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Government Information Quarterly 23 (2006) 169–190

**Government
Information
Quarterly**

Assessing Section 508 compliance on federal e-government Web sites: A multi-method, user-centered evaluation of accessibility for persons with disabilities

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Available online 5 June 2006

Abstract

Section 508 of the Rehabilitation Act requires federal e-government Web sites to be accessible to persons with disabilities. While some studies have assessed the accessibility of federal e-government sites, most of these studies did not sufficiently examine the breadth and depth of issues related to Web site accessibility. This article details a multi-method, user-centered study of the accessibility of federal e-government sites that addresses the complexities of accessibility and the reasons for continued inaccessibility on federal e-government sites. By employing policy analysis, user testing, expert testing, automated testing, and a survey of federal Web developers, this study provides a multi-dimensional, user-centered portrait of the levels of accessibility of federal e-government Web sites, reasons for the current levels of accessibility, and perceptions about accessibility. This article discusses the legal requirements of accessibility, the previous research, and the data and findings of this study, and ultimately offers recommendations for increasing federal e-government Web site compliance with Section 508.

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doi:10.1016/j.giq.2006.03.002

1. Accessibility, Section 508, and federal e-government

Accessibility is extremely important for persons with disabilities. In the United States, 54 million people have a disability, and that number will continue to grow as the baby boom generation ages.¹ For a Web site to be accessible, it should provide equal or equivalent access to all users, and it should work compatibly with assistive technologies such as narrators, screen enlargement, and many other devices that persons with disabilities may employ to navigate cyberspace. A Web site that is not accessible can limit or prevent access and use by persons with disabilities. For example, approximately 400,000 people in the United States use screen readers to access online content; when a Web site is incompatible with screen readers, those 400,000 potential users are unable to access that Web site.²

Accessibility for persons with disabilities has been frequently neglected in the development of information and communication technologies (ICTs), including e-government Web sites.^{3–6} As a result, many individuals with disabilities are excluded from using ICTs unless appropriate assistive technologies are developed to facilitate access.^{7,8} “An understanding of disability is still not regarded as something that should be considered from the outset and made integral to the shaping of existing and new technologies”.³

Section 508 of the Rehabilitation Act,⁹ which was passed in 1998, established requirements for federal e-government Web sites to meet by 2001 in order for those sites to be accessible to persons with disabilities. Section 508 requires persons with disabilities who are “seeking information or services from a Federal department or agency to have access to and use of information and data that is comparable to the access to and use of the information and data” by other people (29 U.S.C. § 794d(a)(1)(A)(ii)).

The requirements of Section 508 for Web sites value content over presentation to ensure that all users can get to the content on a Web site.¹⁰ The primary guidelines for Web site design and implementation that are required to comply with Section 508, known as the Internet and Intranet Accessibility Standards, can be summarized as:

1. A text equivalent should be provided for every nontext element;
2. Equivalent alternative formats of elements of multimedia presentations must synchronize to the appropriate parts of the presentation;
3. All information conveyed through color must also be conveyed without color;
4. Documents must be organized so as to be readable without an accompanying style sheet;
5. Redundant text links should be provided in each active region of server-side image map;
6. Client-side image maps should be used whenever possible to facilitate the map being readable by assistive technologies;
7. Row and column headers should be identified on data tables;
8. Markup should be used to associate data cells and header cells in data tables to ensure graceful transformation;
9. Frames should be titled with text that identifies frame and facilitates navigation;
10. Pages should avoid flicker rates above 2 Hz or below 55 Hz;
11. A text-only equivalent page must be available for every page that cannot otherwise be made completely compliant with all other requirements;

12. All scripting language related to content must be identifiable and readable by assistive technologies;
13. For any Web site that employs applets, plug-ins, or other applications on the users' computers, these applications must comply with the Section 508 guidelines for software products and Web sites;
14. All electronic forms that are designed to be completed online must allow users with assistive technologies to access the information, field elements, and functionality required for completion and submission of the forms, including directions and cues;
15. A method should be available to allow users to skip repetitive navigation links; and
16. Users should not be timed out of applications—for timed applications, users should be given an alert message and the option to indicate that more time is necessary.¹¹

The actual guidelines are more specific and technical in the explanations, offering examples of when and how each applies. These guidelines address the accessibility needs of persons with visual, mobility, neuro-motor, hearing, cognitive, and other types of impairments, making them the most inclusive accessibility standards available.¹² While Section 508 does provide exceptions from compliance, including undue financial burden or national security, such exceptions do not widely apply to e-government Web sites.^{12,13}

Though Section 508 requires agencies to ensure that persons with disabilities have equal access to and use of federal e-government Web sites, widespread accessibility on e-government sites has not materialized since the 2001 compliance deadline. Studies of the accessibility of federal e-government sites have found low levels of accessibility, with usually fewer than one-third of sites being labeled accessible by these studies.^{14–18} This widespread lack of accessibility on e-government Web sites is a serious concern.

In 2002, Congress passed the *E-government Act* (P.L. 107–347) to establish guidelines for the delivery of federal government information and services through the use of the World Wide Web.¹⁹ The goals of the act include increasing “opportunities for citizen participation in Government,” providing “citizen-centered Government information and services,” and promoting “access to high quality Government information and services” (P.L. 107–347, § 2). As e-government continues to grow in scope and function due to political and legal mandates,^{19,20} the importance of accessibility will similarly increase as more and more information and services become available primarily or exclusively online. The accessibility of e-government Web sites is an issue that must be addressed to avoid creating virtual social exclusion and disenfranchisement from e-government for persons with disabilities.^{21–24}

While the existing data reveal that e-government Web sites remain far from universally accessible, the methods used to evaluate accessibility have not provided a full picture of accessibility of e-government.^{12,13,22} Accessibility has many nuances and complexities. A site may be completely inaccessible for users with one type of disability and fully accessible for users with a different type of disability. Even within the same type of disability, persons with one level of severity of a disability may have different accessibility issues than persons with a different level of severity of a disability. Also, labeling a site accessible or inaccessible is not sufficiently explicit, as the significant questions relate to how the site is inaccessible, what features are inaccessible, and who is not able to access the site. Beyond the need to address

the dimensions of accessibility, there are the issues of why so many sites continue to have accessibility problems so many years after the compliance deadline. Identifying and addressing the reasons for noncompliance or flawed compliance represent the most viable method for improving accessibility on e-government sites.

In examining these issues, this study represents an attempt to create research about the accessibility of e-government that adequately addresses the complexity of the issues involved. Research can play a role in helping e-government become inclusive of all users, including meeting the requirement of Section 508. Research can help identify best practices in achieving accessibility, reasons for continuing inaccessibility on sites, agency attitudes toward Section 508 requirements, and suggested means for improving accessibility, among other contributions. Prior to detailing the findings of this study, this article discusses the methods of previous studies.

2. Previous studies of e-government accessibility

A number of studies have investigated the accessibility of the federal e-government Web sites in the United States. These studies have produced findings about the accessibility of e-government sites in terms of the percentage of sites accessible or inaccessible. Such studies, however, generally do not provide results that fully describe the level of accessibility. Even when these studies identify a site as accessible, the studies do not reveal what kinds of disabilities for which the sites are accessible, the types of services that are accessible, or the kinds of sites that offer accessibility features.²²

Due to the limitations of the methods employed, many of these studies offer insufficient insight into why certain Web sites are accessible and others are not. Issues like cost, resistance, and lack of understanding play a significant role in determining what Web sites or pages will be accessible,¹² yet such issues are missed by the methodologies used. Understanding the reasons why sites are not fully accessible and what factors facilitate accessibility is of vital importance to increasing accessibility. When the reasons for the lack of accessibility are understood, they can be addressed.

For the most part, previous studies have relied on free automated testing software, such as Bobby, WebXact, or Ask Alice, which are designed to check Web sites for errors that might cause accessibility problems. However, automated testing programs can misidentify elements as accessible or inaccessible, do not take into account different disabilities or variations of abilities among people with similar disabilities, do not address issues of usability or functionality, do not address issues of compatibility with assistive technologies, and miss many accessibility problems that a person can identify, among other limitations.^{10,22,25,26} The error rate for automated software may average at least 30 percent, depending on the testing tool.²⁷ Furthermore, the emphasis on automated software tools tends to create a false impression that a good rating from a tool equates to a highly accessible Web site.²⁸

Most studies of e-government Web sites have primarily or exclusively used automated testing tools. These studies include ones that have recently examined the accessibility of e-government sites of the U.S. federal government,^{14,17,29–31} of European Union member

nations,^{32,33} of U.S. state governments,^{34,35} and of local government sites in the U.S.^{36,37} Studies of e-government Web sites are not unique in relying on automated testing tools to measure accessibility. Studies of the accessibility of retail, airline, tourist, employment, college, distance learning, and popular Web sites, among others, have relied on an automated tool as the primary or sole means of testing.^{27,28,30,38–43}

When studies of accessibility venture beyond the reliance on automated testing, the methods are not necessarily more insightful. Studies that directly incorporate the perspectives of users with disabilities tend to involve them in very limited roles, such as consultants, while some researchers have even pretended to have disabilities—such as using blindfolds to imitate a visually impairment—when evaluating accessibility of Web sites.²⁷ Interestingly, one researcher has recommended against involving persons with disabilities in the testing of Web sites because it is inconvenient and time-consuming, though nevertheless admitting that persons with disabilities are the best qualified to assess the accessibility of a Web site.⁴⁴ A few studies have taken a more comprehensive approach to the study of the accessibility of e-government Web sites. Several studies examining the accessibility of school Web sites have argued for using a combination of automated testing, expert testing, and user testing.^{26,45}

3. Methodology

In the evaluation of e-government sites, the use of a multi-method approach to evaluation is optimal.⁴⁶ This study employed a number of methods to collect data—policy analysis, expert testing, user testing, automated testing, and Webmaster questionnaires. This combination of methods was intended to be complimentary, with each individual method having its own strengths and providing a different perspective on the issues.

The sites involved in this study were purposefully selected using several criteria. Each site studied belonged to one of two categories, being either a primary site for citizen interaction with e-government or a site that is of primary interest to persons with disabilities. The first category of sites was studied to evaluate the levels of access available to persons with disabilities on major e-government sites. By examining these types of sites, this study assessed how well persons with disabilities can access important general government sites that relate to primary citizenship functions. The second category of sites was studied to evaluate the levels of accessibility of sites specifically oriented toward issues with disabilities. The sites in this category would logically have the most incentive in terms of agency mission and the most external public pressure to be accessible, as persons with disabilities are primary users of the sites. Given the multiple methods used in this study, the number of sites tested was limited to a total of ten, with five in each category. By focusing on a small, very specific set of sites, it was possible to study the accessibility of each individual site in much greater depth.

The methods in this study provided a detailed perspective of the accessibility of the sites tested. The policy analysis was used to examine the intent of the Section 508 regulations and analyze whether following the regulations would actually result in accessible Web sites. The expert testing provided breadth in measuring accessibility, as the expert testing instrument was designed to assess sites for accessibility in terms of a range of disabilities and different assistive

technologies. The user testing provided depth, focusing narrowly on two types of disabilities to gain a detailed portrait of accessibility from the perspectives of users with visual or mobility impairments. The automated testing was used to determine how helpful such tools are and what role they might be able to play in a multi-method evaluation. The Webmaster questionnaire offered insight into these issues from the perspective of the developers of the sites. Each of the methods, its purpose, and its goals is explained more fully below.

3.1. Policy analysis

Comprehensively reviewing policy documents, research, and nongovernmental guidelines related to Web site accessibility, this analysis explored Section 508 and its regulations to determine if compliance with these standards would result in an accessible Web site. If, upon examination, fully complying with the law and regulations would not create an accessible Web site for persons with disabilities, the entire context of the accessibility of government Web sites would be based on flawed assumptions. Such a conclusion would have tremendous implications for the actual accessibility testing of federal e-government Web sites, as compliance then would not necessarily result in a site that was fully accessible. On the other hand, should an analysis of the law and regulations indicate that compliance with Section 508 would produce an accessible Web site, the accessibility testing will be based on a valid premise that compliance leads to accessibility. Therefore, to ascertain if compliance with Section 508 equates to an accessible e-government Web site, this analysis excoriated the origins of Section 508, its relation to other accessibility guidelines, and the specific content of the law and regulations related to Section 508.

3.2. Expert testing

Using an instrument that has been specially designed to evaluate the accessibility of e-government Web sites in terms of users with disabilities, and which had been employed in previous studies, the researcher performed comprehensive assessments of the accessibility of the selected federal e-government sites. The goals of the expert testing were to provide an understanding of whether the sites meet Section 508 accessibility standards and how the sites interact with assistive technologies. This phase of testing provided a more general assessment of accessibility than the user testing provided, as user testing is much more focused on the individual participants. While expert testing will not likely be able to identify all potential accessibility issues for all users, it is a way through which to identify the breadth of accessibility issues on a site.⁴⁷ Furthermore, as expert testing is intended to identify potential problems for a range of users, some areas flagged in expert testing ultimately may be found not to be problems when users test the site.

The instrument used in the expert testing of these e-government Web sites has been developed through the process of a number of research projects over the course of three years.⁴⁸ The instrument was designed for evaluation of government Web sites in terms of the requirements of Section 508 by identifying potential barriers to users. Development of the instrument began in 2003, and it has been used in further studies.^{48–50} The version of the

instrument used in this study is an extension of the instrument that has been thoroughly pretested and vetted to ensure that it is accurate, complete, and accomplishes what it is intended to do. Each of the items on the instrument addresses specific points of design or function of sites that should be in compliance with the Section 508 guidelines. The items embrace both the guidelines of the Section 508 requirements promulgated by the Access Board and the principles of equal access that underlie the Section 508 legislation. Certain items on the instrument relate to the needs of people with one specific disability (i.e., whether there is a text equivalent of audio content), while other items have wider applicability to people with one of a number of different disabilities (i.e., whether content enlarges legibly).

3.3. *User testing*

Perhaps the most significant distinguishing factor for this study from previous ones is the emphasis given to involving persons with disabilities in the testing. Accessibility testing involving persons with disabilities is widely considered the best way to determine whether ICTs, including Web sites, are accessible.^{4,5,7,10,22,25,26,51,52} In this study, the user testing focused specifically on users with visual impairments and mobility impairments. A population consisting of these two specific types of disabilities was selected because barriers to access on Web sites are most likely to affect users who have visual or mobility impairments.^{10,22,25,47,52,53} More than six million people in the United States have a visual impairment that affects the use of computer displays, while nearly nine million people have mobility impairments that affect the use of a keyboard or a mouse.⁴⁷ Ten participants had either a visual impairment or mobility impairment, and the levels of severity of disability differed among the members of each population to increase representativeness. The majority of user tests were conducted in a face-to-face setting, though a few user tests were conducted via electronic means to include people with disabilities not otherwise represented in the user population.

The user testing procedure consisted of scripted walk-throughs (an established set of questions and tasks that the participant performed in a specific order as guided by the researcher) and think-aloud protocols (a personal narrative spoken by the participant as they interacted with the site in a less structured manner). Both of these methods of data collection have been used extensively in usability testing and have been found to be an equally important tool for accessibility testing.^{25,52} First, the users were guided by the scripted walk-through of the site to determine if problems would arise as they tried to use the information and services of the site. By having participants interact with many different elements of a site, the scripted protocol led users to discover whether information and services on the site are accessible for their particular needs and work with any assistive technologies they may use. For each site, after completion of the activities in the scripted protocol, users were asked to explore each site at their own pace and express thoughts and reactions about the accessibility of the site. The think aloud method provided insights into areas that the scripted protocol did not cover and allowed each participant to provide a unique, personal narrative based on individual experiences and different levels of disability. In the user tests conducted via electronic means, these procedures were modified slightly, due to the parameters of the medium, to more seamlessly blend the protocols together.

3.4. Automated testing

Though freely available automated tools are not yet sufficiently effective to serve as the only method of accessibility testing in this kind of research, they were included to determine if the tools are able to provide an overview of some issues or find issues that other methods of testing missed. In spite of the limitations of these tools, there are several reasons that the use of free automated testing tools is quite attractive; they are cost-effective, easy to use, readily available, and provide quick results. The positive benefits from the use of these programs might make them valuable to those looking for a readily achievable, if not completely comprehensive, way to evaluate accessibility. In the context of this study, the programs were examined for their overall utility and place in multi-method evaluation, and their findings were compared to the findings from the other methods used in the study.

3.5. Webmaster questionnaire

In order to better understand the context within which decisions about compliance with Section 508 on federal e-government Web sites occur, a questionnaire was prepared and distributed to the Webmasters of the sites being studied in this research. The questions on the questionnaire asked how the agency decided to implement Section 508 guidelines, what factors influenced the decision, where they turned for information on accessibility in implementing the Section 508 guidelines, and what types of accessibility testing the agency has performed on the site. A primary goal of the Webmaster questionnaire was to gather data for comparing agency perceptions about the accessibility of their Web sites with the accessibility of the sites as revealed by the other data collection methods.

4. Findings

Most of the methods produced important information that generally would not have been available without the incorporation of that specific method. The findings from each individual data-collection method are presented in this section.

4.1. Policy analysis

The primary findings from the policy analysis are that the Section 508 requirements and guidelines, if correctly implemented, should produce Web sites that are accessible to most or all persons with disabilities. These standards were intended to make the Web sites of all entities covered by Section 508—federal government agencies, federal government vendors, and state and local government agencies receiving certain types of federal funding—accessible to persons with a wide range of physical and cognitive disabilities. The standards address accessibility for persons with visual, auditory, mobility, cognitive, and learning disabilities, as well as very specific conditions, such as seizure disorders.

The Section 508 standards, though modeled on the Web Content Accessibility Guidelines of the W3C,⁵⁴ were designed to be the most inclusive standards for Web site accessibility. The first eleven elements of this list are present in an equivalent form in the W3C accessibility guidelines, using language that was enforceable in a government context, but the remaining five elements of Section 508 are unique.² These differences with the W3C were deliberate; the preamble to the Section 508 guidelines explains that these five requirements “are different than any comparable provision [in the W3C] and generally require a higher level of access or prescribe a more specific requirement.”¹¹ As a result, the Section 508 standards better work to ensure accessibility for persons with certain disabilities, such as cognitive and learning disabilities.

The Section 508 guidelines also benefit from the range of stakeholder perspectives that were incorporated. The Architectural and Transportation Barriers Compliance Board (commonly known as the “Access Board”), the government agency that has been creating access standards in the physical environment since 1968, created the standards for Section 508. The Access Board received input from the Electronic and Information Technology Access Advisory Committee (EITAAC), which is comprised of government officials, representatives of industries related to technology, and citizens with disabilities. The Access Board also worked in conjunction with the General Services Administration and its Center for Information Technology Access division to ensure that the standards produced fit the needs of agencies and their capacities to achieve compliance.

After the Section 508 standards were promulgated, the National Council on Disability (NCD), the government agency responsible for advocating for persons with disabilities, called the standards “the most far-reaching source of legal authority for accessible electronic and information technologies” and “the most sophisticated model to date of a civil rights law that closely integrates accessible design and enforcement strategies”.⁵⁵ The standards were also lauded by the Chair of Federal Communication Commission,⁵⁶ legal scholars,^{57,58} and even President Bush.⁵⁹ As a result of the factors discussed above, compliance with the Section 508 standards seems the best way to achieve accessible e-government Web sites.

4.2. *Expert testing*

The expert testing instrument employed a very detailed set of criteria—drawn directly from the Section 508 regulations for Web sites—that account for the accessibility needs of persons with the range of disabilities that can be an issue in the online environment. The instrument is designed to provide data on multiple levels through one evaluation. First, open-ended questions allow the researcher to detail the positive and negative elements of the site in relation to each question. In some cases, a question may have sub-elements that are encompassed by the main question, but which are important enough to accessibility to merit being specifically articulated. This part of the instrument provides the robust details about the specific successes and failures with accessibility on the site from the perspective of the user.

Second, a scoring element allows the researcher to give a rough grade for each question and, by totaling the scores from each question, an overall score. For each question, a score of 0 is assigned if that type of accessibility is lacking, a score of 1 is assigned if it is partially present, and a score of 2 is

assigned if it is consistently present. With a total of ten questions, the maximum possible score for a site is 20, while the minimum possible score is 0. The open-ended questions provide rich details that are more important for understanding the accessibility of each site, but the scoring element gives comparative perspective on the meaningful open-ended data.

The testing of the sites was conducted to ensure as wide an analysis of the sites as possible. Sites were tested through multiple browsers to see if there were significant differences in levels of accessibility. In terms of assistive technologies, the sites were tested for a range of technologies related to different types of disabilities, including narrators and screen readers, screen enlargement software, magnifiers, alternate color schemes, and alternate navigation devices, among others.

The expert testing revealed accessibility issues on each of the sites tested. These issues spread across the sites will affect users with visual, auditory, mobility, learning, and cognitive disabilities. In Fig. 1, perhaps the most interesting point is that the sites oriented toward issues of disability were much more likely to have a higher score. The top four sites are all oriented toward issues of disability; the Government Accountability Office is the only site in the top half of the scores that is not a general site. The fairly low scores of many sites reflect the problems identified during the expert testing.

Fig. 2 details the types of accessibility problems identified in the expert testing by the two categories of agencies tested. This list does not include all problems identified on each site, but rather focuses on the major problems that seem most likely to inhibit the use of the sites for users with various different disabilities. The problems found on general sites were not only more numerous, but were usually more significant and widespread on the sites.

Despite the gap between the results from disability-oriented sites and other sites, there were common accessibility concerns across most of the sites tested. Most sites had issues or inconsistencies when working with some forms of assistive technologies. The impact of these issues, however, ranged from small (i.e., a specific button did not enlarge) to significant (i.e., an entire site was not readable by a screen reader).

4.3. User testing

The user testing was the most productive method for identifying the depth of accessibility issues on the Web sites. While the expert testing produced insights into the levels of accessibility of the sites, the results of the user testing were much more detailed. In most

Website	Score
Section 508 (www.section508.gov)	17/20 (85%)
Access Board (www.access-board.gov)	16/20 (80%)
National Council on Disability (www.ncd.gov)	16/20 (80%)
National Institute of Health (www.nih.gov)	15/20 (75%)
General Accountability Office (www.gao.gov)	13/20 (65%)
White House (www.whitehouse.gov)	11/20 (55%)
FirstGov (www.firstgov.gov)	11/20 (55%)
Disability Info (www.disabilityinfo.gov)	10/20 (50%)
Government Printing Office (www.gpo.gov)	10/20 (50%)
Department of Education (www.ed.gov)	9/20 (45%)

Fig. 1. Websites ranked by expert testing score.

Agency/Organization Type	Identified Accessibility Problems
Agencies with missions oriented toward issues of disabilities	<ul style="list-style-type: none"> -Compatibility problems with screen enlargement -Compatibility problems with screen readers -Compatibility problems with alternate color schemes -Cluttered layout and organization -Problems with consistency and clarity of context, orientation, and navigation
General Agencies	<ul style="list-style-type: none"> -Compatibility problems with screen enlargement -Compatibility problems with screen readers -Compatibility problems with alternate color schemes -Use of flash and moving images to convey content -Lack of consistent and clear navigation, context, and orientation information -Cluttered layout and organization -Audio content does not have a text equivalent -Graphics lack Alt tags -Difficult drop-down, mouse-over menus

Fig. 2. Key accessibility issues identified in expert testing by type of agency site.

instances, the user testing was not finding issues missed by the expert testing, but it was better revealing the extent of the issues identified and the ways in which the issues manifest. The users with visual impairments included individuals with virtually no vision, low vision, double vision, and inability to focus. The assistive technologies employed by these users included screen readers and narrators, alternate color schemes, large screens, magnification, and screen enlargement software. The users with mobility impairments included individuals with neuro-cognitive and psycho-motor issues with mobility (i.e., as a result of cerebral palsy or multiple sclerosis), lack of function in their hands (i.e., as a result of quadriplegia), and degenerative conditions that limited mobility. The assistive technologies employed by these users included screen enlargement software, alternate types of mice, trackballs, stylus, magnification, and voice activation software.

There was significant continuity between the observations of the members of each group of users with disabilities. While accessibility problems were generally more pronounced for users with more extensive disabling conditions, the problems were mostly shared by all users. For the users with visual impairments, in spite of the range of severity in their visual disabilities, the problems that each user identified were very similar. In many cases, these same elements were problematic across the two groups of participants, as well. Fig. 3 collates the key accessibility issues identified by the users for each site tested in this study.

At an individual level, each participant was able to identify barriers to accessibility on most of the sites. While not all of the problems in Fig. 3 affected each user, this tabulation of the major accessibility problems identified by the user testing reveals both the effectiveness of user testing and the extensiveness of the accessibility problems across the Web sites tested.

The least accessible sites, as determined by users, were ultimately the same sites found to be the least accessible in the expert testing. Similarly, the sites that users found the most accessible also had the fewest numbers of accessibility problems identified in the expert testing. Many of the problems identified by users are not difficult to fix. If more of the sites employed a larger font, put more space between lines of text, employed consistent design, put less content on pages, used color more thoughtfully, resisted the urge to fill pages with pages,

and tested to ensure compatibility with assistive technologies, many of the accessibility problems would be eliminated.

Users were asked, after viewing all of the sites, to identify the site that was the most accessible and the site that was least accessible for them. Most users chose the Section 508 site or the National Institute of Health site as the most accessible. Half of the users selected the Government Printing as the least accessible site, with the White House and the Department of Education sites also receiving multiple votes. One user nominated all three.

Some users were angry at the accessibility problems they encountered on many of the sites, while others seemed resigned to the inaccessibility. A few users even seemed to take personal

Agency/Organization	Identified Accessibility Problems
Access Board	<ul style="list-style-type: none"> -Some elements do not enlarge -Compatibility problems with screen readers -Font size small -Spacing between lines not large enough -Some problems with alternate color schemes -Pages cluttered, busy, and poorly organized -Insufficient navigation elements
Department of Education	<ul style="list-style-type: none"> -Compatibility problems with screen enlargements -Compatibility problems with screen readers -Compatibility problems with alternate color schemes -Uses flash and moving images to convey content -Lack of Alt tags -Font too small -Color scheme hard to read -Pages cluttered, busy, and poorly organized -Insufficient spacing between lines and individual words -Inconsistent layout -Inconsistent navigation -Navigation elements too small -Links too small -Poor use of available space
Disability Info	<ul style="list-style-type: none"> -Compatibility problems with screen enlargement -Compatibility problems with alternate color schemes -Small problems with screen readers -Font size small -Mouse-over menus difficult to use -Too much scrolling required -Pages cluttered, busy, and poorly organized
FirstGov	<ul style="list-style-type: none"> -Compatibility problems with screen enlargements -Compatibility problems with screen readers -Compatibility problems with alternate color schemes -Pages cluttered, busy, and poorly organized -Insufficient spacing between lines and individual words -Font too small -Requires large amounts of scrolling -Inconsistencies in navigation elements -Header text too small -Problems with printer-friendly version of site
Government Accountability Office	<ul style="list-style-type: none"> -Compatibility problems with screen enlargements -Compatibility problems with screen readers -Compatibility problems with alternate color schemes -Font too small -Color scheme reduces readability -Insufficient spacing between lines and individual words -Problems with navigation elements -Pages busy
Government Printing Office	<ul style="list-style-type: none"> -Compatibility problems with screen readers -Compatibility problems with screen enlargement -Compatibility problems with alternate color schemes

	<ul style="list-style-type: none"> -Pages cluttered, busy, and poorly organized -Mouse-over menus difficult to use -Insufficient spacing between lines and individual words -Navigation elements confusing and extremely hard to use -Uses graphics and color to convey content -Some buttons not working -Search function problems
National Council on Disability	<ul style="list-style-type: none"> -Compatibility problems with screen readers -Compatibility problems with screen enlargement -Font too small, some font sizes unreadable -Some font colors hard to read -Spacing between lines not large enough -Problems with navigation elements -Tables too closely spaced
National Institute of Health	<ul style="list-style-type: none"> -Small font on deeper pages -Some problems with alternate color schemes -Links and accompanying descriptors too small -Tabs too small
Section 508	<ul style="list-style-type: none"> -Compatibility problems with alternate color schemes -Small number of elements (i.e., buttons) do not enlarge -Insufficient spacing between lines and individual words -Pages cluttered -Requires large amounts of scrolling
White House	<ul style="list-style-type: none"> -Compatibility problems with enlargement -Compatibility problems with screen readers -Compatibility problems with alternate color schemes -Font size too small -Color scheme hard to read -Pages cluttered, busy, and poorly organized -Poor use of available space -Lack of text equivalents for audio content -Requires large amounts of scrolling -Problems with text-only version of site -Insufficient spacing between lines and individual words

Fig. 3. Key accessibility problems identified by participants in the user testing.

responsibility for not being able to overcome the barriers to accessibility. None of the users, however, appeared to be at all surprised that most of the sites had accessibility problems for them. Some participants seemed shocked when they did not encounter major accessibility problems on a site. For several users, the sizeable problems with the White House site were emotionally affecting; the symbolic weight of the inaccessibility of the White House site even brought some participants to tears.

4.4. Automated testing

After testing a number of programs, investigating resources related to the programs, and consulting with Web developers, it was determined that free automated testing tools would not contribute to the findings of this study. When the findings from the user testing and expert testing of sites in this study were compared to the findings from use of automated tools on the same sites, the free automated tools had missed accessibility errors that were identified in other testing. A clear depiction of this difference can be demonstrated by comparing the results from Ellison,²⁹ which found two accessibility errors on the White House Web site using two different automated testing programs with the results of the user testing of the White House Web site from this study detailed above. As such, in multi-method evaluations of Web site accessibility like this type of research, it is hard to imagine a major role for free

automated tools. Automated tools are certainly better than no evaluation, but if other evaluations are being performed, the free automated tools are not likely to contribute much information that would not otherwise be identified.

4.5. Webmaster questionnaire

Responses to the survey were received from six of the agencies. Of the six responses, however, only four actually provided detailed responses. Two agencies sent an auto-reply to the survey, which included merely general information. Some of the responses came from agencies oriented toward issues of disability, while other responses came from agencies that focus on general issues. This mix of perspectives provided insight into the processes at agencies of different sizes and missions.

Web site accessibility was presented as a priority at the responding agencies. This attitude is not surprising, as these agencies actually took the time to respond to the questionnaire. All of these agencies directly stated in their responses that they feel that

Question	Key answers
1. Do you feel that the accessibility of your website for persons with disabilities is a priority within your agency?	-All respondents said accessibility was a priority -One respondent also noted lack of funding as negatively impacting implementation
2. When working to make your website accessible for persons with disabilities, where do you turn for resources and guidelines?	-Access Board -Consumer task force -Internal guidance documents -Section508.gov -Usability.gov -W3C -WAI
3. Do you perform accessibility testing on your website to test how well it can be used by persons with disabilities? If so, at what point in the website development process is this testing done?	-“Began testing early in development” -“Bobby from CAST” -Employees with disabilities -“508 testing tools” -JAWS -Testing “done at all stages” -Web host for agency site -Window Eyes
4. What factors (i.e., staff time, staff skills, funding, agency mission, etc.) influence the priority accorded to the accessibility of your website for persons with disabilities?	-Acquisition process -Agency prioritization -Emergencies -508 technical support -508 training -Funding -Government discussion forums -Part of agency mission -Staff time -Site must be accessible regardless of resources
5. Have you received any feedback from users of your site regarding its accessibility? If so, were the comments generally positive or negative?	-Generally positive, but will fix any issues identified -No comments about accessibility
6. If you feel that the accessibility of your website could be improved, what resources would you find beneficial in working to improve it?	-Auto correction tools -Comments from users -Funding -“Highly skilled technical staff” -Monitoring tools -None

Fig. 4. Key answers to the questions on the Webmaster Questionnaire.

the accessibility of the Web site is a priority within their agency, and it is an issue that will continue to be pursued. Though they take differing approaches to monitoring the accessibility of their Web sites, all of the agencies employ multi-step approaches to maintaining accessibility and draw guidance from multiple sources of information.

The use of automated tools and manual checking by agency employees that one respondent engages in is particularly encouraging, as is the agency that has a standing peer review group to assess sites once they are completed. The responding agencies also regularly test their sites for accessibility and draw upon any comments submitted by users of the sites. Furthermore, none of the responding agencies indicated in their comments that accessibility was considered an unnecessary burden by agency staff, though some agencies did imply areas of frustration with trying to accomplish accessibility. Based on the responses to the questionnaire, these responding sites clearly are trying to be oriented toward monitoring and maintaining the accessibility of their Web sites. [Fig. 4](#) summarizes key findings from the questionnaire.

The descriptions of how accessibility is monitored on the sites of the agencies must be contrasted with the fact that the expert testing and the user testing each identified accessibility issues on every site examined in the study. In spite of what these agencies are saying, and may well believe, these sites are not fully accessible. While none of the sites specifically claimed to be fully accessible, the comments of the agencies did indicate a belief that the accessibility of the Web sites was very high for most users with disabilities. Nevertheless, the overall tone and content of these responses are certainly encouraging.

5. Analysis

The results of the multi-method evaluation can be used to paint a detailed portrait of the accessibility of federal e-government Web sites in terms of compliance with the requirements of Section 508. When the results from the multiple methods of data collection are viewed together, nine key themes emerge from the data.

1. Compliance with Section 508 requirements varies widely between Web sites. The user testing and the expert testing demonstrated a large range of levels of accessibility in the sites studied. Some sites, more often the sites of organizations related to issues of disability, had higher levels of accessibility. The sites identified in the expert testing as having higher levels of accessibility also were consistently found to have higher levels of accessibility in the user testing, and the same held true for the sites with lower levels of accessibility. Though no sites were found to be without accessibility problems, the wide range of levels of accessibility demonstrates that the implementation of the requirements of Section 508 for federal e-government Web sites has been far from consistent.
2. The level of importance accorded to Web site accessibility varies between agencies. The findings of the policy analysis, user testing, expert testing, and Webmaster questionnaires all point to variances in the importance given to Web site accessibility between agencies. Some agencies have made Web site accessibility a much higher priority than other

agencies, and the level of priority seems partially related the mission and goals of the agency. The policy analysis identified many examples of agencies resisting compliance with Section 508 or misunderstanding the requirements of Section 508. The Webmaster questionnaires provided further evidence of the differences in levels of interest in providing accessible Web sites.

3. Agencies oriented toward issues of disability are more likely to have accessible Web sites. In the user testing and expert testing, agencies with a mission related in some way to issues of disability typically were much more accessible than agencies with a more general mission. In the expert testing, four of the five highest scoring sites had a mission oriented toward issues of disability. The users predominantly found the fewest problems on and had the most favorable impressions of the sites that performed the best in the expert testing.
4. Agencies lack a standardized approach to Section 508. Based on the Webmaster questionnaire, not only does the level of accessibility on e-government Web sites vary, the approaches to trying to provide accessibility are not consistent. Some agencies consult external sources, while others have people from within the agency to check the sites or even have established review panels to monitor accessibility. Some agencies use automated testing tools, while other agencies check their sites by using assistive technologies. User testing is done on a limited basis. Accessibility is a part of the design of sites for some agencies and is only considered after a site is finished at others. If Web site accessibility is to become consistently available on federal e-government Web sites, standardized approaches that have a greater chance of success would be very beneficial.
5. Some e-government Web sites focus on certain aspects of accessibility. Some agencies seem to be prioritizing, intentionally or otherwise, accessibility for certain groups of users. In the user testing, some sites were better designed for users with mobility impairments, while others were better designed for users with visual impairments. Certain types of inaccessibility were also recurring themes in the user testing. The failure of text or buttons on sites to enlarge, the lack of sufficient space between lines of text, and the use of colors that were hard to distinguish were frequent problems identified in the user testing across many sites. The expert testing found groups whose accessibility needs seem generally neglected in design, such as users with learning disabilities and users with cognitive impairments, who benefit from clear and consistent navigation mechanisms and consistent context and orientation information.
6. The channels of communication between e-government Web sites and users need improvement. Distributing the Webmaster questionnaires revealed that some sites being studied did not promote contact, as one agency had invalid e-mail addresses posted, another had a disclaimer noting that the Web developers would not respond to e-mails, one lacked any e-mail contact information for the Web development staff, and two of the sites sent an auto-reply to the questionnaire. It seems likely that by making it difficult to contact e-government Web developers, these sites are reducing the number of people who will make contact. On the Webmaster questionnaire, the respondents said they had received few comments about the accessibility of their Web sites. While that may be taken to mean that users are finding no problems on the Web sites, it can also indicate that users feel that their input is not wanted or that users cannot find a way to get their input to the Web developers.

As more government information and services are moved into the online environment, responsiveness to comments from users must be a priority to ensure that users can help identify problems and provide other feedback.

7. Agencies' perceptions about the accessibility of their sites are not entirely accurate. The user testing and expert testing found accessibility problems on all of the sites in the study. The sites ranged from having a large number of significant errors to having a much smaller number of less significant errors. Though all of the sites had identifiable accessibility problems that were not in compliance with the Section 508 guidelines, each of the responses to the Webmaster questionnaire indicated that the Web developers felt their sites were generally in compliance with the Section 508 requirements. Even the response from the agency that, among the respondents, had the most problems identified in the user testing and expert testing evidenced a belief that the site was mostly accessible.
8. Compliance with Section 508 could be increased with funding and education for Web developers. Based on the responses to the Webmaster questionnaire, agencies feel that they would be better equipped to address issues of Web site accessibility if they had additional funding. A lack of funds was raised in terms of providing personnel, time, testing, and training in various responses, as well as an obstacle to procuring software to help design for accessibility. Also, responses indicated a belief that there was insufficient training about the requirements of Section 508 available. One agency directly stated that they had trouble finding people in the applicant pool with knowledge of Section 508 requirements and the creation of accessible Web sites.
9. Commonly accessible e-government sites are still an unfulfilled goal. Overall, based on the findings from all of the data collection methods, consistent Web site accessibility in federal e-government remains a goal rather than a reality. Although it was originally passed in 1998 and was to have been implemented in 2001, the requirements of Section 508 are partially or predominantly unfulfilled on many e-government Web sites. This study revealed layers of inaccessibility on each site studied, almost five years beyond the compliance deadline.

6. Conclusions and future research

By employing a multi-method approach, this study was able to provide a detailed portrait of the levels of accessibility, showing that, while levels of accessibility vary, many e-government Web sites present barriers to accessibility. The multi-method approach and the findings of this study can provide the basis of future explorations of the accessibility of e-government. However, based on the data collected in this study, several preliminary suggestions can be made regarding how federal agencies may be able to improve compliance with the Section 508 requirements:

- Design for accessibility from the outset of Web site development. A Web site that is designed for accessibility from the outset will require less effort and will be more likely to comply with the Section 508 requirements than a site that is retrofitted for compliance.

- Involve users with disabilities in the testing of the site. Users with disabilities are the best equipped to judge whether a site is accessible. Such depth and granularity of information provided about Web site accessibility cannot be reached any other way.
- Have a designated accessibility expert on the Web development staff. Expert testing can identify a broad range of accessibility issues. Having a staff member charged with expertise in the Section 508 requirements would help to ensure that the accessibility requirements are always considered.
- Only use free automated testing tools as a part of a larger testing process. Automated tools can be helpful as a first step in testing for accessibility. The use of automated tools, however, can never replace the insights that can come from other methods of testing.
- Keep channels of communication open and actively solicit feedback. As users with disabilities are best qualified to assess accessibility, the channels of communication between users and Web development staff must be clear, easy to find, and easy to use, starting with an obvious way to e-mail the Web development staff.
- Test for accessibility on an iterative basis. As one of the respondents to the Webmaster questionnaire noted, “there’s always room for improvement.” Even a site that meets all of the Section 508 requirements will need to have the accessibility maintained as new elements are added and as content changes.
- Focus on the benefits of an accessible Web site to all users. Complying with the Section 508 requirements will give equal access to persons with disabilities, while also improving the usability of the site for all who visit it.

These recommendations can serve a first step in working toward federal e-government Web sites that comply with the requirements of Section 508.

The barriers to accessibility identified are a serious problem for persons with many different disabilities. Many of the sites studied were partly or completely inaccessible to users with certain types of disabilities and to users employing certain assistive technologies. As such, federal e-government sites are not offering equal access to government information and services to all users. For persons with disabilities, the accessibility of e-government Web sites remains an unfulfilled goal that creates serious limitations on the ability to use e-government.

The struggles for equal access to ICTs, in the public sphere and in the private sphere, are countless.⁴ The inaccessibility of e-government is especially significant and highly symbolic. Persons with disabilities have fought for years for the right to have equal access to and be included in government functions, from access to public education to the right to serve on juries.¹ To be widely excluded from e-government is a powerful symbol that government in the age of the World Wide Web is replicating the exclusions of previous eras. The poignancy of the accessibility problems of the White House Web site was not lost on many users in the study. Ultimately, inaccessible sites deny participation to persons with disabilities in a very practical sense. As more information and services become available online, then become available exclusively online, persons with disabilities will be denied equal access, unless accessibility is significantly improved.

E-government is becoming an increasingly important part of the democratic process and of typical activities of citizens in the United States.⁶⁰ As a result of the legal standards and the available ICTs, fully accessible federal e-government Web sites are achievable. Future user-centered, multi-method studies of e-government can prove a vital part of improving e-government access for all by identifying problems and suggesting best practices, policy changes, and other solutions.

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