Designing Beneath the Surface of the Web

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ABSTRACT

At its most basic, the web allows for two modes of access: visual and non-visual. For the most part, our design attention is focused on making decisions that affect the visual, or surface, layer — colors and type, screen dimensions, fixed or flexible layouts. However, much of the power of the technology lies beneath the surface, in the underlying code of the page. There, in the unseen depths of the page code, we make decisions that influence how well, or poorly, our pages are read and interpreted by software. In this paper, we shift our attention beneath the surface of the web and focus on design decisions that affect nonvisual access to web pages.

Categories and Subject Descriptors

H.5.4 [Information Interfaces and Presentation (e.g., HCI)]: Hypertext/Hypermedia—Navigation, User issues.

General Terms

Design, Human Factors, Standardization

Keywords

Accessibility, Usability, Universal Usability, Universal Access

1. INTRODUCTION

In a web transaction, the first read of a page is by software that parses and acts upon the source code: for example, by rendering the page visually, reading the page aloud, or extracting and storing information about the page. The accuracy and effectiveness of software's rendering and actions is affected by the quality and design of the source code.

In striving to achieve good design, we generally focus on visual presentation. Our efforts are aimed at designing a visual display that is usable and appealing, with little attention given to the source code since visual users are only indirectly affected by its design. However, nonvisual users, such as vision impaired users and search engine software, do not work with the visual display. Unlike visual users, their experience is directly affected by the design of the underlying source code. Organization, quality, and clarity influence how well software can read and interpret the source code. Nonvisual web access can be improved by applying the following guidelines for source code design.

Shneiderman defines universal usability as an approach to design that is focused on "enabling all citizens to succeed in using information and communication technologies to support their tasks" [18]. A focus on page code design improves the universal usability of web pages by addressing access challenges in a variety of contexts. For instance, the small viewport on mobile devices presents many of the same challenges as nonvisual access. This paper concludes with a discussion of how these guidelines can be applied to improve web access for mobile users.

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2. GUIDELINES

Several factors influence the effectiveness of nonvisual web access. As with most applications of universal design [5], these factors improve access for all users, including visual users and users of mobile devices.

2.1 Integrity

The soundness and stability of document structure.

2.1.1 Use markup to describe document structure

Designers have a toolset of time-honored principles to communicate the structure of a document. Alignment and proximity convey information about the relatedness of elements. Typographic emphasis draws attention to important elements [10]. While effective, visual design is not a science. Structure is only implicit in the application of these principles. Additionally, principles are often misused, or abandoned in favor of more avant-garde approaches. At the end of the day, visual design conventions are meaningful to people who can see them, and even among those who can see them, are open to interpretation.

On the other hand, markup provides a means to explicitly define document structure. With markup, designers can embed information structure and relationships among page elements into content of a document. Encoded structure can be read by software, making possible "a web of data that can be processed directly or indirectly by machines," envisioned by Berners-Lee [1].

HTML offers designers a set of tags for use in describing information structure of web documents. While limited, these tags add a layer of meaning, thereby enhancing software's capacity to read and interpret of web documents. In addition, software can use structural markup to provide additional functionality to the user, such as providing a document overview using heading tags, or announcing the number of items in a list.

Use the HTML toolset (Table 1), along with design principles (see subsection 2.2.2, below), to communicate document structure to nonvisual users.

Table 1: Common HTML structural tags

Element	Usage
h1, h2, h3, h3, h5, h6	Headings
p	Paragraphs
blockquote	Quoted text
ul, ol, li	Unordered and ordered lists
table, th, tr, td	Tabular information
fieldset, legend, label	Form labels
em, strong	Emphasized words and phrases
cite	Citations (e.g., book titles)
abbr, acronym	Abbreviations and acronyms
code	Computer code
dfn	Defined term

2.1.2 Avoid meaningless and misleading markup

Web standards provide a formal grammar for constructing machine- and human-readable documents. If all web designers apply the same syntax, then all web documents are written in the same language, increasing the potential for connections among documents and data exponentially [2].

Coding to standards [22] is a relatively new practice among web designers, and is certainly not one that has been universally adopted. Many designers use markup to accomplish visual design effects, exert control, and achieve consistency across browsers. Additionally, web authoring tools don't always encourage good coding practices or generate standards-compliant code. Many popular web sites are not designed according to web standards.

Visual users are largely unaffected by non-standard code. A user cannot tell just by looking whether a page uses tables for layout. On the other hand, nonvisual users cannot help but experience the source code that lies below the surface. When reading web documents, software cannot discriminate between markup that is used purposefully and markup that is pressed into service for other than its intended purpose. For example, software cannot distinguish a table that is used for layout from a table containing data. Therefore, for nonvisual access:

- Avoid presentation markup. Tags such as <font>, <i>, and <b> do not convey meaning that can be interpreted by software. Instead, use structural markup to describe page elements and CSS to describe their presentation.
- Avoid using text for visual purposes. This includes punctuation such as horizontal bars or brackets to separate links. Software cannot recognize when punctuation is only relevant visually. Instead, use images and CSS for visual effects.
- Avoid misappropriating tags. Using tables to create columns or <blockquote> to indent text weakens the integrity of document structure and is likely to be misinterpreted by software. Instead, use CSS for layout [8].

2.2 Usability

The ease with which users can access content.

2.2.1 Eliminate unnecessary clutter

Signal-to-noise is a principle that measures the ratio between the signal, or relevant information, and the noise, or extraneous information, contained in a design. A high signal-to-noise ratio results in more effective communication, while a low ratio reduces usability because it asks users to filter out noise in order to receive and interpret information [10]. Many web pages have low signal-to-noise, as much of the display area is given over to the browser interface, advertising, navigation, and branding (Figure 1) [13].

Figure 1: Visual signal-to-noise ratios for articles on popular news sites

For nonvisual users, contending with clutter is difficult because software cannot readily discriminate between signal and noise. There is no <advertisement> or <company logo> tag that software can quickly skip over, and no <content> or <navigation> tag that software can use to find its way directly to content. Unlike visual users, who can identify and largely ignore clutter, nonvisual users must consider each element before making a determination whether it is signal or noise [7].

Minimize or eliminate elements that are not directly related to page content.

2.2.2 *Communicate relationships among elements*

Navigating an information space requires that we understand how elements in the space relate to one another. In a visual content, we use design to delineate elements and describe their relationship to one another—for example, by enclosing elements within a bounding box and labeling the box.

Differentiate elements using structural markup: for example, use the FIELDSET tag to group related form elements and label the group using LEGEND. With markup fails, use the following design principles to group elements [10, 21]:

- Proximity: Elements that are close to one another will be perceived as related. To design proximity into page code, put related elements in sequence. For example, code an image caption directly following the image.
- Similarity: Elements that are similar will be perceived as part of a group. Design similarity into page code by using the same method to mark up like elements. For example, use lists to mark up navigation links.
- Continuity: Elements that are presented without interruption will be perceived as part of a group. In designing page code, avoid breaks in the flow of discourse.

2.2.3 *Apply a consistent design*

Design consistency allows users to apply what they know to different contexts, making new tools easier to learn and use. External consistency can be accomplished by applying common standards to a design [10]. Armed with learned knowledge of conventions—what Norman calls "knowledge in the head"—users are able to form a conceptual model of a new design based on existing rules and constraints [14].

With no formal guide or stylistic conventions, the web as a whole lacks consistency. However, as the technology matures, conventions are evolving naturally. Pages generally begin with a site logo, followed by navigation and search, and end with provenance and contact information. Search features often include a "Search" text label, text input field, and submit button. Adopting these and other established conventions improves efficiency by allowing users to apply existing knowledge to new pages. In addition, consistency within a site further enhances usability by allowing users to form a mental map of a site that they can apply to all pages. In a nonvisual context, conventions and internal consistency allow users to predict the location and design of page elements.

Use established conventions wherever possible. Design for internal consistency among pages, particularly with regards to functional elements—where they are in the page code and how they are designed.

2.3 Functionality

The degree to which users can operate functional elements.

2.3.1 *Make functional elements workable via the keyboard*

Along with conveying information, web pages provide access to functionality, such as filling out and submitting forms and activating links. For universal access, functional elements must be workable using keyboard commands. An interface that requires point-and-click interaction will not be usable by users who cannot work a pointing device. Specifically, nonvisual users do not work with a rendered page and therefore cannot see to point and click. On the other hand, keyboard commands for movement, input, and activation [19] can be issued using a variety of input devices [3]. For universal usability, all functional elements must be operable from the keyboard.

In addition, functional elements must adhere to the guidelines discussed elsewhere, in particular:

- *Use structural markup.* Software can use structural markup to make elements easier to operate. For example, use labels to explain the purpose of form fields.
- *Communicate relationships.* Define the boundaries of functional groups, such as navigation and forms—whether explicitly using markup or implicitly using design principles.
- *Accommodate serial access.* Functional elements are commonly accessed in sequence (see subsection 2.4.2, below). For example, arrange form elements so they follow a logical sequence of label and field, and position the "submit" action at the end of the form (Figure 2).

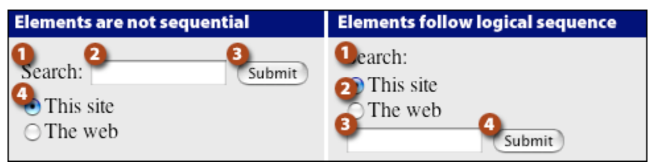

Figure 2: Functional elements must be sequential to support serial access

2.4 Readability

The degree to which content can be understood.

2.4.1 *Use text for essential information*

Text is the most effective format for conveying information to visual and nonvisual users because text can be read by software. Additionally, software can adapt text, so that users who cannot access a text-based design can transform the information into a format that is accessible—for example, by having the text read aloud by software. On the other hand, information conveyed using other formats, such as images or audio, cannot be readily accessed by software, making it less likely to be readable by all users.

HTML has provisions for providing non-textual content with accompanying fallbacks, so that users who cannot access information in its primary format have access to a text-based equivalent. The most common fallback is the ALT attribute of the IMG tag, which allows for a short textual description of the information contained in an image. Other non-text formats require more effort, such as a text transcript of an audio presentation [4]. Equivalents are certainly preferable to inaccessible content.

However, for universal design, "same means of use" is preferable to "equivalent use," making text the preferred format for nonvisual access [5].

Whenever possible, use text to convey information. When a non-text format is central to the message, provide a text equivalent.

2.4.2 Accommodate serial access to page content

Document order is the order in which elements appear in the page code. Software generally starts at the beginning of source code and works its way through sequentially. The result of this serial access is that information contained at the top of the page is the first accessed by software [7, 11].

The inverted pyramid is a way of conceptualizing and communicating information. In writing, the inverted pyramid style presents the most important information at the beginning of a text [12]. Overlaying an inverted pyramid structure onto the page code of most web pages shows that the base of the pyramid is commonly composed of branding, advertising, and navigation, with content appearing well toward the tip. In a visual context, the "first read" is not affected by document order because visual users can skip over marginal elements and go directly to the main content. However, due to serial access, document order largely determines the quality of nonvisual access. Readability suffers with pages that are top-heavy with irrelevant information.

Provide relevant content near or at the top of the page code, followed by navigation, advertisements, and other marginal content.

3. DISCUSSION

The principles and guidelines discussed affect web access in multiple contexts. Mobile access works better with text than with images. In addition, small screens present many of the same challenges as the limited "viewport" of nonvisual access, requiring that we communicate the relationships between elements, minimize clutter, and design for serial access [16]. The efficacy of search engine software also improves with structural, standards-based markup [20]. And all users enjoy the usability gains derived from the consistent application of conventions and design principles.

Here we focus on four guidelines for nonvisual web access that also improve access for mobile users.

- *Use markup to describe document structure.* One approach to providing web access on small screen devices is to extract content from pages designed for large screens and apply a mobile-friendly design. Opera's Small Screen Rendering (SSR) works by adapting attributes such as layout, color, and type to display in the mobile context. With structural markup, SSR can apply different visual styles based on the structural information contained in the document [15].
- *Eliminate unnecessary clutter.* The small viewport and serial access to content increases the usability costs of low signal-to-noise in the mobile context. Additionally, large pages take longer to load and display, and many mobile providers charge for data transfer. Limiting or removing clutter reduces costs in usability, time, and money.
- *Use text for essential information.* Images can be problematic in the mobile context. Images that are wider than the screen must either be scaled to fit by the client software or accessed full-size via horizontal scrolling. When images are scaled, important details such as text may not be readable [17]. On the other hand, horizontal scrolling is generally viewed as a suboptimal method for accessing information. Because of the high cost of loading images and the relatively low gains, mobile users may opt to disable image loading, making it essential that designers supply equivalent text for important content.
- *Accommodate serial access to page content.* Mobile browsing is affected by document order. For instance, SSR converts a multi-column large-screen design into a single column layout. The sequence of elements in the single-column design is defined by the order in which they appear in the source code [15]. Typical web designs have branding and navigation before content, meaning users have to scroll, often extensively, to get to the main content of the page [17]. Additionally, studies [9, 17] have shown that users can be disoriented by pages that begin with standard elements. With top-heavy designs, the first screen looks the same across all pages of a site. Mobile users do not receive visual feedback when a new page has loaded with unique content. The inverted pyramid style for source code design works well for mobile devices by highlighting relevant content on the first screen and providing direct access to content.

4. CONCLUSION

Web technology allows for adaptive interfaces that meet the needs of diverse users accessing pages in multiple contexts. The beauty of the web is more than screen deep. By attending to design at the source code level, we further the goal of universal usability for both visual and nonvisual users.

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