles; research based on system analyses (which examined the most effective ways to structure hypermedia); and, research based on performance which ranged from use of pre-made software to the construction of one's own software. Some of the conclusions included a generally positive attitude for hypermedia, an indication that multimode hypermedia can address different learning styles more effectively than single-mode teaching, and, indications that hypermedia is at least as effective as lecture and especially effective with remedial

and learning-disabled students. As well, having students construct their own hypermedia had benefits which go much further than the acquisition of content; one study reported increases in many higher level cognitive processes such as "finding and interpreting information, articulating and communicating knowledge, and using computers as cognitive tools" (p. 516).

As a counterbalance to this optimistic review of the potential of hypermedia for learning, McKnight, Dillon & Richardson (1996) provide a different viewpoint. After reviewing various studies on learning and hypermedia, and finding few significant differences between results for linear instruction and hypermedia, they conclude "If there is little reliable evidence (yet) to support the claims that hypertext systems can really support alternative and superior modes of learning, and we have few effective means of measuring the process of learning anyway, where does that leave us? They conclude that we shouldn't expect so much of hypertext, that we need to focus less on the process of learning and more on the outcomes (student achievement) and that an evolutionary approach to design based on user-centered task-based design should be taken. It will be interesting to view what outcomes are forthcoming when this research focus is extended to the World Wide Web with its unlimited potential for individualized learning along with the concomitant problem of disorientation.

Guidelines for Hypertext Creation

Shneiderman (1998) provides the following guidelines for creating a hypertext database:

- Know the user and their tasks.
- Ensure that meaningful structure comes first.

- Apply diverse skills (by including information specialists, content specialists and technologists on the project team).
- Respect chunking. Organize information into chunks that deal with one topic, theme or idea.
- Show interrelationships (by using links to related articles).
- Ensure simplicity in traversal. Design the link structure so that navigation is simple and consistent throughout the system
- Design each screen carefully.
- Require low cognitive load. Minimize the burden on the user's short term memory. Do not require the user to memorize terms or codes. The goal is to enable users to concentrate on the contents while the computer vanishes (p. 558-559).

Navigation

Navigation in webspace is another important topic to be addressed in web design. Hypermedia can be liberating, allowing the user to plot their own course through a body of information or it can be disorienting, when users get lost in hyperspace (Poncelet and Proctor, 1993). These problems can be addressed through the use of orientation and navigation information (Schwier and Misanchuk, 1993), as well as through attention to structure (Lai & Waugh, 1995; Lynch & Horton, 1997).

Orientation

Orientation information helps the user to identify where he(she) is in the site. It is equivalent to page numbers and chapter headings in a book. Orientation information is easiest to use if it is located in the same place on every page. It is crucial in web design since users may jump into your site at any level. Lynch and Horton (1997) recommend that the following items should be present on every page of a site to aid in orientation: "state the title, the author, the

author's institutional affiliations, the revision date and provide at least one link to a local home page in every WEB page in your system". Since users can enter your site in a location other than the home page, they also suggest including buttons on each page which will move the user to the next or previous page of a sequence.

Shneiderman also discusses orientation methods. He suggests four different techniques to convey a site's organization: use an executive summary which gives an overview of the site and contains links to all the major concepts; adopt a hierarchical approach which links to major categories only; design the home page as a detailed table of contents; and, provide a search option as a first step. However, searching a site may be problematic as well - recent research on within-site searching found that "users were 50 percent more likely to find what they were looking for if they never hit the search button" (Festa, 1998, p.1). Rosenfeld (1997) adds another orientation device, the alphabetized site index, as another means of assisting the user's inquiry while Balasubramanian (1993) comments that graphical browsers, overview diagrams, web views, paths, trails, guided tours and tabletops, history lists, timestamps, footprints, bookmarks, backtracks, embedded menus, fisheye views and roam and zoom techniques are all tools added to assist in orientation and navigation.

Structure

Lai and Waugh (1995) conducted research on several different types of hypertext menu design and their effect on search tasks. Their design featured: (1) external menus based solely on hierarchical structures; (2) menus which featured a mixture of hierarchical and embedded

structures (a hierarchical overview with embedded links on the pages for elaboration); and, (3) a system of embedded menus (which consisted entirely of contextual links embedded in text). They concluded that "network structured documents (2 & 3) could improve search accuracy, though not efficiency". Further conclusions were: the search task affected the type of menu used, with hierarchical menus (1) working better for straightforward tasks and "embedded menus (2 & 3) may be used when search tasks are mostly complex and not fully known and the designers wish to encourage in-depth searching behavior" (p. 46-47). Lynch and Horton (1997a) also recommend a hierarchical structure since "web sites should always be organized as offshoots of a single home page."

When designing navigation throughout a site, the research suggests that several large menus work better than a large number of menus with smaller amounts of links. Research which studies breadth vs depth in menus suggests that "breadth should be preferred over depth...when the depth goes to four or five [levels], there is a good chance of users becoming lost or disoriented (Shneiderman, 1988, p. 249). Suggestions for ways of grouping menus include: create groups of logically similar items; form groups that cover all possibilities; make sure the items are non overlapping; and, use familiar terminology, but ensure that items are distinct from one another.

Based on web research conducted by Spool, Instone (1997) suggested the following:

> The best-rated sites coupled their navigation and content tightly. If you doubled the amount of content, the navigation pages would have doubled in size. The navigational links tended to be textual, and descriptive, so that users knew

what to expect even before they jumped. (page 3)

Nielsen (Nov. 1997) suggests the following as ways a designer can aid their users with navigation issues: include a site identifier on every page; make it easy to go to landmark pages such as the home page or the search page; emphasize the structure of your site by making each page show which subsite it belongs to; do not change the default colors for links and visited links (keeping the underlines intact would make it easier for monochrome viewers); and, draw a sitemap to illustrate the relationships between main areas of your site.

Web Site Guidelines

After surveying the web for guidelines about web design, Boling, Bichelmeyer, Squire and Kirkley (1997) identified the following problems: a) guidelines are often derived from studies of paper-based materials, or they are not based on research at all; b) guidelines are inconsistently named and organized; c) guidelines tend to focus on single elements rather than integration of elements; d) standard guidelines are difficult to apply to the context of web page design; and e) guidelines often do not address cross-cultural & international diversity. From this initial survey of guidelines, Boling, et al. (1997) then proceeded to carry out research designed to organize these guidelines into a meaningful framework. Focussing on the function of web sites, they devised a classification of seven profiles for web sites based on a matrix of high information, high motivation to low information, low motivation. For each profile, they provided guidelines for site design. A quick summary of their profiles are as

follows:

Profile 1: No Expectations - very low need to motivate users or deliver content - eg. personal home pages;

Profile 2: All Motivation - high need to motivate users to view site - eg. promotional commercial sites;

Profile 3: All Content - high need to deliver content where site may be the only provider of this information or users are highly motivated to use site already- eg. search engines or research results;

Profile 4: High Motivation - a need to provide some content along with motivating factors, at same time users must be able to distinguish between content and glitz - eg. Bill Nye, the Science Guy;

Profile 5: High Content - need for content outweighs the need for high motivational factors but an attractive site is necessary - eg. government agencies, universities;

Profile 6: Mixed Elements & Profile 7: Great Expectations - " in both these profiles the need to deliver specific content and the need to motivate users to a specific response are highly interdependent and interrelated" - eg. commercial catalogue sites, sites devoted to charitable or political causes, or educational sites. (See Appendix I for a complete description of these Profiles and the guidelines accompanying each profile)

The authors also include some universal guidelines for web design which include the need to eliminate distracting elements from a design, the need to follow web conventions to ensure

consistency, and the need to consider the low-bandwidth or low- end system users when designing a site.

Small (1997) developed a checklist for rating the motivational quality of websites which included four dimensions: engagement; meaningfulness; relevance and organization. This checklist is included in Appendix K.

Summary

This paper has discussed the design of web pages using research pulled from instructional screen design (for multimedia and CBI) and human computer interface design. Further emphases include a discussion of the concepts of classical graphic arts design, hypertext and the problems of hypertext navigation. Final topics included a checklist for designing motivational web sites and a series of functional web site profiles which could be used to design sites for specific genres (Shneiderman, 1998). It is hoped that this compilation of research findings and guidelines will be useful heuristics for the design of instructionally valid, aesthetically pleasing web sites.

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