Accessibility Meets Usability: A Plea for a Paramount and Concurrent User–centered Design Approach to Electronic and Information Technology Accessibility for All

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This paper identifies challenges for a user–centered design process with respect to infusing accessible design practices into electronic and information technology product development. Initially, it emphasizes that when user–centered design is paramount and concurrent with accessible design, electronic and information technology can be accessible for all. Next, it provides an overview of the Americans with Disabilities Act (ADA) Section 508. Last, it provides basic accessible design heuristics that can be integrated into the design process. It concludes with recommendations for a paramount and concurrent user–centered design approach to product development.

INTRODUCTION AND CURRENT SITUATION

Last fall, I taught multimedia classes where students had an opportunity to design and develop a multimedia newsletter, *Tift Newsbytes*, to be incorporated into Mercer University's web pages for the Tift College of Education. At the outset of the course, students were very eager to design a web publication that contained lots of "bells–and–whistles" and represented their technical accomplishments with Dreamweaver and Flash (Macromedia products). My first step in correcting this viewpoint was to get them to hone skills on understanding the needs of global audiences with varying physical and sensory abilities. My second step in correcting this viewpoint was to create an awareness about web accessibility, specifically ADA–508. In taking these two key steps, the class was able to apply accessible design requirements on the front–end of the product development life cycle. By the end of the course, a review of lessons learned indicated that the emphasis on accessible design during the "define" stage allowed them to create an accessible, user–centered web pages.

A recent survey by the Royal National Institute for the Blind (RNIB) (2001) tested websites for 17 stores and banks for accessibility compliance for low vision users. None of the companies achieved a 100% acceptance rate on five key criteria.

Laux, McNally, Paciello, and Vanderheiden (1996) state, " Assistive and adaptive technology has become the acceptable norm while accessible design has become the usability orphan." (p. 97). As demonstrated by the introductory scenario, when user–centered design is paramount and concurrent with accessible design, electronic and information technology can be accessible for all.

Accessibility is …

Accessibility is an essential component of usability and is a hot topic for discussion in classrooms, business meetings, journals, books, e–commerce, on–line discussions, and by web page content developers. Accessibility is also a mandate by the federal government (section 508 of the Rehabilitation Act of 1973, http://www.508.org). Accessible design is often misunderstood and a neglected consideration by content development teams. Laux et al. (1996) note that few products and interfaces include accessible design and may occur after products ship. The opening story supports these findings that developers may not consider accessible design at product inception. Products are accessible when they are used effectively by audiences with varying physical and sensory abilities and are the result of a paramount, user–centered design process that includes concurrent, accessible design.

Usability is …

A variety of definitions have emerged in the literature since 1988. Most recently, Brink, Gergle, and Wood (2002) define usability as the "… degree to which people (users) can perform a set of required tasks. It is the product of several, sometimes conflicting, design goals." (p. 2). They suggest that typical design goals may be "functional correctness," "efficiency," "ease of learning," "ease of recall," "error tolerance," and "satisfaction." Usability experts, Quesenbery, Jarrett, Ramey, and Redish (2001), define usability as exploring and thinking about how people use products, evaluating why and how they use products, applying a user–centered design approach to product development, and integrating ease of use to achieve the anticipated user experience. Quesenbery, Jarrett, Ramey, and Redish (2001) and Barnum (2002) note that usability is defined by ISO 9241–11 International Organization for Standardization as "… the extent to which a product can be used by specified users to

achieve specified goals in a specified context of use with effectiveness, efficiency, and satisfaction in a specified context of use." Nielsen (1988) defines usability as "The measure of quality of the user experience when interacting with something—whether a Web site, a traditional software application, or any other device the user can operate in some other way or another." (See *Ten Usability Heuristics*, http://www.useit.com)

User–centered design is …

Barnum (2002) cites three principles that are central to understanding user–centered design: (a) "early focus on users and tasks," (b) "empirical measurement of product usage," and (c) "iterative design" (p. 7). Elaborating, Barnum also suggests that user–centered design encourages product developers to

- gather information from users before product development begins,
- identify tasks that users will want to perform before product development begins,
- include users in the product development process,
- use an iterative product development life cycle.

USER–CENTERED DESIGN PROCESS AND CONCURRENT ACCESSIBLE DESIGN

Brink, Gergle, and Wood (2002) identify four key usability problems with web sites: (a) "human perception problems," (b) "navigation," (c) "human memory," and (d) "data base integration." Human perception problems relate to contrast, column layout, and typography. The authors cite five key problems that are central to problems with link labels: (a) "ambiguous language," (b) "poor use of hypertext," and (c) "poor visual contrast," (d) "hidden links," and (e) "use of arrow graphics for navigation" (pp. 4–11). Human memory problems related to site structure, hierarchy, and information complexity. Data base integration problems are exhibited when web pages do not reflect current data base content (e.g., hotel reservation data bases, airline reservation data bases, etc.). Another data base integration problem relates to tasks that require the end user to reload pages.

Pearrow (2000) expands the ten usability heuristics given in Nielsen's article, *Ten Usability Heuristics* (http://www.useit.com). Nielsen's heuristics include (a) "visibility of system status," (b) "match the system to the real world," (c) "provide user control and freedom," (d) "apply consistency and standards," (e) "prevent errors," (f) "use recognition rather than recall," (g) "plan for flexibility and efficiency of use," (h) "use aesthetic and minimalist design," (i) "help users recognize, diagnose, and recover from errors," (h) "provide help and documentation." Additional heuristics as added by Pearrow include: (a) "use chunking," (b) "use the inverted pyramid style of writing," (c) "place important information 'above the fold," (d) "avoid gratuitous use of features," (e) "make web pages easy to scan," and (f) "keep download and response times low" (pp. 165–193). This paper identifies accessible design heuristics in 20 areas: (a) architecture, (b) browsers, (c) computer technology, (d) content, (e) forms, (f) hardware and software, (g) international, (h) links, (i) navigation and control, (j) network, (k) PDF files, (l) screen flicker, (m) spacing, (n) standards, (o) style sheets, (p) system design, (q) testing and validation, (r) text design, (s) text–only pages, and (t) usage. Questions to ask for each of these accessible design heuristics are given in Table 1.

Table 1. Requirements Analysis Questions for Accessible Design

Architecture
How shall a clear, recognizable structure be articulated?
How shall we avoid placing a cognitive load on the user for recall tasks?
What shall be the size of the website?
How shall we ensure consistency in presentation?
Browsers
How much backward compatibility shall be used for browser effectiveness?
How shall web pages be tested for browser support?
What interim browser solutions shall be provided to accommodate end–user preferences for assistive technologies and other browsers?
Computer Technology
What types of hardware shall be considered for accessible design?
What flexibility shall be necessary for various browser settings?
What browser flexibility shall be necessary?
What flexibility for data input shall be provided?
What flexibility for data output shall be provided?
How shall the system make color setting adjustments?
What resolution settings shall the system support?
What contrast control shall be provided for on–screen print?
What access modes (laptop, cell phone, portable desk accessory, desktop computer) shall be supported?
What shall be the minimal standard of technology that the product supports?
Content
How shall we implement an inverted pyramid style for content developers?

How shall we enforce brevity and conciseness?
How shall we ensure that web page elements do not block the display of important information?
What grammatical conventions shall be used?
What shall be done to eliminate grammatical and spelling errors?
What shall be done to eliminate jargon from content?
What shall be done to evaluate end–user satisfaction?
Forms
What forms shall be needed?
How shall forms be created?
What cues and instructions for use shall be needed?
How shall links to alternate, accessible forms be provided?
How shall image map buttons be used?
How shall image map "submit" buttons be used?
How shall text labels be used?
What groupings and labels shall be assigned to menu controls?
Hardware and Software
What platforms shall be supported?
What screen resolutions shall be supported?
What non–optimal situations with hardware can be anticipated?
What non–optimal situations with software can be anticipated?
What shall be done to plan for future trends and design changes as the site develops?
How shall we plan for platform differences as new technologies emerge?
What compromises shall end–users be required to make when designing for multimodal (on–screen and paper)?
International
What international considerations shall be important to the development of the site?
Who shall be the target audience?
What language will the site support?
Links
How shall repetitive links be handled?
How shall links be associated with image maps?
What conventions shall be used for writing link names?
What rules shall be followed for structuring links?
How shall links be structured to accommodate assistive technologies?
Navigation and Control
What shall we do to ensure a clear way–finding strategy?
How shall system status be presented to the end–user?

How much flexibility do the end–users need to accomplish tasks?
How much control do end–users need to accomplish their tasks?
How much freedom do end–users need for a task?
What accessibility standards shall be used?
What usability standards shall be used?
How shall we designate concise link names?
What types of descriptive words shall we use to convey information about the link?
What type of site map will be helpful to the end–users?
Network
How shall optimization and testing of the site be done to accommodate minimal network capabilities of end–users?
PDF Files
How shall PDF files be integrated into the site?
Screen Flicker
What shall be done to avoid screen flicker?
Spacing
What spacing considerations shall be important?
Standards
What standards shall be followed for accessible design?
What standards shall be followed for varying screen resolutions?
What standards shall be followed for usable design?
Style Sheets
What guidelines shall be followed for style sheets?
System Design
How shall the system be designed for real–world, natural settings?
What user standards shall be followed?
How shall consistency be applied?
What minimalist design principles shall be used?
What fonts shall the system support?
What varying physical and sensory abilities of end–users shall be supported?
What browser default values shall be supported?
Testing and Validation
What automatic tools shall be used for testing and validation?
What direct observation studies shall be made?
How shall clarity and complexity of language be evaluated?
How shall style sheets be tested and validated?
How shall graphics browsers be tested and validated?
How shall self–voicing browsers and assistive

technologies be validated?
Who shall be selected for end–user testing and validation?
Who shall provide review feedback of the site?
What hardware platforms shall be tested and validated?
What software platforms shall be tested and validated?
Text Design
What shall be done to ensure effective information design principles are being used?
Chunking:
How shall information be chunked?
How shall important information be identified?
What information shall be presented first?
How shall web material be sequenced?
What shall be done to improve brevity?
Queueing
How can we facilitate scanning and skimming tasks by end–users?
How many levels of headings shall be necessary?
What fonts shall be used?
How concise shall the self–describing hyperlinks be?
How much white space shall be used to set apart hyperlinks?
What topics shall be of primary importance?
What topics shall be secondary in importance?
Filtering
How shall filtering (lists, tables, etc.) be accomplished?
How shall color be used?
Mixed Mode
How shall graphics be used?
How shall audio be used?
What closed caption or other text equivalent shall be required?
How shall multimedia be used?
Abstracting (Layout)
How shall abstracting (layout) be accomplished?
How shall we ensure that web page layouts facilitate reading and navigation?
Text–only Pages
When shall text–only pages be used?
How shall the content of the text–only pages be updated?
Usage
What shall be done to maintain flexibility for error prevention?
What shall be done to ensure efficiency?
How shall we control for unnecessary (gratuitous) features?
How shall we ensure efficient downloads?
What shall be done to improve response times?
How shall we plan for error control?
How shall on–line help be provided?
How shall documentation be provided?
What augmentative and alternative communication shall be supported for speech?
What augmentative and alternative communication shall be supported for methods, strategies, and devices (writing, typing, dialing, calculation, drawing, signing, and other forms of expressive communication)?
What methods of adaptive computer access for data entry (mouth stick, head stick, splinted hand, keyboard, etc.) shall be supported?
What methods of adaptive computer access for scanning (row–column, linear, circular, other ways of controlling a sequentially stepping selection) shall be supported?
What methods of encoding (entering sequenced pulses from special switches) shall be supported?

Sources: Adapted from textual material in Alschuler, 1998; Arditi, 1994; Brink, Gergle, & Wood (2002); Chisholm et al. (2001); Flanders & Willis, 1998; Fontaine, 1995; Kilian, 1999–2001; Fontaine, 1995; Lay et al., 2000; Lynch & Horton, 1999; Miller, 1956; Nielsen, 2000; The Lighthouse, 1995; Text Matters, 2001; Reece, 1992; Reece, 1993; Reece, 1993–1994; Reece, 2001; Reece, 2002; Royal National Institute for the Blind, 1995–2002, 2000; Sullivan & Manning (1996–1998); Usable Web., 1999–2002; and Vanderheiden, Chisholm, & Ewers, 1997.

ADA–508 AND HOW TO GET STARTED …

The Architectural and Transportation Barriers Compliance Board (Access Board) is responsible for formulating accessibility standards for electronic and information technology covered by Section 508 of the Rehabilitation Act Amendments of 1998. Information on ADA–508 can be found at http://www.508.org. ADA–508 covers the following: (a) software applications and operating systems, (b) web–based intranet and internet information applications, (c) telecommunications products, (d) video and multimedia products, (e) self–contained and closed products, (f) desktop and portable computers.

ADA–508 functional requirements include (Federal Register, pp. 80526–80527):

- " At least one mode of operation and information retrieval that does not require user vision shall be provided or support for assistive technology used by people who are

blind or visually impaired shall be provided."

- "At least one mode of operation and information retrieval that does not require visual acuity greater than 20/70 shall be provided in audio and enlarged print output working together or independently, or support for assistive technology used by people who are visually impaired shall be provided."

- "At least one mode of operation and information retrieval that does not require user hearing shall be provided, or support for assistive technology used by people who are deaf or hard of hearing shall be provided."

- "Where audio information is important for the use of a product, at least one mode of operation and information retrieval shall be provided in an enhanced auditory fashion, or support for assistive hearing devices shall be provided."

- "At least one mode of operation and information retrieval that does not require user speech shall be provided, or support for assistive technology used by people with disabilities shall be provided."

- "At least one mode of operation an information retrieval that does not require fine motor control or simultaneous actions and that is operable with limited reach and strength shall be provided."

ADA–508 information, documentation, and support requirements include (Federal Register, p. 80527; available at http://www.508.org)

- "Product support documentation provided to end–users shall be made available in alternate formats upon request, at no additional charge."

- "End–users shall have access to a description of the accessibility and compatibility features of products in alternate formats or alternate methods upon request, at no additional charge."

- "Support services for products shall accommodate the communication needs of end–users with disabilities."

CONCLUSIONS

Evaluations of web pages for ADA–508 compliance are beginning. As we develop information systems, it is critical for developers to use a paramount and concurrent user–centered design approach when developing information technology that is accessible for all.

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