Design Principles for Online Information: Readability, Usability, and Accessibility
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ABSTRACT
The Web is becoming the standard media for disseminating information. But whether the information is a simple form (such as a user feedback survey), a collection of raw data (such as survey results), or a series of reports and data analyses, “putting it on the Web” involves more than uploading a few files to your Web server. Before information goes online, you need to think about who will be using it and how they will be using it. Page design (such as colors and fonts), navigational ease and consistency, and – with the increasing importance of Section 508 requirements – site accessibility are all issues you must consider. By explaining the concepts and providing concrete guidelines, this paper will help you make your online information as effective as possible.

INTRODUCTION
Would you publish a book written in Russian, if you knew the targeted readers couldn’t read Russian? Would you advise a business to make a billboard dark pink with light pink letters? Would you tell a client their report was in a locked room, then refuse to give them the key? Of course not. All the above scenarios are ridiculous. But unfortunately, much of the content on the World Wide Web is just about as ridiculous: content that is unreadable, pages that are unusable, information that is inaccessible. None of this is done on purpose, but rather because the people who put information on the Web may not be aware of readability, usability, and accessibility issues and standards.

After reading this paper, you should come away with a firm grasp of some of the basic do’s and don’ts of web design. Following the suggestions here will assist you in developing online information that is readable, useable, and accessible to a wide audience. To further help you design good Web content, the section on testing talks about what goes into usability testing. And, since this paper is limited in scope, the “Web Design Resources” section lists several links you can follow to gain more in-depth information on web design. The Appendix provides some actual HTML code that implements some of the Tips given in this paper.

READABILITY
Although research into readability of printed material is plentiful, there has been less done in the area of readability of online information. And what studies have been done have come up with contradictory advice. Readability consists of both legibility and understandability. Legibility depends on many factors, such as font size and typeface, color combinations, background texture, word style (bold, italicized, etc.), and computer pixel size. Understandability depends on things such as sentence length and word choice.

Following these general guidelines should help you create readable Web pages:
Font and Typeface
- Don’t use tiny font sizes. The smaller the font, the greater the eyestrain. Many times, people will skip over hard-to-read font sizes, ignoring the information.

Tip: Use Cascading Style Sheets (CSS) and JavaScript to dynamically scale font sizes on your Web pages to the user’s screen resolution.

- Use popular typefaces wherever possible. These include Arial, Helvetica, Verdana and Times Roman. If a user doesn’t have the font you use loaded on their computer, the browser will substitute a different, available font (with possible degradation to your site design).

Tip: Use Cascading Style Sheets (CSS) to control font substitution.

- Use plain text (as opposed to italics or boldface) for the majority of the information on pages. Use bold for headings or important words. Italics are hard to read online, and should rarely be used.
- Check your website readability on a few major screen resolutions.

Color Choices
- Choose colors that provide high contrast. Low contrast irritates the reader and causes eye fatigue. Viewers with impaired vision may not be able to read low contrast text at all. What is contrast exactly? It is the difference in intensity between two areas. For example, highly saturated green on highly saturated red does not provide good contrast, while highly saturated green on light red does provide sufficient contrast. The most common examples of high contrast is white on black or black on white – but these may not be the most readable color choices. Figure 1 shows some high-contrast and low-contrast color combinations.

<table>
<thead>
<tr>
<th>Good – High-Contrast Color Combinations</th>
<th>Not-so-Good – Low-Contrast Color Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary Had a Little Lamb</td>
<td>Mary Had a Little Lamb</td>
</tr>
<tr>
<td>Its Fleece Was White as Snow</td>
<td>Its Fleece Was White as Snow</td>
</tr>
<tr>
<td>Everywhere that Mary Went</td>
<td>Everywhere that Mary Went</td>
</tr>
<tr>
<td>That Lamb Was Sure to Go</td>
<td>That Lamb Was Sure to Go</td>
</tr>
</tbody>
</table>

*Figure 1. High-Contrast vs. Low-Contrast Color Combinations*

- Use really bright and highly saturated colors only sparingly and judiciously.

Tip: Use the color wheel to pick complementary colors.
- Avoid mixing colors that are on the extreme ends of the color spectrum (i.e., blues and red). This is because blues have short wavelengths, while reds have long wavelengths; it is difficult for the human eye to focus on both at the same time, and fatigues the eyes.

**Backgrounds**
- Avoid “busy” backgrounds that distract the eye and make the text hard to read. Although “tiling” is a popular technique, it can detract from the text on the page, and can also negatively affect page download time.
- For large chunks of text, avoid dark backgrounds with light text because they are difficult to read, as Figure 2 illustrates.

```
Four score and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation or any nation so conceived and so dedicated can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting-place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this. But in a larger sense, we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead who struggled here have consecrated it far above our poor power to add or detract. The world will little note nor long remember what we say here, but it can never forget what they did here. It is for us the living rather to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us—that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain, that this nation under God shall have a new birth of freedom, and that government of the people, by the people, for the people shall not perish from the earth.
```

*Figure 2. Unreadability of Dark Background with Light Text for Large Chunks of Information*

**Word Choice**
- Keep sentences short (10 words or less).
- Use easily understandable words.

**Tip:** Use JavaScript to provide glossary popups.

- Proof read for grammatical and spelling errors.

**USABILITY**
Especially online, people scan for information – they do not read web pages from top to bottom, left to right. To get people to see the information you want them to see requires you to carefully layout your Web pages. The most important considerations are
1) how well information is broken into “digestible” chunks
2) how consistent the navigation scheme is
3) how clear the links are.

So, what do these really mean?
**Chunk Information**

- When creating headings, make them one or two point sizes larger than the body text and make them bold. Subheadings can be the same size as the rest of your text, but should also be bold.
- Use bullets, subheadings, and bolded phrases to draw attention to specific information.

**Tip:** Use height and width settings in your IMG tags so users can easily read the text on the page while graphics are loading, and things don’t jump around constantly.

**Consistent Navigation Scheme**

- Use the same links on every page, in the same order, in the same place.
- For long pages, use a “back to top” link and/or graphic, both at the very bottom, and occasionally throughout the page.
- Provide information cues that answer these three questions:
  - Where did I come from?
  - Where am I?
  - Where can I go?
- Global navigation should allow a user to always get back to the home page as well as to search from any page in case the user is lost. Figure 3 illustrates some of these navigation elements.
- Avoid what Vincent Flanders, author of “Web Pages that Suck,” calls “Mystery Meat Navigation,” which he defines as having to “mouse over a graphic to discover whether it's a link and where the link will take you.” Says Flanders, “This new, evil form of navigation has moved from trendy design sites to the corporate world and it must be stopped because it violates the first rule of navigation: clearly show people where to go.”
Figure 3. Consistent, Complete Navigation Elements
(source: http://www.stcsig.org/ctc/pages/MoreResources.htm)

The web page shown in Figure 3 illustrates a good, clean navigation system:
- The left column clearly lists various information categories.
- The current category, “Resources and Links” is highlighted in yellow in the left column.
- Across the top, under the title, you see “Resources and Links → Consultant’s Resources”. This is a visual map that tells the user where they are in the information hierarchy.
- Finally, each main heading (such as “General Consultant’s Listings” has a “Top” button – as the entire web page is about 4 pages, long, these come in handy for navigating around the page.
- To further assist navigation on this fairly long page, the main headings are listed at the top, so users can jump to the heading that interests them.
Links that Look Like Links

• Make your links look like links. (The norm is blue and underlined).
• Don’t underline other things on the page that aren’t links.

Other Usability Guidelines

• Provide a well-organized sitemap page.
• Avoid running text across the entire page. Break text up into comfortable columns. (Usually navigation links use one column on the left, and possibly also on the right, so the text itself occupies the center half of the page, which is easily scanned left to right.)
• Avoid the over-use of capitals. LONG STRINGS OF ALL UPPERCASE LETTERS ARE TIRING TO READ…
• Keep your home page small; keep other pages short as well. Remember – chunk!
• Avoid frames if possible. Some browsers do not render them well, and they can also be hard for search engines to navigate, making your page hard to find on the Web.
• When providing downloadable files, choose the file format wisely – also provide the file size in parentheses. PDF format is good for files that people are going to read only. For files (such as templates) that they will need to edit, Microsoft Word is a good format.
• Try to reduce loading times, because people hate to wait. Large graphics and Flash animation are nice to look at – but if people don’t wait for the page to load, they will never see them.


ACCESSIBILITY

Can a blind person read the information on your Web site? Can a person with no hands navigate your Web site easily? There are compelling reasons why you should care about the answers to questions.

Web Users with Disabilities Represent a Significant Market Share

Making your site accessible provides you benefits both in added customers and better public relations. At least sixteen million people in the U.S. have hearing or vision problems, and a growing number of aging people experience significantly limited sight, hearing, and manual dexterity. Consider the following disabilities and the questions they raise:

• color blindness – can users see red-colored data?
• hearing impairment – can users hear multimedia video?
• macular degeneration – if users magnify the screen, is the information still navigable?
• significant loss of both sight and hearing – can users find the restaurants and bus schedules they need? Can they download information in Braille format?
• mobility restrictions – can users without the use of their hands easily access the web site search function, using voice-recognition software?

Judy Brewer, Director of the Web Accessibility Initiative International Program Office pointed out, “With close to 20% of the U.S. population having disabilities…companies that forgo design for accessibility inadvertently throw away part of their marketplace.”
Accessible Design Benefits Other Audiences, Too
The same design techniques that make information accessible to people with disabilities offer significant advantages for other audiences. As Tom Morrissey, a Web designer in Colorado (who happens to be also visually impaired), pointed out, accessible Web sites have faster download times and facilitate transmission of Web-based data to cell phones, palm devices, and personal digital assistants (PDAs). An accessible site is more likely to be compatible with a greater number of browsers, as well.

Accessible Web sites are also more easily processed by search engines. For example, a site that captions for audio not only benefits deaf users, but also increases the efficiency of indexing and searching for audio content on the Web.

Finally, designing an accessible Web site requires you to think of your site as a logical entity. According to Morrissey, “glitz is usually just a cover for no content.” A site that is easily accessed by the disabled is also a coherent site that has the right information in the right places.

Americans with Disabilities Act Is Increasingly Relevant
If your web site is part of a government web site, then you are required to incorporate accessibility into your web design. However, the precedents are being set for applying the ADA to private Web sites, as well. By implementing accessibility, you limit your company’s exposure to future legal action.

Consider the following events:
- In 2000, a blind Australian filed a complaint with the Australian Human Rights and Equal Opportunities Commission because he found the Sydney Olympics 2000 Web site inaccessible.
- On February 9, 2000 the Subcommittee on the Constitution convened to hear “The Applicability of the ADA to Private Internet Sites.”
- Also in 2000, the National Federation of the Blind brought suit against AOL for accessibility problems. The case was later dismissed by mutual agreement, but the NFB retained rights to renew their action against AOL, if necessary.
- On June 21, 2001, a report titled “The Accessible Future” was released by the National Council on Disability (NCD). This report cites to the work of Cynthia Waddell, who is on the Advisory Board of the International Center for Disability Resources on the Internet. Waddell is a prominent proponent of applying the ADA to the World Wide Web.
- In 1996, a person with a mental illness (a disability) sued a private on-line bridge club (Hooks vs. OKBridge). In this landmark case, the Dept. of Justice (DOJ) clearly indicated that the ADA applied to Internet transactions. Although Hooks lost the case due to technicalities, the decision that the ADA applies to the Internet as a “place of public accommodation” still stands.
Ten Tips for Accessible Web Design

A truly accessible Web site can interact, or at least not interfere, with many of the following assistive technologies:

- screen readers
- screen magnifiers
- voice-recognition software
- alternative keyboards, switches, and mouse devices (such as head mouse, head pointer, or mouth stick)
- scanning software (that announces verbally the information displayed on the screen)

These ten tips will help you design accessible Web sites:

1. **Use style sheets to control layout and presentation.** Allow users to override the default style sheet so they can configure information to suit their needs.

2. **Use color with common sense.** Ensure that all information conveyed with color is also available without color (e.g., from context). Ensure that foreground and background color combinations contrast sufficiently.

3. **Support keyboard access.** Provide keyboard shortcuts to important links, form controls, and hot-spots. Allow users to create their own keyboard shortcuts.

4. **Provide a text equivalent for every non-text element** by using the ALT or LONGDESC tags. These elements include sounds, audio files, audio tracks of video, and video. Avoid descriptive text that is cryptic when read out of context, like “Click Here!” Consider creating a text-only version of the page and placing a link to it at the top of the graphical version of the Web page.

5. **Label information.** Use column and row headers in tables. Label frames and form fields. Consider using buttons instead of image maps, or at least provide the links elsewhere on the page to ensure accessibility.

6. **Give users control over content.** Allow users to slow the presentation rate of audio, video, and animations. Allow users to freeze moving content and scrolling text. Avoid auto-refreshing pages.

7. **Ensure that text, navigation mechanisms, and style of presentation are consistent across all pages.**

8. **Avoid or provide alternative content for scripts, applets, and plug-ins.**

9. **Avoid potentially annoying text attributes** such as blink, or at least allow users to turn them off.

10. **Test your design.** Perform usability testing with disabled users. If that is not feasible, use the tools available at bobby.watchfire.com/bobby/html/en/index.jsp. The Bobby site analyzes a Web page and provides a report on where accessibility might be improved. You can also see how a text-based browser will display your site by visiting www.delorie.com/web/lynxview.html.

If nothing else, provide alternate accessible formats, such as Braille, large print, and/or audio materials. Note the availability of such materials in a text (i.e., screen-readable) format on the Web page, along with instructions for obtaining the materials.
TESTING
When you have implemented a set of Web pages that you think is useable, it is time to find out what the rest of the world thinks. You may be surprised at what you find out. Usability testing starts small, and reaches outward:
- Start with colleagues
- Move to people outside your department
- Consider using your company’s intranet for broad internal testing

When choosing who should test your site, always use targeted users. That is, choose users who are similar in education, motivation, and purpose to your actual intended audience. So, if your site is designed for statisticians, test with statisticians (not students). If it is designed for marketing personnel, test with marketing personnel (not statisticians).

What should you test for? Here are some ideas:
- Learnability – the time and effort required to reach proficiency, given a specified amount of training and user support.
- Ease of use – the ease and degree to which goal-directed tasks can be accomplished at the required level of performance, with predictable results.
- Errors – the proportion of non-productive actions and errors committed, in comparison with useful actions, and amount of time and effort needed to recover appropriately from errors.
- Productivity – the level of effectiveness achieved relative to the resources users must expend, in terms of effort, time, materials, or cost, to meet the goals of using the product or system.
- Retention – the time and effort required to relearn to use the site to a certain level of performance, following a given period of non-use.
- Satisfaction – the quality of the user's experience with the site, and attitude during and after use with respect to comfort, frustration, and enthusiasm.
- Accessibility – the ease with which disabled users (vision-impaired, mobility-impaired, for example) can use your site.

Besides testing user response, remember to test the environment as well:
- Test with at least two browsers (Internet Explorer and Netscape, for example). You may want to test with several versions as well.
- Test on the Mac, PC, and UNIX.

WEB DESIGN RESOURCES
General Web Design
- www.mc.cc.md.us/departments/dispsvc/universal_design.html – provides design tips and nice HTML code examples
- www.webpagesthatsuck.com/ – hopes to educate people by showing what doesn’t work
- www.pageresource.com/ – a Web development tutorial and information site
- www.dreamink.com/design1.shtml – a comprehensive discussion of Web design
Readability
- hort.ifas.ufl.edu/TEACH/floral/color.htm – discussion of color wheel
- hubel.sfasu.edu/research/AHNCUR.html – discussion of color, font, and type
- www.successful-sites.com/archive/readability-01-22-04.php – gives poor/good contrast examples
- www.pagetutor.com/pagetutor/makapage/picker/ – good color-picker site
- www.cba.nau.edu/becker-a/Accessibility/ReadMe.html (ReadMe Tool – assess readability according to several readability indices)

Usability
- usableweb.com/#Keith%20Instone'sSite – a list of links devoted to human factors, user interface issues, and usable design specific to the World Wide Web
- www.pantos.org/atw/35317.html – usability checklist

Accessibility
- www.techdis.ac.uk/seven/eval_tool.html – list of several accessibility evaluation tools
- ltg-projects.ummu.umich.edu/~melledge/accessibilitysite/compliance.html – another good list of tools, including one that specifically checks for issues with colorblind users
- www.vischeck.com/showme.shtml – lets you see how people with various color disabilities see the world; can check an image or an entire Web site.
- www.icdri.org/aceprim.htm – alphabetical list of Web accessibility resources

ADA, Section 508, and W3C WAI
- www.access-board.gov
- www.section508.gov
- www.508compliant.com
- www.ittatec.org (Information Technology Technical Assistance and Training Center)
- www.w3.org/wai/ (Web Accessibility Initiative)

Testing
- www.delorie.com/web/lynxview.html – see how your pages look in text-only mode
- jthom.best.vwh.net/usability/usable.htm – describes various methods of usability testing

CONCLUSION
By all accounts, the amount of information available on the World Wide Web grows astronomically every day. For your own information to stand out among the rest, it is important that you make it as easily readable, useable, and accessible as possible to as many users as possible. Following the guidelines in this paper will help you reach that goal.
CONTACT INFORMATION
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Tip: Use Cascading Style Sheets (CSS) and JavaScript to dynamically scale font sizes on your Web pages to the user’s screen resolution.

(Credit: http://www.design-ireland.net/)

```html
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<title>Scalable Fonts</title>
<meta name="Author" content="John Collins">

<script language="javascript">
    //scales fonts sizes dependant upon screen width

    var sWidth = screen.width;
    //calculates the actual font size, then stores it in a global variable (fSize)
    fSize = parseInt((sWidth/100)+2);

    //now the css class is written in with the variable font size
    document.write('<style type="text/css">');
    document.write('.mainFont {font-family:arial; color:black; font-size:'+fSize+'pt;}');
    document.write('</style>');
</script>
</head>
<body>

<p class="mainFont">This is a dynamic font size of
<script language="javascript">document.write(fSize);</script>pt.
</p>

</body>
</html>

The key line in this example is the actual formula that calculates the font size:

```javascript
fSize = parseInt((sWidth/100)+2);
```

This formula takes the screen width (stored as variable 'sWidth'), then divides this by 100, then takes the integer value of this by using the parseInt() function, and finally adds 2 to this value. The '2' in this is the controlling factor, this may be increased or decreased to suit your preference. For example, if the screen width is 1024 pixels, 1024/100 = 10.24, the integer value of this is 10, 10+2 = 12. Therefore, at 1024x768 resolution, the dynamic font size is 12-point. The same formula applied at 1600x1200 resolution results in an 18-point font.
The CSS classes containing these new font sizes are then written to the document (mainFont in the above example). Although all the above code is shown to be in one HTML file, realistically you would store this script in a separate JavaScript (.js) file which can be accessed from every page throughout your site.

**Tip: Use Cascading Style Sheets (CSS) to control font substitution.**

<!--
BODY {font-family: "Arial", "Helvetica", sans-serif; background-color:#ffcc; margin: 0px 0px 0px 0px;}

//more style sheet definitions
-->

In this example, if the user does not have the Arial font installed, the browser will substitute Helvetica. If neither Arial or Helvetica is available, the browser will substitute a generic sans-serif font.

**Tip: Use JavaScript to provide glossary popups.**

```html
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<title>Glossary Popups</title>

<script language="javascript">

//Define a function to display definitions
function displayDefinition(what) {
    var b = new Array();

    //Store the definitions of the terms in an array
    b[0]="A device that displays the wave form created by an electrical generating device such as a generator, inverter, or utility.";

```
b[1]=" the instrument connected to a telescope that separates the light signals into different wavelengths, producing a spectrum. The user can then view, record, and analyze the spectrum.";

//Now write the definitions
var wnum = 0;
var name="Glossary";
var
w=window.open("",name,"resizable,status,scrollbars,left=30,top=100,width=450,height=350");
w.focus();

var d=w.document.open();
d.write("<h2>Definition for " + what + ":</h2>);
d.write();
if (what == 'oscilloscope')
    d.write(b[0]);
if (what == 'spectrometer')
    d.write(b[1]);

//Add a handy close-window button
d.write("<br><br>");
d.write('<center><button onclick="window.close(name)">Close window</button></center>');
d.bgColor="ccff99";
d.close;
}
</script>

</head>
<body>

<p>Performing this experiment requires an <a href="javascript:displayDefinition('oscilloscope');">oscilloscope</a>.</p>

</body>
</html>

In this paragraph, the word “oscilloscope” appears as a link. When a user clicks on it, the displayDefinition() function creates a second window that displays the definition of the word. Again, as with the scalable font code, you would probably want to store the displayDefinition function in a .js file so you can access it from all your pages.
Tip: Use the color wheel to pick complementary colors.

The color wheel is divided into three categories: primary, secondary, and tertiary. The three primary colors are red, yellow, and blue. These colors are considered to be foundation colors because they are used to create all other colors. By combining two of the primary colors, three secondary colors are formed. They are orange, green, and violet. The six tertiary colors are made by combining a primary and an adjacent secondary color. These colors are red-orange, red-violet, yellow-green, yellow-orange, blue-green, and blue-violet.

Tip: Use height and width settings in your IMG tags so users can easily read the text on the page while graphics are loading, and things don’t jump around constantly.

```html
<img src="Truck1.jpg" border=0 width=57 height=31 alt="Little Truck Graphic">
```

With this code, the browser allots a space 57 pixels wide and 31 pixels high for the graphic at the very beginning of the page load process. Any text that follows or is to the side of the graphic appears in the correct spot immediately, whether the graphic has loaded or not. If the WIDTH and HEIGHT parameters are not used, the text on the page jumps down and to the right as the browser figures out how much space each graphic needs—making reading the text before the entire page loads virtually impossible.

Tip: Label form fields for better accessibility.

(Credit: http://bobby.watchfire.com/bobby/html/en/gls/g41.html)

```html
<Form action="http://somesite.com/foo" method="get">
    <Label for="name">Name:</Label>
    <Input type="text" id="name" size="50">
</Form>
```
For each FORM control, place its label in a LABEL element. A LABEL is attached to a specific form control through the use of the "for" attribute. The value of the "for" attribute must be the same as the value of the "id" attribute of the form control. An HTML LABEL allows the browser to tell the user definitively which label applies to the given control. Usually, clicking on the label positions the cursor in the form field, or toggles the value of radio buttons or check boxes. This is intuitive for many users and provides a larger target for the mouse.