Abstract

University of Wisconsin-Milwaukee requests $495,600 IMLS funding for a three-year (07/01/2016 – 06/30/2019) research project that focuses on the goal of creating digital library (DL) design guidelines on accessibility, usability and utility for blind and visually impaired (BVI) users. The guidelines will address the help-seeking situations in BVI users' interactions with DLs, and also incorporate perspectives from DL stakeholders and related guidelines. The investigators and consultants, led by Dr. Iris Xie, include interdisciplinary researchers and practitioners with expertise in BVI users' help needs, DL development and evaluation, as well as research and guidelines creation on accessibility, usability and utility. Partners include organizations developing and managing DLs (American Library Association-OITP, The Digital Public Library of America, Milwaukee Public Libraries, Milwaukee Public Museum, Milwaukee Art Museum, UWM Libraries, and Recollection Wisconsin and organizations serving the BVI community (American Council of the Blind, Association for the BVI, Blind Service Association, Learning Ally, National Federation of the Blind-WI Chapter, and Vision Forward). The Library of Congress also supports the project. The advisory board consists of members from: ALA, ARTStor, Blind, Inc., Digital Library Federation, DPLA, HathiTrust, Learning Ally, The New York Botanical Garden Mertz Library, OCLC-CONTENTdm, ProQuest, and different guidelines working groups and standards committees. Collectively, the team represents DL organizations and vendors; BVI associations; and scholars and experts in the areas of accessibility, usability and utility.

The project is motivated by the belief that 20.6 million BVI Americans cannot utilize DLs effectively due to their sight-centered design. Limitations of existing accessibility and usability guidelines do not address many of the help-seeking situations BVI users face, preventing the accessibility and effective use of DLs. Making DLs accessible for BVI users is a legal necessity per the Americans with Disabilities Act (ADA). Compliance with accessible Web design guidelines as outlined by WCAG, and other guidelines, is necessary, but not sufficient, for BVI users to effectively access and use the DLs. This project is at the forefront of the **National Digital Platform** (NDP) to provide access to engaging and meaningful digital content and services, to all Americans. The 2015 NDP Report specifies diversity and inclusion as both a challenge and a priority area. This project will serve this area by answering the question stated in the report: "How can we ensure that the national digital platform serves all Americans?"[1] This will be achieved by addressing the needs of BVI users by creating DL guidelines, which can be adapted for other underserved groups. This research will give the BVI community an important voice alongside with other stakeholders in developing DL design guidelines. This project will also serve the NDP goals by leveraging partnerships with consultants, advisory board members, partners, and stakeholders that will help to develop, promote, and implement DL guidelines nationwide.

The project consists of four stages. In Stage 1, two document analyses will be provided to: 1) address help-seeking situations and needs of BVI users in DLs; and, 2) identify existing design guidelines on accessibility, usability, and utility in digital environments, and their limitations. In Stage 2, a user study will identify the help-seeking situations BVI users encounter in DLs and associated help needs, and develop the draft of guidelines. In Stage 3, two-round Delphi surveys will be administered to three groups of stakeholders to refine the guidelines. In Stage 4, DL developers will use the guidelines to assess 15 of the leading DLs and test the feasibility of the guidelines. Focus groups will be formed to discuss participants' experience with the assessment. Based on final suggestions and feedback, DL design guidelines will be finalized.

The project will generate three products: 1) DL design guidelines organized by types of help-seeking situations associated with accessibility, usability and utility; 2) report on the current status of how DLs satisfy BVI users' help needs and support DL interactions; and 3) methodology that can be applied to other underserved users to develop similar guidelines for DLs and different types of information systems. Primary audiences for the project include: BVI users, digital librarians, web application librarians, usability or assessment librarians, archivists, researchers, designers, and vendors of DLs and other systems. The project will inform policy makers, researchers, and practitioners to understand DL design problems, and enable DL developers to enhance DLs for universal access. Success indicators include the promotion and adoption of DL design guidelines.

---

[1] Erway, R., Hill, C , Streams, S., and Harmon, S. (Eds.) (2015, April 28). *IMLS Focus Summary Report: National Digital Platform.* Retrieved from https://www.imls.gov/sites/default/files/publications/documents/2015imlsfocusndpreport.pdf

CREATING DIGITAL LIBRARY (DL) DESIGN GUIDELINES ON ACCESSIBILITY, USABILITY AND UTILITY FOR BLIND AND VISUALLY IMPAIRED (BVI) USERS

STATEMENT OF NEED

The project goal will create digital library (DL) design guidelines on accessibility, usability and utility by incorporating the perspectives of key stakeholders. Most importantly, the guidelines will address the help-seeking situations that blind and visually impaired (BVI) users experience in DL interactions. A help-seeking situation is characterized by a user engaged in information seeking within a DL in order to achieve his/her tasks/goals, and needing some form of help in the process.

The need: Addressing challenges of BVI users using sighted-centered DLs

BVI Users and their unique needs. An estimated 20.6 million adults with significant vision loss live in the US. [1]. BVI users comprise an atypical group of users who interact with DLs in entirely different ways from sighted users. In this proposal, BVI users include those who lack the functional sight to see information on a computer screen. They interact with the Internet by listening to information read aloud by a screen-reader (SR), which identifies and interprets textual content on the screen presented aurally through a synthetic voice [2-3]. Screen readers are the most popular assistive technology used by BVI users, and a recent WebAIM survey (2015) confirms that a majority of SR users are BVI [2; 4]. This study will focus on BVI users who rely on SR's when searching for information online.

The challenge of using sighted-centered DLs. BVI users face unique needs, challenges, strategies, and preferences in their interactions with DLs. To design DLs that meet the needs of BVI users, DL developers and researchers must first understand these special needs. DLs are comprised of digital content created by libraries and cultural heritage institutions, and include manuscripts, images, audio, and video. Currently, DLs are sight-centered by design. There is no single design model for DLs; the DL structure is highly complex where the content is inherently heterogeneous in format and system dimensions [5-10]. Such complexities, combined with the sight-centered design, can present significant problems in retrieving information non-visually, giving rise to help-seeking situations for BVI users.

BVI users' help-seeking situations. BVI users exhibit unique help-seeking situations in Web interactions. Prior literature reveals that they face multiple cognitive and physical constraints during information retrieval online due to several factors: 1) avoidance of pages due to dynamic content; 2) browsing difficulty due to structural problems and the linear nature of screen reading; 3) sequential interaction and loss of contextual information; 4) lack of important navigational and interpretive cues; 5) cognitive overload; and 6) improper labeling of interface objects [2; 11-17]. Although few studies investigate BVI users' problems and coping strategies [18], a systematic examination of their help-seeking situations and associated factors has not yet been conducted. This creates a research gap on BVI users' help needs for effective DL interactions. Addressing this gap is the first step towards building a BVI-friendly DL environment. **Our team has begun addressing this gap through a pilot study** with 30 blind users to explore their help-seeking situations in DL interactions (Supportingdoc1). Preliminary results identified 17 unique help-seeking situations both at the physical level (e.g. inability to view visual items, inability to find a system function) and cognitive level (e.g. cognitive overload, confusion about structure) [19]. The results revealed that accessibility and usability are the major barriers for blind users to use DLs. Nevertheless, BVI users recognized the utility of DLs, and wanted to use them. A typical quote from the pilot study is: "Even though there was good information there, finding the information that I wanted wasn't easy... the content of the site was great, but the organization and design is less than desired." It can be concluded that accessibility and usability problems of blind users arises primarily because DL design fails to support their needs.

Legal requirement for accessibility. Making DLs accessible for BVI users is a legal necessity per the Americans with Disabilities Act (ADA). The ADA mandates all digital content available for public consumption be accessible to users with disabilities. For the BVI, this means the DL interface, content and features should be accessible with SRs. Compliance with Web accessibility guidelines, Section 508 of the

U.S. Rehabilitation Act, and other guidelines are necessary, but not sufficient, for effective access for the BVI [3; 11; 20-23]. Additionally, despite availability of help, most users do not use existing forms of help available in most information systems because they are simply not helpful [24-26]. A standard set of DL design guidelines has not been created.

The solution: Creating DL design guidelines on accessibility, usability and utility

The proposed project will determine the unique help-seeking situations of BVI users in DL interactions, and examine existing accessibility and usability guidelines to identify the gap between existing design guidelines and BVI help needs. The project will address the following **research questions**:

> 1) What are the help-seeking situations and information needs of BVI users in DL interactions? 2) What are the limitations of existing DL guidelines on accessibility, usability and utility in meeting the information needs and help-seeking situations of BVI users? 3) What are the perspectives of DL developers, scholars and experts on creating design guidelines on DL accessibility, usability and utility for BVI users? 4) What guidelines on accessibility, usability and utility are needed to assist BVI users in successfully interacting with DLs and feasible for DL developers to follow in DL design and assessment? 5) What is the current status of DL design in supporting BVI users to interact with DLs in terms of accessibility, usability and utility? 6) What is the methodology that can be applied to create guidelines to support other types of underserved user groups?

Limitation of existing guidelines. DL research has paid primary attention to accessibility and usability [27-28], with the most commonly used guidelines focusing on Web accessibility [2]. The problem is that these guidelines do not address many of the interaction problems and help-seeking situations BVI users face in their use of DLs [18; 29-30]. **Accessibility of DLs is only the first requirement** since BVI users need to access DLs and associated pages first. The most well-known guidelines produced for the Web Accessibility Initiative (WAI), under the World Wide Web Consortium (W3C), are the Web Content Accessibility guidelines (WCAG), which is a technical standard for Web developers. WCAG 2.0 guidelines cover a wide range of recommendations to make Web content more accessible and were developed for people with a variety of disabilities, including BVI users. Although WAI released the updated WCAG 2.0 in 2008, many of the problems from WCAG 1.0 persist in WCAG 2.0 [29]. **First, WCAG guidelines are considered as ambiguous instructions** for librarians who develop library websites for accessibility of disabled users due to vagueness and lack of specifications [31-32]. **Second**, **WCAG is not granular enough to address the unique problems and challenges faced by BVI users** [11; 15; 21-22; 29; 32]. For example, WCAG recommends that Web content must be understandable, but it does not sufficiently explain how designers can make it understandable to reduce the problems BVI users face. **Third**, although WCAG 2.0 guidelines cover a wide range of accessibility issues, they **are not able to address the needs of people with all types, degrees, and combinations of disabilities** [33]. The other most commonly used accessibility guidelines are the United States Federal Section 508 standards. Researchers suggest that both WCAG guidelines and Section 508 standards address most users' physical needs, but **fail to address users' cognitive needs** [2].

Usability of DLs is the second requirement because ease of understanding and ease of use are vital for BVI users to interact with DLs. Usability testing is a critical component of user-centered design and an approach to improving user interfaces. Usability of DLs is associated with how easily users can interact with the DL interface [34]. Usability attributes include: learnability, efficiency, memorability, errors and satisfaction [35]. Disabled users, in particular BVI users, experience not only accessibility problems but also usability problems [29; 36, 37]. Many researchers emphasize that true accessibility requires both technical accessibility and usability, and both concepts are included in the definitions of accessibility used in most laws, standards, and guidelines [29; 37]. They also suggest that usability and accessibility must identify a broader set of design principles based on data obtained from BVI users. **WCAG guidelines should incorporate a usability perspective on accessibility issues for better guidelines** [36]. Other research suggests that the design of help features significantly impacts the perceived usability of systems [24]. **Utility is the third requirement**, the most difficult one to fulfill, as various disabilities may lead to complicated physical and cognitive help-seeking situations. Most important, the ultimate goal for information retrieval is to assist users in achieving their tasks

[38-41]. Utility is defined as the usefulness of retrieved documents from a system in helping users to achieve their information needs and tasks [39-40; 42]. Utility is typically addressed using various types of terminology, such as functionality and usefulness [27; 28; 43]. Research also shows that usefulness of the system or information available online is one of key determinant of technology adoption of users with disabilities [44-45]. **No research has been done on BVI users' utility issue in the DL context**, as it requires the examination of users performing real tasks.

The significance of creating new guidelines. The great promise of DLs becoming the gateway to the universal access to information will go unrealized for BVI users if they cannot effectively use DLs to meet their information needs. While DL researchers have taken into account various aspects of accessibility, usability, and utility in DLs [27; 28; 46-47], few researchers have examined the unique help-seeking situations and needs of BVI users in order to develop DL guidelines for effective DL interactions. Literature indicates that existing guidelines do not fully address the unique problems and needs BVI users experience when interacting with DLs. The limitation of the existing research calls for the need to develop DL design guidelines to support BVI users in effective DL interactions. Literature addresses some of the constraints BVI users face in Web searching, but no research has involved creating design guidelines to address their help-seeking situations or their desired help needs in accessing DLs. Additionally, researchers fail to solicit perspectives from different stakeholders on the subject. More important, the creation of design guidelines will enable DL developers to enhance the accessibility, usability, and utility for DLs to support BVI users. The primary audiences for the project outcomes include: BVI users, digital librarians, developers/web application librarians, usability or assessment librarians, archivists, researchers, and designers and vendors of DL software.

NATIONAL IMPACT

Project products. This project will generate three final products: 1) DL design guidelines organized by types of help-seeking situations associated with accessibility, usability and utility based on the WCAG structure; 2) report on the current status of how DLs satisfy BVI users' help needs and support DL interactions; 3) methodology that can be applied to other underserved users to develop similar guidelines. The project intends to answer the question: "How can we ensure that the national digital platform serves all Americans?"[48, p 7] raised by the **National Digital Platform** (NDP) report. An important aspect of the NDP report that this project will address is that "the user should figure prominently in our strategy" [48, p. 6]. This project will also serve the NDP goals of diversity and inclusion, by serving all Americans. This research will bring BVI users directly into the national conversation, giving this community an important voice alongside other DL stakeholders, in the process of developing DL design guidelines. This will be achieved by leveraging partnerships with consultants, advisory board members, partners, stakeholders, national associations, and consortiums that will help to develop, promote, and implement DL guidelines, nationwide.

Filling the gap. DLs are increasingly becoming the preferred resource for searchers, replacing or supplementing physical interactions with traditional libraries. The proposed project innovatively addresses the issue of DL accessibility, usability and utility for one of the key underserved groups by creating design guidelines to address BVI users' help-seeking situations. As previously reviewed, it is difficult for BVI users to adapt to different types of DLs. Limitations of existing design guidelines that do not holistically address these problems result in poor DL design and, subsequently, hinder BVI users' ability to use DLs. Existing guidelines must be assessed for their gaps, and new guidelines need to be developed to make DL's accessible, usable, and useful. None of the research has addressed building guidelines for DL design that supports the accessibility, usability, and utility needs of BVI users. The research will impact DLs across the country by filling gaps in existing guidelines that are not addressed in the current DL infrastructure; new guidelines will ensure that DLs are meeting the needs of diverse communities.

Evidence of the project success. The interdisciplinary nature of this project team and its incorporation of different stakeholders of DLs —involving scholars and experts, digital librarians, and end users—will produce an impact far beyond the immediate success of the project itself. The project has received the support of national, regional, and local organizations presented below that will leverage this structure to register a

transformative impact to a diverse and stratified collection of beneficiaries. The team has conducted a pilot study with BVI users, and its instruments and preliminary results are valuable to this project. The project design, consisting of four stages of work: building a foundation for guidelines, creating guidelines, refining guidelines, and testing and finalizing guidelines, ensures the success of the project.

Impact beyond BVI users and DLs. This research is at the forefront of the **National Digital Platform** movement to provide access to engaging and meaningful digital content, and services, to all Americans. The issue examined in this research is universal, as all users can potentially utilize DLs. **Methods employed in this project can be applied to generate guidelines for other types of users**. While accessibility, usability and utility problems in DLs are exacerbated for BVI users, they create difficulties for other types of users as well, including the sighted, elderly, users with other disabilities (e.g. deaf, and members of other underserved communities). **The resulting design guidelines can be implemented in different types of systems** (e.g. DLs, web search engines, online databases, and online public access catalogs), because design guidelines offer detailed requirements of the system features needed to support BVI users. The significance of this research is its universality, practical implications, and methodological approaches.

Evaluation. This project will undergo three forms of evaluation. **First,** the team will establish the internal validity and reliability of the project. This will include the thorough examination of multiple data collection and qualitative and quantitative data analysis methods to ensure the accuracy and generalizability of the results. In particular, inter-coder reliability will be examined thoroughly for open coding analysis of categories. **Second**, the involvement of BVI users, digital librarians, and DL scholars/experts in DL design guidelines creation will evaluate and ensure the feasibility of design guidelines for BVI users. The team will conduct an outcomes-based evaluation based on feedback. In addition to advisory board members and partners, the team will solicit opinions about the project findings from other researchers and practitioners when organizing panel discussions, or presenting at different workshops and conferences. **Third**, success indicators include promotion by national library associations, BVI associations, and consortiums, and the rate of adoption of guidelines by DLs. This project will also create a website which will provide a channel to disseminate related information and solicit feedback. Simultaneously, citation and circulation of findings as well as the number of people who attend the workshops and request design documents will also indicate the success of the project.

This project will register a transformative impact, but will do so **at no known risk**. The team represents the leading experts in a variety of cross-disciplinary fields. It represents different stakeholders of the DL creation and use. In addition, the pilot study is done, and evaluation plan is well developed and informed by a variety of methods, people, and contexts. The project will be useful as a theoretical basis for DL research by helping to understand the nature of BVI users' unique help-seeking situations and behaviors, but also offers a practical contribution by creating DL guidelines to support BVI users' effective DL interactions. Moreover, it also has methodological implications in terms of how to develop design guidelines for other types of users and systems.

PROJECT DESIGN, TASK GOALS AND OUTCOMES

In order to address the research questions proposed above, the proposed project consists of four stages.

Stage 1 Build a foundation for DL design guidelines (6 months, Research Questions 1, 2, 3, 4, 5, 6)

1.1 Identify unique help-seeking situations by document analysis

A thorough and comprehensive literature search for the last 20 years and document analysis [49] will be conducted to identify a list of help-seeking situations that BVI users encounter in their Internet interactions since very little research has been conducted in the DL environment. Both physical and cognitive levels of situations will be analyzed. These findings will enable the team to create a draft of design guidelines that address the variety of help-seeking situations that BVI users may experience during their DL interactions. The document analysis will build on the literature review conducted in LIS and other related fields during the pilot study. Four levels of facets will be generated: unique needs of BVI users of DLs, their help-seeking situations, factors leading to the situations, and their desired help needs. Findings will be verified and enhanced by data gathered from the user study in Stage 2.

1.2 Survey existing guidelines and papers by document analysis

Two types of analyses will be conducted to identify the current status and problems with the existing guidelines as they relate to accessibility, usability and utility: 1) analysis of existing accessibility and usability guidelines and 2) analysis of associated research on the topic. A comprehensive search will be conducted to identify the existing guidelines and associated papers through web search engines and major online databases for the last 20 years. The scope of these guidelines will cover both US and international territory. The inclusion criteria are: 1) guidelines, standards or policies that are related to accessibility, usability or utility for information systems, Web pages, software, etc., and 2) papers that address the coverage, components, structure, problems or future directions of guidelines, standards, best practices and policies. Next, the team will describe various aspects and components of the guidelines in detail, develop a meta-analysis of guidelines that provides an overview on the coverage, components, and structure of the existing guidelines, and identify types of problems and future directions. Finally, BVI users' help-seeking situations and needs identified in the literature will be compared to the document analysis of the guidelines to help inform the user study and guidelines development in Stage 2. These two types of document analyses will complement each other, providing a comprehensive overview on how, where, and why existing guidelines fail to address the help-seeking situations and needs of BVI users of DLs, with the primary goal of identifying the types of guidelines needed to fulfill these needs.

Stage 2 Develop draft of DL guidelines (15 months, Research Questions 1, 2, 4, 6)

2.1 Recruit participants and prepare IRB

Participant recruitment will occur for three different communities participating in various stages of the DL design guidelines development. First, 60 BVI participants will be recruited for a user study in digital libraries in order to identify help-seeking situations. Second, 150 participants will be recruited for two-round Delphi surveys to provide feedback for the draft of guidelines. Third, 30 DL developers will be recruited for the assessment of 15 digital libraries and participation in focus groups to test the guidelines.

Since the BVI population comprises a low-incidence user population, recruiting a sufficient number of participants can pose unique challenges. To ensure success in recruitment, participants will be recruited from BVI partner organizations (see Partnercommitment.pdf), Participants will also be recruited from mailing lists, such as NFB Net, Blind geek zone, The New Blind Tech, Blind Cool Tech, Blind Webbers, Blind World, and NOBE (National Organization of Blind Educators). Additionally, the consultants and advisory board will also make recommendations for and help with participant recruitment. In addition, they will be recruited at different BVI conventions. **Sixty (60) participants will be recruited representing BVI users** across the US with different characteristics. Diversity is the key for recruitment. Each participant will receive $75 as an incentive for completing the study. Participants must: (a) use a screen reader to access the Internet, (b) have at least three years of experience in using the Internet, and (c) be 18 years and older. Potential participants will be prescreened via a pre-questionnaire. Due to the mobility restrictions of BVI users, the team will travel to different sites that are convenient to participants, when needed.

To reflect various opinions of heterogeneous stakeholders involved in the research, development, and use of DLs, a variety of stakeholders will participate in two-round Delphi surveys. **150 participants** will be recruited to represent the following four groups: scholars, experts, digital library developers, and end users. The number and the selection criteria of each group are specified as: ***Scholar*s (N=25)**: scholars who have conducted research on accessibility, usability and utility with high citations. ***Experts* (N=25)** are people who perform accessibility and usability tests for BVI users as well as screen reader developers. Experts will be recruited through organizations and units, such as the American Foundation for the Blind (AFB) Tech Lab, Microsoft Accessibility unit, Google Accessibility lab, and The Trace Research and Development Center. They will also be recruited at conventions, including the CSUN International Technology & Persons with Disabilities Conference, and the International Conference on Computers Helping People with Special Needs**. *Digital library Developers* (N=50)**: Digital librarians who have been in charge of DL development and management for several years. Recruiting messages will be sent to related listservs (e.g., Diglib, Imagelib, CONTENTdm-L). ***End users***

(N=50): BVI users. All participants will be instructed to fill in pre-questionnaires, consisting of three parts: 1) demographics information; 2) experience in researching, developing, managing, or using DLs; and 3) experience and perceptions in dealing with issues in relation to accessibility, usability and utility.

Thirty of the **50 DL developers** who participated in the Delpi surveys will be recruited to participate in the DL assessment and guidelines feasibility assessment including focus groups. The reasons for the selection of this group are: 1) they are the implementers of the guidelines for the design and improvement of DLs; and, 2) they offer feedback for the draft guidelines, and are familiar with guidelines. After completing the assessment, these members will participate in focus groups to discuss their experiences in applying the guidelines to DLs. They will each be compensated $200 for their time commitment and input. **An IRB Protocol form** including all instruments and consent forms, will be prepared and submitted to University of Wisconsin-Milwaukee Institutional Review Board (IRB) board for approval.

2.2 Identify help-seeking situations through a user study

In Stage 2, the team will develop an understanding of various help-seeking situations BVI users encounter in DLs when performing specific search tasks, and the types of help needed to resolve these situations. In addition, the team will investigate the factors that lead to the help-seeking situations. By identifying help-seeking situations and factors, the team will uncover the specific needs of BVI users in order to prepare for the development of DL design guidelines.

To be selected, a DL must include: 1) a wide variety of content and media formats in which BVI users might be interested; 2) different types of interface design features. To identify diverse types of interactions, a combination of two types of search tasks (one assigned and one self-generated) will be employed in the study, including specific information search and subject-oriented search. In specific information search, a user looks for exact data or facts. In subject-oriented search, a user looks for items with common characteristics [38]. The participant will conduct each search task in two different DLs, and the 6 most popular DLs will be selected for the user study. These tasks will help investigate the different types of help-seeking situations BVI users experience when accomplishing search tasks.

Multiple data collection methods will be applied to explore BVI users' help-seeking situations: pre-questionnaires, pre-search interviews, think-aloud protocols, transaction logs, and post-search interviews. Pre-questionnaires and pre-search interviews will be used to solicit demographic information. Laptops with a popular screen reader (SR) and Morae software, which captures participant verbalization, screen shots, and transaction logs, will be used for this study. Think-aloud protocols will provide detailed information about BVI users' perception of their help-seeking problems and desired features. Transaction logs will show the unique help-seeking patterns of BVI users. In post-search interviews, the team will ask participants to identify: typical problems in fulfilling the search tasks, interface features used, desired features, etc. The pilot study demonstrates that these data collection methods work for the BVI participants. The team will enhance these instruments (Supportingdoc1.pdf) for the proposed project.

Data will be analyzed both qualitatively and quantitatively. Based on open coding and content analysis, the team will identify types of help-seeking situations that BVI users encounter during the search process and associated factors as well as desired help needs. First, qualitative data will be analyzed by using open coding, which is the process of breaking down, examining, comparing, conceptualizing, and categorizing unstructured data [50]. Taxonomies of help-seeking situations will be specified and categorized into help-seeking situations unique to BVI users at the physical level and the cognitive level. Second, open coding will also be applied to specify associated help needs for each type of help-seeking situation. Third, relationships between factors and different types of help-seeking situations will be analyzed by applying ANOVA and multiple regression.

2.3 Develop the draft of guidelines

Based on Stages 1.1, 1.2, and 2.2, a draft of guidelines will be developed. The document analysis including a review of WCAG and other guidelines that will be reviewed against BVI users' help-seeking situations and

challenges. Similar to the analysis in Stage 1.2, design guidelines will be organized by types of help-seeking situations associated with accessibility, usability and utility, and consist of design principles, help needs, conformance criteria, specification of definitions, intent, benefits, examples, techniques, common failures, and related sources for the development and implementation of DL guidelines based on the WCAG structure.

In order to develop the draft of guidelines, the research team will analyze and re-analyze the results of the user study using open coding and compare findings to the existing guidelines. The key DL design principles will be identified in association with the three overarching areas of accessibility, usability and utility. Each of the help-seeking situations of BVI users, help needs and desired features will be grouped together under the relevant and appropriate design principles. Next, specific guidelines will be developed as guided by the principles, associated help needs, and desired features. These guidelines will also be developed from the findings of the document analyses, which is the comprehensive review and analysis of relevant literature on help-seeking and development of guidelines on accessibility, usability and utility for digital environments. To determine how well the DL design supports the help needs of BVI users, conformance criteria will be built for each of the guidelines. Conformance criteria are the requirements necessary for meeting the principles and guidelines, and include levels and checkpoints for measurement. A specification of definitions will be provided. The intent of the conformance criteria explains the purpose for the criteria, and the benefits provide justification for how the criteria will support BVI users. Techniques include basic practices, tools, and suggestions for DL developers and web content authors indicating ways to meet the conformance criteria. Common failures indicate things that cause help-seeking situations (e.g. factors) that DL developers should avoid in DL design. Practical examples will be provided, when applicable, of actual help-seeking situations, instances when DL design has failed, and techniques for improving the design and meeting conformance criteria. In addition, related resources of theoretical research and practical best practices of how to design DLs on accessibility, usability and utility to support BVI users will also be offered.

Stage 3 Refine DL guidelines (6 months, Research Questions 3, 4, 6)

Two-round Delphi surveys will be administered to 150 participants representing four groups of stakeholders to provide feedback for the draft of guidelines. Each participant will only respond to the survey that is applicable to his/her group. Data obtained in Stages 1.1, 1.2, 2.2, and 2.3 will be incorporated in the development of the Delphi surveys. The purpose of the first round is to solicit qualitative and quantitative feedback on the guidelines drafted in Stage 2. The survey will instruct participants to review the current guidelines and suggest additional conformance criteria, specification of definitions, intent, benefits, techniques, and common failures related to DL design guidelines on accessibility, usability and utility they perceive to be important. This option will ensure the comprehensiveness of the list relevant to different groups of stakeholders. Quantitatively, the Delphi survey will instruct participants to fill out the survey on a “1 to 7” Likert scale for each component of the guidelines. For each component, four types of questions will be asked related to: importance, relevance, clarity, and feasibility. Importance will serve as a key variable to rank each element. Qualitatively, suggestions to modify each component of the guidelines will be analyzed. The results from the previous round will be incorporated into the second round. In the second round, participants will instruct to review the updated guidelines quantitatively and qualitatively in the same format as the first round. The findings of the second round will help the research team modify the DL design guidelines for BVI users.

Stage 4 Test and finalize the guidelines (9 months, Research Questions 4, 5, 6)

4.1 Apply guidelines for DL Assessment and finalize the guidelines

At this stage, the guidelines will be used to assess 15 DLs representing different types of DLs. Each of the thirty (30) DL developers, selected from Stage 3, will be instructed to assess two (2) of the selected DLs based on the guidelines. In total, each DL will be evaluated by four DL developers. The objectives of 4.1 are two-fold. First, the guidelines will be tested to see whether they can be used to assess DLs and further enhancements will be suggested to improve the DL design guidelines. Second, the guidelines will be used to assess the current status and conformance levels of the 15 DLs in terms of whether they meet conformance criteria for accessibility, usability and utility for BVI users. The DL selection criteria in Stage 2 is adopted for

this stage as well. Each DL will be assessed qualitatively (strengths and problems) and quantitatively (the extent of DL's conformance) to review the current status of DLs. Each DL will be assessed based on the conformance criteria, techniques, and failures for each of the DL guidelines. Simultaneously, each DL developer will also record his/her problems in applying the guidelines and make suggestions for the improvement of the guidelines. Each component of DL guidelines will be rated numerically for its importance, relevance, clarity, and feasibility for its application.

Following the DL assessment, four focus groups with 7-8 participants in each group will be formed to discuss participants' experience in assessing the DLs according to the new guidelines. Focus groups will provide suggestions on how to best finalize the guidelines. GoTo Meeting will be used to facilitate and record the discussions of the focus groups. Focus groups will include open-ended questions and seek modification suggestions to address the problems. Audio-recordings will be transcribed and the transcripts will be analyzed. Focus groups will be analyzed using open coding discussed in Stage 2. Taxonomies of problems with the guidelines and suggested modifications will be identified from the data. Based on the suggestions and feedback from the 30 DL developers, the team will work with advisory board members to finalize the guidelines.

4.2 Disseminate/ implement guidelines and write a report

The research design, sampling, multiple data collection and data analysis methods employed in this project can be applied to generate design guidelines to support different types of users in different types of systems. The final products include the DL guidelines, current DL status in supporting BVI users as well as methodology for the creation of the guidelines. The team will write a report to submit to IMLS and disseminate the findings of this project through multiple channels. Most important, the team will work with our advisory board members and partners to recommend the guidelines for integration into the existing guidelines (e.g., WCAG), and disseminate and implement the guidelines in DL design, nationwide. See the Communication and Sustainability section for a detailed discussion.

DIVERSITY PLAN

In Statement of Need, a discussion of why BVI users are chosen and why DL design guidelines on accessibility, usability and utility for BVI users are needed is justified. In Project Design, the discussion focuses on how diverse BVI users will be selected as participants of the study and how the team can create DL design guidelines to satisfy the unique needs of BVI users and other underserved groups.

PROJECT RESOURCES: PERSONNEL, TIME, BUDGET

To ensure the success and sustainability of the project, our team will work with consultants, advisory board members, and partners representing different DL stakeholders to develop, promote, and implement the design guidelines. The team include consultants and advisory board members who are leading experts in a variety of cross-disciplinary fields, such as DLs, BVI users, interface design, usability, web accessibility, guidelines creation, implementation and evaluation, as well as partners representing multiple DL stakeholders. **Consultant** responsibilities include: analyzing existing DL design guidelines; helping to identify problems found through the user study but not addressed by existing guidelines; assisting in the creation of new guidelines and providing ongoing feedback at various stages of development of guidelines; supporting the assessment of 15 leading DLs; and helping to disseminate the results and working with different partners and organizations to promote and implement the guidelines. Each consultant will work for about 150 hours for the project. **Advisory board members** will provide feedback to products generated in all stages, offer general guidance on project activities, and assist the research team in implementation and promotion of guidelines. **Partners** will contribute throughout the project by offering feedback and consultation, as well as assistance with participant recruitment, implementation of project products in real settings, dissemination of findings, and the promotion of the project's products. See Projectstaff.pdf and Resumes.pdf for a list of key personnel and abbreviated curricula vitae as well as PartnerCommitment.pdf for a list of letters from consultants, board members and partners. Consultants, advisory board members and partners will meet via GoToMeeting, and have ongoing discussion via a listserv.

Dr. Iris Xie, Principal Investigator, will oversee and manage the project. Dr. Xie has been actively involved in the research of digital libraries (DL) for about 15 years and help-seeking for sighted users for more than 10 years. Her research interests and expertise focus on DL design and evaluation, interactive IR, usability, as well as user needs and user studies. Her research is highlighted in her two books, "Interactive Information Retrieval in Digital Environments," and, "Discover Digital Libraries: Theory and practice." Her DL-related projects range from the IMLS grant (PI), "Designing Interactive Help Mechanisms for Novice Users of DLs," the NSF grant (senior personnel), "Creation of the Internet Research Ethics Digital Library," to the OCLC/ALISE grant (PI), "Universal Accessibility of Digital Libraries: Design of help mechanisms for blind users." The OCLC/ ALISE grant will offer insightful information for the creation of DL design guidelines. She also served on the ASIST standards committee for several years. This project is a natural progression in the active focus of Dr. Xie's research. ***Dr. Rakesh Babu*****,** Co- Principal Investigator, is blind and has a strong motivation to undertake research to empower the BVI in the information society. Dr. Babu has conducted research on accessibility and usability for BVI users for approximately 10 years. His research expertise includes systems accessibility and usability, user-centered design and evaluation, cognitive modelling, and active social cyberlearning. His research on systems accessibility and usability for the BVI appears in multiple journals and proceedings. He has research projects sponsored by agencies such as NSF, European Research Council, and OCLC/ALISE. **Doctoral students Melissa Castillo and Hye Jung Han** will work on the project as research assistants.

Consultant *Dr. James Allan* has been the chair of the W3C User Agent Accessibility Guidelines Working Group (UAWG) for the Web Accessibility Initiative since 2005. His expertise covers accessibility guidelines creation, implementation and evaluation. **Consultant *Jeremy Boggs'*** expertise is in front-end development, user interface, usability, and aesthetics for DL projects. He was the Omeka's Development Team Lead. **Consultant *Dr. Krystyna Matusiak***'s expertise covers DL development, evaluation, and usability. Dr. Matusiak worked as a Digital Librarian for 10 years and designed over 20 distinct digital collections. She chairs the ASIST Special Interest Group for Visualization, Images, and Sound, and also serves as a member of the ASIST Standards Committee. The **advisory board** consists of members from different types of digital libraries, experts on accessibility, usability and utility, and different BVI associations and service groups. ***Mary Alexander and Kristen Witucki,*** **Learning Ally**. Alexander and Witucki both support the Learning Ally's College Success Program, which helps college students who are BVI and in need of additional support. ***Dan Cohen*****,** Executive Director, **Digital Public Library of America (DPLA)**. Cohen has expertise in the development of digital libraries. ***Susan Fraser*****,** Director, **The New York Botanical Garden Mertz Library**. Fraser's expertise is in the creation of digital libraries. ***Mike Furlough*****,** Executive Director, **HathiTrust**. Furlough has more than a dozen years of experience leading initiatives in digital scholarship, content stewardship, and scholarly communications. ***Geri Bunker Ingram***, Community Manager for **OCLC's CONTENTdm** community. She has helped develop and design the CONTENTdm user experience. ***Bethany Nowviskie,*** Director, **Digital Library Federation.** Nowviskie's expertise is in the digital humanities. ***Serena Rosenhan***, Director, User Experience Design group, **ProQuest**. Rosenhan has conducted usability test with disabled users in ProQuest platform. ***Carrie Russell*****,** Program Director, Public Access to Information, **American Library Association (ALA)**. Russell's expertise is improving access for people with disabilities, copyright education, and public policy. ***James Shulman*****,** President, **Artstor**, developed and implemented plans for creating Artstor. ***Dan Wenzel*****,** Executive Director, **BLIND, Inc.** Wenzel has extensive experience for various agencies and programs serving the blind and visually impaired. ***Marcia Zeng,*** professor Zeng has experience serving **IFLA's DL Guidelines Working Group** and the ASIST standards committee. Zeng's expertise is in linked data, metadata, and digital humanities.

The project has received support from and will be in partnership with several national and regional associations and organizations. **BVI partner organizations and accessibility partners** include: American Council of the Blind, Association for the Blind and Visually Impaired, Blind Service Association, National Federation of the Blind-WI Chapter, and Learning Ally. **Associations include**: ALA-Office for Information Technology Policy. **Library and Museum partnerships** include: DPLA, Milwaukee Public Library, Milwaukee Public Museum, Milwaukee Art Museum and Wisconsin Library Services (WiLS), and UWM Libraries. The project has also received support from the **Library of Congress,** Office of the Law Librarian**.**

The total amount requested from IMLS is $495,600 and the cost sharing is $ [redacted] Table 1 presents the project management plan. Please see the Budgetjustification.pdf for detailed budget information and the scheduleofcompletion.pdf for the timeline of each project activity.

Table 1. Management plan

Stage	Time	Objective	IMLS Funding
1	07/01/16–12/30/16	Build a foundation for DL design guidelines	$ [redacted]
2	01/01/17-03/31/18	Develop draft DL guidelines	$ [redacted]
3	04/01/18-09/30/18	Refine DL guidelines	$ [redacted]
4	10/01/18-06/30/19	Test and finalize guidelines	$ [redacted]

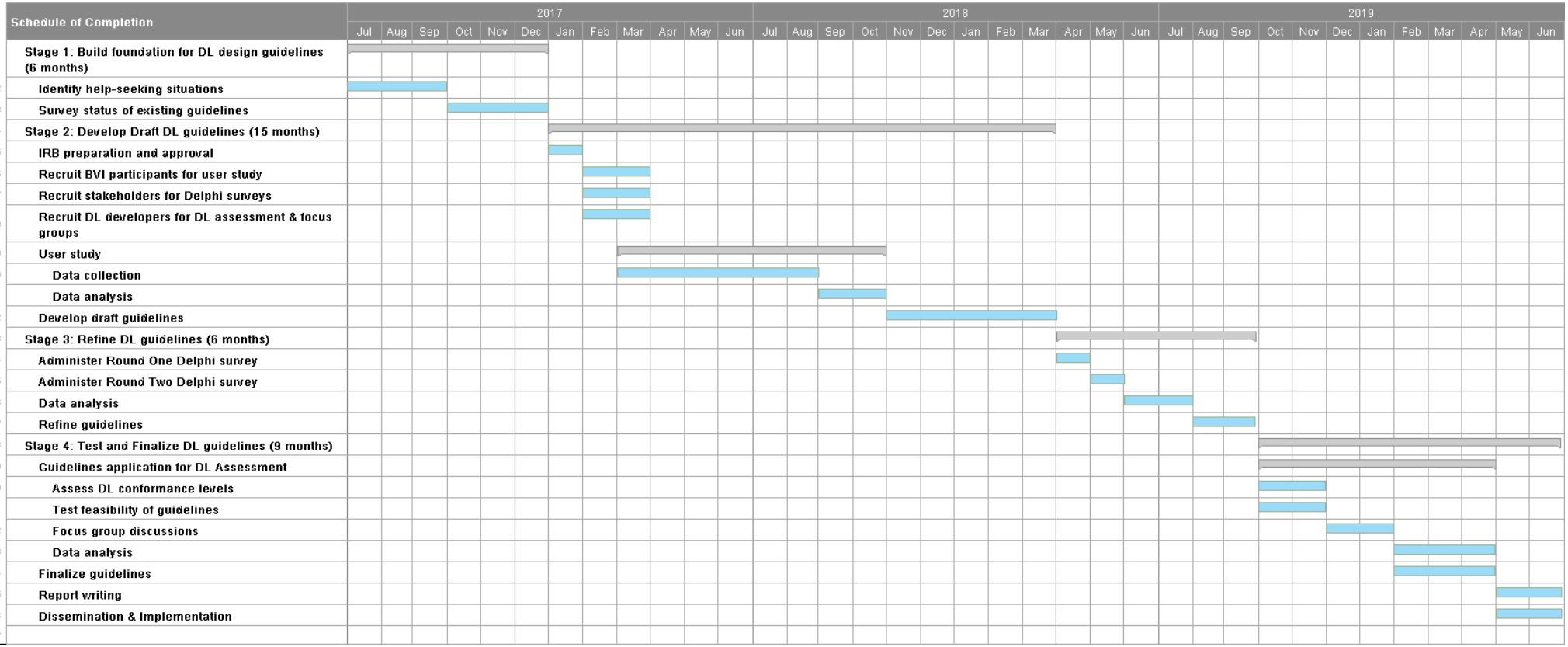
COMMUNICATIONS AND SUSTAINABILITY

Multiple channels will be used to disseminate the findings of this study: **1.** The team will **work closely with advisory board members, partners, various associations, consortiums, and organizations** (DLF, ALA, DPLA, HathiTrust, IFLA, WAI, ASIST, and Web for All), to disseminate and promote guidelines (e.g., news release, panel discussions, publications, workshops) nationally. **2. A project website** will be created to present findings and products including DL design guidelines and associated tutorials of this project, the website will also serve as a communication platform for anyone interested in DL design guidelines to share ideas on the topic as well as soliciting feedback for the guidelines. Moreover, UWM Digital Commons (http://dc.uwm.edu/) will serve as the repository to store the collected data, design guidelines and other associated documentation; **3.** The researchers will present the findings and offer workshops to librarians, developers, and vendors at **professional conferences** (e.g., ALA; DLF; CHI-ACM, Computer-Human Interaction Conference; Code4Lib; and Educause) so that the guidelines can lead to the improvement of existing DL and information system design; **4.** Results will be presented at **research conferences**, such as the Joint Conference on Digital Library (JCDL), or the Annual Meeting of ASIST, so that researchers in the field may apply the findings to their own research. Findings will be submitted to respected scholarly and professional journals in the field (e.g., D-Lib, JASIST, and Journal of Human-Computer Interaction); **5.** Presentations and workshops will be offered at different **conferences on accessibility, usability and utility** to promote DL design guidelines for BVI users (e.g. CSUN International Technology & Persons with Disabilities Conference, Accessing Higher Ground Accessible Media Web and Technology Conference, and the International Conference on Computers Helping People with Special Needs); **6**. **Social media** will be used to promote the products of the project; and **7. Reports of the project** will be submitted to IMLS and deposited in online databases, etc.

For sustainability, through consultants, advisory board members and partners, the guidelines will be submitted to W3C for consideration, and incorporated and adopted by different organizations and DLs. They will broadly be made available to stakeholders involved in DL development, interface design, management, and use through multiple channels discussed above. Since the external environments and related technologies change continuously, the PIs will conduct related studies to reflect the changes. Also, the team will provide consultation to those who want to incorporate the guidelines into their DLs. The team will continue to advance the project by applying for IMLS, NSF (e.g., Research in Disabilities Education), and Department of Education (e.g., National Institute of Disability & Rehabilitation Research) grants to develop design guidelines for OPAC systems or other information systems in libraries or museums and extend the methodologies used in this project to support other types of underrepresented groups, such as people with other types of disabilities (e.g. deaf, older adults, children). This project could serve as an exemplary study to develop design guidelines for different user groups in different library/museum digital platforms.

REFERENCES (see Supportingdoc2)

Schedule of Completion



17 Types of Help-seeking Situations

The research team identified 17 help-seeking situations that blind users encountered while using digital libraries, including nine at the physical level and eight at the cognitive level.

Xie, I., Babu, R., Joo, S. & Fuller, P., (2015). Using digital libraries non-visually: understanding the help seeking situations of blind users. *Information Research*, 20(2), paper 673. Retrieved from http://InformationR.net/ir/20-2/paper673.html

Physical Help-Seeking Situations

1) Difficulty accessing information

a) Difficulty in accessing format information of an item
b) Difficulty in finding alternative text for an image
c) Difficulty in recognizing pre-existing text in the input box

2) Difficulty identifying current status and path

d) Difficulty in identifying the current location
e) Difficulty in returning to home
f) Difficulty in recognizing page loading status

3) Difficulty evaluating information efficiently

g) Difficulty in finding a specific word or phrase in the digital library pages
h) Difficulty in finding heading information
i) Difficulty in efficiently evaluating information

Cognitive Help-Seeking Situations

1) Confusion about multiple programs and structures

a) Confusion about multiple programs
b) Confusion about digital library structure

2) Difficulty understanding information

c) Difficulty in recognizing a label
d) Difficulty in understanding help information

3) Difficulty understanding or using digital library features

e) Difficulty in understanding how to use a specific function
f) Difficulty in making sense of organization criteria

4) Avoidance of specific formats or approaches

g) Avoidance of visual items
h) Avoidance of browsing approach

Supportingdoc1: Pilot Study Instrument and Data Coding Scheme

Subject No: _____

Filling out this questionnaire indicates that I am at least eighteen years old and I am giving my informed consent to be a participant in this study.

Pre-Questionnaire

Age

θ 18-29 θ 30- 39 θ 40-49 50-59 >59

Gender

θ Female θ Male

Native Language

θ English θ non-English

Ethnicity/Race

θ African American θ Asian θ Caucasian θ Hispanic θ Native American θ Other

Profession

Job title _____

Vision condition

Are you partially sighted or blind?

If partially sighted, what is your corrected vision?

Are you congenitally blind or acquire blindness later in your life?
Congenitally blind/Acquire blindness

Have you used computer before you lost sight? Yes/ No

Internet Use

How many years have you used Internet?

How often do you use Internet?
1=never use, 2=rarely use, 3=occasionally use, 4=often use, 5=use daily

What are the main purposes that you use Internet? Identify three main reasons that you use Internet.

Search Skills

How do you rate your information search skills in using Internet?

- None (never tried to search information)
- Little knowledge or skills (just started learning how to search information, need lots of help)
- Beginner (I need some help to search something)
- Intermediate (Fluent with using commercial search engines like Google and Yahoo)
- Advanced (Fluent with using advanced search functions)
- Expert (Good at using advanced search functions, complex Boolean operations, understand back-end information retrieval mechanism)

Assistive technology use

What are the primary assistive technologies you use to access Internet? How long have you used for each of the assistive technology?

Assistive technology	Length of time

Filling out this questionnaire indicates that I am at least eighteen years old and I am giving my informed consent to be a participant in this study.

Post-search Interview

Note: Please repeat each search task when ask task related questions.

[Subject knowledge]
Overall how do you rate your level of subject knowledge of the questions you searched in the digital library?

T1	Not at all	1	2	3	4	5	6	7 Extremely knowledgeable
T2	Not at all	1	2	3	4	5	6	7 Extremely knowledgeable
T3	Not at all	1	2	3	4	5	6	7 Extremely knowledgeable

[Learn how to use]
How did you learn to use American Memory? What were the problems, if any, associated with learning to use this digital library?

[Problems encountered - help situations] [Problem solving - help situations]

1. What problems did you encounter during Task 1? How did you try to solve the problems you encountered? Which approaches were successful or unsuccessful to solve the problems?

2. What problems did you encounter during Task 2? How did you try to solve the problems you encountered? Which approaches were successful or unsuccessful to solve the problems?

3. What problems did you encounter during Task 3? How did you try to solve the problems you encountered? Which approaches were successful or unsuccessful to solve the problems?

[Explicit help uses]
Explicit help features: Help page, ask a librarian,

1. (an interviewer reminds the subject of help features he/she used) Why did you use these help features? Was it helpful?

2. Please rate the helpfulness of explicit help:
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

3. If the subject did not use any help feature, ask him/her: Why didn't you use any explicit help feature? Were you aware of these explicit help features such as Help page or ask a librarian?

[Implicit help uses]
Implicit help features: FAQ, query suggestion, search limiters, advanced search, etc.

1. (an interviewer reminds the subject of help features he/she used) Why did you use these help features? Were they helpful?

2. Please rate the helpfulness of implicit help:
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

[System help]

1-a. (Help for query creation) To what extent the system helped you to create and submit search queries?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

1-b. In what ways did the system help you to create and submit search queries?
1-c. What types of help features would you like to have in order to create and submit search queries?

2-a. (Help for query reformulation) To what extent the system helped you to modify your search queries?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

2-b. In what ways did the system help you to modify your search queries?

2-c. What types of help features would you like to have in order to help you to modify your search queries ?

3-a. (Help for search result evaluation) To what extent the system helped you to find relevant items from search result pages?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

3-b. In what ways did the system help you to find relevant items from search result pages?

3-c. What types of help features would you like to have in order to find relevant items from search result pages?

4-a. (Help for browsing) To what extent the system helped you to find relevant topics or items from categories?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

4-b In what ways did the system help you to find relevant topics or items from categories?

4-c. What types of help features would you like to have in order to find relevant topics or items from categories?

5-a. (Help for accessing individual items) To what extent the system helped you to open the items you selected from search results or browsing categories?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

5-b. In what ways did the system help you to access to the items you selected from search results or browsing categories?
5-c. What types of help features would you like to have in order to access to the items you selected from search results or browsing categories?

6-a. (Help for accessing back to previous pages) To what extent the system helped you to go back to previous pages?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

6-b. In what ways did the system help you to go back to previous pages?

6-c. What types of help features would you like to have in order to go back to previous pages?

7-a. (Help for evaluating individual item evaluation) To what extent the system helped you to judge relevance or usefulness of individual items?
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

7-b. In what ways did the system help you to judge relevance or usefulness of individual items?

7-c. What types of help features would you like to have in order to judge relevance or usefulness of individual items?

8-a. (Help for obtaining items) To what extent the system helped you to download or save the items you found relevant?
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

8-b. In what ways did the system help you to download or save the items you found relevant?

8-c. What types of help features would you like to have in order to download or save the items you found relevant?

[Multimedia resource use situations]
(an interviewer reminds the subject of multimedia resources he/she used such as images or videos) How did you judge the relevance or usefulness of image/video files? What were the problems in using these multimedia items?

[Overall DL assessment: Ease-of-use]

Please rate the ease-of-use level in using the American Memory DL.
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely easy)

What made you feel easy or difficult while using this DL?

[Overall DL assessment: Satisfaction]

Please rate the satisfaction level in using the American Memory DL.
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely satisfactory)

What made you feel satisfactory or unsatisfactory while using this DL?

[Help feature suggestion]
Are there more help features you would like to use that are not mentioned above?

[Overall experience/ final thoughts]

Could you please describe briefly your overall reaction to the use of this digital library? Any final thoughts you want to share with us?

Instruction for Search Tasks

In this study, our goal is to examine the experiences of blind people in searching for information using a digital library. We ask you first to explore the digital library and then to perform three search tasks while thinking aloud. We will capture your verbalizations, and later analyze it to identify what aspects of the design are not blind-friendly. We will then try to identify design improvements that will make information seeking from a digital library barrier-free for blind people. This is not a test of your skills. Rather, it is a test of how well the system is designed.

As you perform the tasks, please verbalize the following:

- What is your goal?
- How do you plan to achieve the goal?
- What actions are you performing? Specify each system feature you use and each key command you are executing.
- Did you encounter any problem?
- How did you solve the problem?
- Did you achieve your goal?
- How do you know that you achieve your goal?

You can ask for sighted help if you get stuck and unable to move forward.

Keeping this in mind, please visit the website of the American Memory Digital Collections of the Library of Congress available at:
http://memory.loc.gov/ammem/index.html

First please spend about 10 minutes to explore the digital library and to get a basic understanding how the digital library works.

After that, please complete the following three tasks, using no more than 30 minutes for each task.

1) Find the Letter written by Alexander Graham Bell to Helen Keller dated March 23, 1907. For this purpose, use two different search approaches—keyword search and browse.

2) Find when President Abraham Lincoln and President James A. Garfield were assassinated and how they were assassinated.

3) Identify at least two issues regarding immigration policy in the U.S., using as many sources from the digital library as you can. Each issue you identify should have a different source.

Filling out this questionnaire indicates that I am at least eighteen years old and I am giving my informed consent to be a participant in this study.

Post-search Interview

Note: Please repeat each search task when ask task related questions.

[Subject knowledge]
Overall how do you rate your level of subject knowledge of the questions you searched in the digital library?

T1	Not at all	1	2	3	4	5	6	7 Extremely knowledgeable
T2	Not at all	1	2	3	4	5	6	7 Extremely knowledgeable
T3	Not at all	1	2	3	4	5	6	7 Extremely knowledgeable

[Learn how to use]
How did you learn to use American Memory? What were the problems, if any, associated with learning to use this digital library?

[Problems encountered - help situations] [Problem solving - help situations]

1. What problems did you encounter during Task 1? How did you try to solve the problems you encountered? Which approaches were successful or unsuccessful to solve the problems?

2. What problems did you encounter during Task 2? How did you try to solve the problems you encountered? Which approaches were successful or unsuccessful to solve the problems?

3. What problems did you encounter during Task 3? How did you try to solve the problems you encountered? Which approaches were successful or unsuccessful to solve the problems?

[Explicit help uses]
Explicit help features: Help page, ask a librarian,

1. (an interviewer reminds the subject of help features he/she used) Why did you use these help features? Was it helpful?

2. Please rate the helpfulness of explicit help:
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

3. If the subject did not use any help feature, ask him/her: Why didn't you use any explicit help feature? Were you aware of these explicit help features such as Help page or ask a librarian?

[Implicit help uses]
Implicit help features: FAQ, query suggestion, search limiters, advanced search, etc.

1. (an interviewer reminds the subject of help features he/she used) Why did you use these help features? Were they helpful?

2. Please rate the helpfulness of implicit help:
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

[System help]

1-a. (Help for query creation) To what extent the system helped you to create and submit search queries?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

1-b. In what ways did the system help you to create and submit search queries?
1-c. What types of help features would you like to have in order to create and submit search queries?

2-a. (Help for query reformulation) To what extent the system helped you to modify your search queries?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

2-b. In what ways did the system help you to modify your search queries?

2-c. What types of help features would you like to have in order to help you to modify your search queries ?

3-a. (Help for search result evaluation) To what extent the system helped you to find relevant items from search result pages?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

3-b. In what ways did the system help you to find relevant items from search result pages?

3-c. What types of help features would you like to have in order to find relevant items from search result pages?

4-a. (Help for browsing) To what extent the system helped you to find relevant topics or items from categories?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

4-b In what ways did the system help you to find relevant topics or items from categories?

4-c. What types of help features would you like to have in order to find relevant topics or items from categories?

5-a. (Help for accessing individual items) To what extent the system helped you to open the items you selected from search results or browsing categories?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

5-b. In what ways did the system help you to access to the items you selected from search results or browsing categories?
5-c. What types of help features would you like to have in order to access to the items you selected from search results or browsing categories?

6-a. (Help for accessing back to previous pages) To what extent the system helped you to go back to previous pages?

(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

6-b. In what ways did the system help you to go back to previous pages?

6-c. What types of help features would you like to have in order to go back to previous pages?

7-a. (Help for evaluating individual item evaluation) To what extent the system helped you to judge relevance or usefulness of individual items?
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

7-b. In what ways did the system help you to judge relevance or usefulness of individual items?

7-c. What types of help features would you like to have in order to judge relevance or usefulness of individual items?

8-a. (Help for obtaining items) To what extent the system helped you to download or save the items you found relevant?
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely helpful)

8-b. In what ways did the system help you to download or save the items you found relevant?

8-c. What types of help features would you like to have in order to download or save the items you found relevant?

[Multimedia resource use situations]
(an interviewer reminds the subject of multimedia resources he/she used such as images or videos) How did you judge the relevance or usefulness of image/video files? What were the problems in using these multimedia items?

[Overall DL assessment: Ease-of-use]

Please rate the ease-of-use level in using the American Memory DL.
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely easy)

What made you feel easy or difficult while using this DL?

[Overall DL assessment: Satisfaction]

Please rate the satisfaction level in using the American Memory DL.
(not at all) 1 - 2 - 3 - 4 - 5 - 6 - 7 (extremely satisfactory)

What made you feel satisfactory or unsatisfactory while using this DL?

[Help feature suggestion]
Are there more help features you would like to use that are not mentioned above?

[Overall experience/ final thoughts]

Could you please describe briefly your overall reaction to the use of this digital library? Any final thoughts you want to share with us?

CODING SCHEME

Help Situation Categories	
Help Situation Type	
Factors	
Existing H/R	
Task	
Sighted H/R	
Desired H/D	
Outcome/R	
Starting Time	
Ending Time	
Subject Number	

Quote/Description:

1) Pre-state (The state before the emergence of help-seeking situation.

2) Help-seeking situation Quote
   Help-seeking situation in *italics*
   Factors <u>underline</u>
   Existing H/R **bold red**
   Sighted H/R **bold blue**
   Desired H/D **bold purple**
   Outcome **bold**

3) Post action (The action the subject takes after the help-seeking situation.)

CREATING DIGITAL LIBRARY (DL) DESIGN GUIDELINES ON ACCESSIBILITY, USABILITY AND UTILITY FOR BLIND AND VISUALLY IMPAIRED (BVI) USERS

References

[1] American Foundation for the Blind, (2014, May). *Facts and Figures on Americans with Vision Loss.* Retrieved from http://www.afb.org/info/blindness-statistics/adults/facts-and-figures/235

[2] Lazar, J., Allen, A., Kleinman, J., & Malarkey, C. (2007). What Frustrates Screen Reader Users on the Web: A Study of 100 Blind Users. *International Journal of Human-Computer Interaction, 22*(3), 247-269.

[3] Di Blas, N., Paolini, P., & Speroni, M. (2004). Usable Accessibility to the Web for Blind Users. Paper presented at 8th ERCIM Workshop on User Interface for All: Vienna, Austria, June 28-29, 2004.

[4] WebAim. (2015, Aug. 28). *Screen Reader User Survey #6 Results.* Retrieved from http://webaim.org/projects/screenreadersurvey6/

[5] Bollen J. & Luce, R. (2002). Evaluation of digital library impact and user communities by analysis of usage patterns. *D-Lib Magazine*, 8(6). Retrieved from http://www.dlib.org/dlib/june02/bollen/06bollen.html

[6] Fox, E.A. & Urs, S.R. (2002). Digital libraries. *Annual Review of Information Science and Technology, 41*, 503-589.

[7] Heradio, R., Fernández-Amorós, D., Cabrerizo, F. J., & Herrera-Viedma, E. (2012). A review of quality evaluation of digital libraries based on users' perceptions. *Journal of Information Science*, *38*(3), 269-283.

[8] O'Day, V.L. & Nardi, B.A. (2003). An ecological perspective of digital libraries, In A.P. Bishop, A.A. Van House & B.P. Butterfield (Eds.), *Digital library use: social practice in design and evaluation* (pp. 65-84), Cambridge, MA: MIT Press.

[9] Saracevic, T. (2004). Evaluation of digital libraries: An overview. Presented at *the DELOS Workshop on the Evaluation of Digital Libraries*. Retrieved from http://www.scils.rutgers.edu/~tefko/DL_evaluation_Delos.pdf

[10] Sumner, T. & Marlino, M. (2004). Digital libraries and educational practice: A case for new models. *Proceedings of the 2004 Joint ACM/IEEE Conference on Digital Libraries (JCDL'04)*, 170-178.

[11] Leuthold, S., Bargas-Avila, J.A., & Opwis, K. (2008) Beyond Web Content Accessibility Guidelines: Design of Enhanced Text User Interfaces for Blind Internet Users. *International Journal of Human-Computer Studies, 66*(4), 257-270.

[12] Craven, J. (2003). Access to electronic resources by visually impaired people. Information Research, 8(4), paper 156.

[13] Bigham, J.P., Cavender, A.C., Brudvik, J.T., Wobbrock, J.O., & Ladner, R.E. (2007). WebinSitu: A comparative analysis of blind and sighted browsing behavior. *Computers and Accessibility Proceedings of the 9th International ACM SIGACCESS Conference,* 51-58.

[14] Salampasis, M., Kouroupetroglou, C., & Manitsaris, A. (2005). Semantically enhanced browsing for blind people in the WWW. *Hypertext and Hypermedia Proceedings of the Sixteenth ACM Conference,* 32-34.

[15] Babu, R. (2011). Developing an understanding of the accessibility and usability problems blind students face in web-enhanced instruction environments. (Doctoral Dissertation). ProQuest Dissertations and Theses. (Accession Order No. AAT 3473492)

[16] Chandrashekar, S. (2010). Is Hearing Believing? Perception of Online Information Credibility by Screen Reader Users who are Blind or Visually Impaired. (Doctoral dissertation, University of Toronto).

[17] Theofanos, M. F., & Redish, J. (2003). Guidelines for accessible and usable web sites: observing users who work with screen readers. *Interactions, 10*(6), 38-51.

[18] Vigo, M., & Harper, S. (2013) Coping Tactics Employed by Visually Disabled Users on the Web. *International Journal of Human-Computer Studies, 71*(11), 1013-1025.

[19] Xie, I., Babu, R., Joo, S. and Fuller, P. (2015). Using digital libraries non-visually: Understanding the help-seeking situations of blind users. *Information Research, 20*(2), paper 673. Retrieved from http://InformationR.net/ir/20-2/paper673.html

[20] Comeaux, D., & Schmetzke, A. (2013). Accessibility of academic library web sites in North America: Current status and trends (2002-2012). *Library Hi Tech*, *31*(1), 8-33.

[21] Babu, R., & Singh, R. (2013). Enhancing learning management systems utility for blind students: A task-oriented, user-centered, multimethod evaluation technique. *Journal of Information Technology and Education-Research, 12*. Retrieved from http://www.jite.org/documents/Vol12/JITEv12ResearchBabu001-032.pdf

[22] Clark, J. (2006). *A List Apart: To hell with WCAG 2.* Retrieved from http://www.alistapart.com/articles/tohellwithwcag2

[23] U.S. Web Design Standards. (2015). Retrieved from https://playbook.cio.gov/designstandards/

[24] Xie, I. & Cool, C. (2009). Understanding Help-Seeking within the context of searching digital libraries. *Journal of American Society for Information Science and Technology. 60*(3), 477-494.

[25] Foss, E., & Druin, A. (2014). Roles of Reaction: Developing and Non-Motivated Searchers. In G. Marchionini (Ed.), *Children's Internet Search: Using Roles to Understand Children's Search Behavior: Synthesis Lectures on information concepts, retrieval, and services #34* (37-44). Chapel Hill: Morgan & Claypool.

[26] Hill, L.L., Carver, L., Larsgaard, M., Dolin, R., Smith, T.R., Frew, J., & Rae, M.-A. (2000). Alexandria Digital Library: User evaluation studies and system design. *Journal of the American Society for Information Science, 51*(3), 246–259.

[27] Bertot, J. C., Snead, J. T., Jaeger, P. T., & McClure, C. R. (2006). Functionality, usability, and accessibility: Iterative user-centered evaluation strategies for digital libraries. *Performance Measurement and Metrics*, *7*(1), 17-28.

[28] Isfandyari-Moghaddam, A., & Bayat, B. (2008). Digital libraries in the mirror of the literature: issues and considerations. *The Electronic Library*, *26*(6), 844-862.

[29] Power, C., Freire, A., Petrie, H., & Swallow, D. (2012). Guidelines are only half of the story: accessibility problems encountered by blind users on the web. *Human Factors in Computing Systems Proceedings of the SIGCHI Conference,* 433-442.

[30] Southwell, K.L. & Slater, J, (2012). Accessibility of digital special collections using screen readers, *Library Hi Tech, 30*(3), 457-471.

[31] Harper, S. & Chen, A. Q. (2012). Web accessibility guidelines: A lesson from the evolving web. *World Wide Web Journal, 15*(1), 61-68.

[32] Yoon, K., Newberry, T., Hulscher, L., & Dols, R. (2013). Call for library websites with a separate information architecture for visually impaired users. *Proceedings of the American Society for Information Science and Technology*, *50*(1), 1-3.

[33] Caldwell, B., Cooper, M., Reid, L. G., & Vanderheiden, G. (2008). *Web content accessibility guidelines (WCAG) 2.0* (Vol. 11). W3C.

[34] Chowdhury, S., Landoni, M., & Gibb, F. (2006). Usability and impact of digital libraries: A review. *Online Information Review*, *30*(6), 656-680.

[35] Nielsen, J. (1993). Iterative user-interface design. *Computer*, *26*(11), 32-41.

[36] Rømen, D., & Svanæs, D. (2012). Validating WCAG versions 1.0 and 2.0 through usability testing with disabled users. *Universal Access in the Information Society, 11*(4), 375-385.

[37] Oud, J. (2011). Improving screencast accessibility for people with disabilities: guidelines and techniques. *Internet Reference Services Quarterly, 16*(3), 129-144.

[38] Xie, I. (2008). Interactive information retrieval in digital environments. Hershey, PA: IGI Pub.

[39] Saracevic, T. (2007a). Relevance: A review of the literature and a framework for thinking on the notion in information science. Part II: nature and manifestations of relevance. *Journal of the American Society for Information Science and Technology, 58*(3), 1915-1933.

[40] Saracevic, T. (2007b). Relevance: A review of the literature and a framework for thinking on the notion in information science. Part III: Behavior and effects of relevance. *Journal of the American Society for Information Science and Technology, 58*(13), 2126-2144.

[41] Saracevic, T. (2015). Why is relevance still the basic notion in information science? (Despite great advances in information technology). *Presented at the International Symposium on Information Science (ISI 2015)*. Zadar, Croatia. May 18-21, 2015.

[42] Janes, J.W. (1994). Other people's judgments: A comparison of users' and others' judgments of document relevance, topicality, and utility. Journal of the American Society for Information Science, 45(3), 160–171.

[43] Smith, T. J. (2008). Senior citizens and e-commerce websites: The role of perceived usefulness, perceived ease of use, and web site usability. *Informing Science: International Journal of an Emerging Transdiscipline*, *11*, 59-83.

[44] Childers, T. L., & Kaufman-Scarborough, C. (2009). Expanding opportunities for online shoppers with disabilities. *Journal of Business Research*, *62*(5), 572-578.

[45] Marshall, A. P., West, S. H., & Aitken, L. M. (2011). Preferred information sources for clinical decision making: critical care nurses' perceptions of information accessibility and usefulness. *Worldviews on Evidence-Based Nursing, 8*(4), 224-235.

[46] Bertot, J. C. (2002). Building a statewide digital public library: A case study. *Public library quarterly*, *21*(2), 5-33.

[47] Jeng, J. (2005). What is usability in the context of the digital library and how can it be measured? *Information technology and libraries*, *24*(2), 3-12.

[48] Erway, R., Hill, C., Streams, S., and Harmon, S. (Eds.) (2015, April 28). *IMLS Focus Summary Report: National Digital Platform.* Retrieved from https://www.imls.gov/sites/default/files/publications/documents/2015imlsfocusndpreport.pdf

[49] Flick, U. (2014). *An introduction to qualitative research*. London: Sage.

[50] Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* Newbury Park, CA: Sage.

DIGITAL STEWARDSHIP SUPPLEMENTARY INFORMATION FORM

Introduction

The Institute of Museum and Library Services (IMLS) is committed to expanding public access to federally funded research, data, software, and other digital products. The assets you create with IMLS funding require careful stewardship to protect and enhance their value, and they should be freely and readily available for use and re-use by libraries, archives, museums, and the public. However, applying these principles to the development and management of digital products is not always straightforward. Because technology is dynamic and because we do not want to inhibit innovation, we do not want to prescribe set standards and best practices that could become quickly outdated. Instead, we ask that you answer a series of questions that address specific aspects of creating and managing digital assets. Your answers will be used by IMLS staff and by expert peer reviewers to evaluate your application, and they will be important in determining whether your project will be funded.

Instructions

If you propose to create any type of digital product as part of your project, complete this form. We define digital products very broadly. If you are developing anything through the use of information technology (e.g., digital collections, web resources, metadata, software, or data), you should complete this form.

Please indicate which of the following digital products you will create or collect during your project
(Check all that apply):

	Every proposal creating a digital product should complete …	Part I
	If your project will create or collect …	**Then you should complete …**
☐	Digital content	Part II
☐	Software (systems, tools, apps, etc.)	Part III
☑	Dataset	Part IV

PART I.

A. Intellectual Property Rights and Permissions

We expect applicants to make federally funded work products widely available and usable through strategies such as publishing in open-access journals, depositing works in institutional or discipline-based repositories, and using non-restrictive licenses such as a Creative Commons license.

A.1 What will be the intellectual property status of the content, software, or datasets you intend to create? Who will hold the copyright? Will you assign a Creative Commons license (http://us.creativecommons.org) to the content? If so, which license will it be? If it is software, what open source license will you use (e.g., BSD, GNU, MIT)? Explain and justify your licensing selections.

A.2 What ownership rights will your organization assert over the new digital content, software, or datasets and what conditions will you impose on access and use? Explain any terms of access and conditions of use, why they are justifiable, and how you will notify potential users about relevant terms or conditions.

A.3 Will you create any content or products which may involve privacy concerns, require obtaining permissions or rights, or raise any cultural sensitivities? If so, please describe the issues and how you plan to address them.

Part II: Projects Creating or Collecting Digital Content

A. Creating New Digital Content

A.1 Describe the digital content you will create and/or collect, the quantities of each type, and format you will use.

A.2 List the equipment, software, and supplies that you will use to create the content or the name of the service provider who will perform the work.

A.3 List all the digital file formats (e.g., XML, TIFF, MPEG) you plan to create, along with the relevant information on the appropriate quality standards (e.g., resolution, sampling rate, or pixel dimensions).

B. Digital Workflow and Asset Maintenance/Preservation

B.1 Describe your quality control plan (i.e., how you will monitor and evaluate your workflow and products).

B.2 Describe your plan for preserving and maintaining digital assets during and after the award period of performance (e.g., storage systems, shared repositories, technical documentation, migration planning, commitment of organizational funding for these purposes). Please note: You may charge the Federal award before closeout for the costs of publication or sharing of research results if the costs are not incurred during the period of performance of the Federal award. (See 2 CFR 200.461).

C. Metadata

C.1 Describe how you will produce metadata (e.g., technical, descriptive, administrative, or preservation). Specify which standards you will use for the metadata structure (e.g., MARC, Dublin Core, Encoded Archival Description, PBCore, or PREMIS) and metadata content (e.g., thesauri).

C.2 Explain your strategy for preserving and maintaining metadata created and/or collected during and after the award period of performance.

C.3 Explain what metadata sharing and/or other strategies you will use to facilitate widespread discovery and use of digital content created during your project (e.g., an API (Application Programming Interface), contributions to the Digital Public Library of America (DPLA) or other digital platform, or other support to allow batch queries and retrieval of metadata).

D. Access and Use

D.1 Describe how you will make the digital content available to the public. Include details such as the delivery strategy (e.g., openly available online, available to specified audiences) and underlying hardware/software platforms and infrastructure (e.g., specific digital repository software or leased services, accessibility via standard web browsers, requirements for special software tools in order to use the content).

D.2 Provide the name and URL(s) (Uniform Resource Locator) for any examples of previous digital collections or content your organization has created.

Part III. Projects Creating Software (systems, tools, apps, etc.)

A. General Information

A.1 Describe the software you intend to create, including a summary of the major functions it will perform and the intended primary audience(s) this software will serve.

A.2 List other existing software that wholly or partially perform the same functions, and explain how the tool or system you will create is different.

B. Technical Information

B.1 List the programming languages, platforms, software, or other applications you will use to create your software (systems, tools, apps, etc.) and explain why you chose them.

B.2 Describe how the intended software will extend or interoperate with other existing software.

B.3 Describe any underlying additional software or system dependencies necessary to run the new software you will create.

B.4 Describe the processes you will use for development documentation and for maintaining and updating technical documentation for users of the software.

B.5 Provide the name and URL(s) for examples of any previous software tools or systems your organization has created.

C. **Access** and **Use**

C.1 We expect applicants seeking federal funds for software to develop and release these products under an open-source license to maximize access and promote reuse. What ownership rights will your organization assert over the software created, and what conditions will you impose on the access and use of this product? Identify and explain the license under which you will release source code for the software you develop (e.g., BSD, GNU, or MIT software licenses). Explain any prohibitive terms or conditions of use or access, explain why these terms or conditions are justifiable, and explain how you will notify potential users of the software or system.

C.2 Describe how you will make the software and source code available to the public and/or its intended users.

C.3 Identify where you will be publicly depositing source code for the software developed:

Name of publicly accessible source code repository: URL:

Part IV. Projects Creating a Dataset

1. Summarize the intended purpose of this data, the type of data to be collected or generated, the method for collection or generation, the approximate dates or frequency when the data will be generated or collected, and the intended use of the data collected.

The project goal is to create digital library (DL) design guidelines on accessibility, usability and utility by incorporating perspectives from DL stakeholders. Most importantly, the guidelines will address the help-seeking situations that blind and visually impaired (BVI) users experience when interacting with DLs. The aims of the project are to: 1) Identify help-seeking situations that BVI users experience and what information needs BVI users encounter when interacting with DLs; 2) Discover limitations of existing DL guidelines on accessibility, usability and utility in meeting the information needs of BVI users; 3) Gather perspectives from DL developers, scholars and experts on research and testing of DLs in terms of creating the DL guidelines; 4) create DL design guidelines to assist BVI users in successfully interacting with DLs and that are feasible for DL developers to implement; 5) Identify the current status of DL design in supporting BVI users DL interactions; and 6) Develop a methodology that can be applied to create guidelines to support other underserved user groups.

In Stage 1 (July 1, 2016 - December 30, 2016), two document analyses will be provided to address: 1) help-seeking situations and needs of BVI users in DLs; and, 2) existing design guidelines on accessibility, usability, and utility in digital environments and their problems. In Stage 2 (January 1, 2017 – March 31, 2018), a user study will identify the help-seeking situations 60 BVI users encounter in DLs when performing specific search tasks, and the types of help needed to resolve these situations. Draft DL guidelines will be created. In Stage 3 **(**April 1, 2018 – September 30, 2018**)**, two-round Delphi surveys will be administered to four groups of stakeholders (150 total) to provide feedback for the draft of guidelines. DL guidelines will be refined. In Stage 4 **(**October 1, 2018 – June 30, 2019**)**, 30 DL developers will use the guidelines to assess 15 of the most popular DLs and test the feasibility of the guidelines, and focus groups will be formed to discuss

participants' experience with the assessment. Based on final suggestions and feedback, DL design guidelines will be finalized.

Multiple data collection methods, such as pre-questionnaires, pre-search interviews, think-aloud protocols, transaction logs, and post-search interviews will be used to collect data. The collected data will be used to generate three products: 1) DL design guidelines, 2) report of current status on BVI digital library help needs, and 3) methodology for developing guidelines for other underserved user groups.

2. Does the proposed data collection or research activity require approval by any internal review panel or institutional review board (IRB)? If so, has the proposed research activity been approved? If not, what is your plan for securing approval?

As we include user studies in the project design, we will submit our study design with instruments in Stage 2 for approval from the Institutional Review Board of the University of Wisconsin-Milwaukee (IRB). The research team has experience in conducting user studies, and fully understands the ethical issues in relation to user-involved research. Also, we conducted a prior study, which tested the user study and associated instruments that will be used in this project. The pilot study was approved by the IRB of UW-Milwaukee (IRB # 13.418).

3. Will you collect any personally identifiable information (PII), confidential information (e.g., trade secrets), or proprietary information? If so, detail the specific steps you will take to protect such information while you prepare the data files for public release (e.g., data anonymization, data suppression PII, or synthetic data).

There is no known risk to research subjects in participating in the research. The research team will protect the subjects by only revealing each participant's identification number, and only trained research team members will have access to the collected data. Also, the research design of the project will be thoroughly examined from the IRB of UW-Milwaukee. We will not start any data collection activity before receiving approval from the IRB. The link between the collected data and the identification information of the individuals will be destroyed after the data coding is completed. Before that, the link data will be securely locked in the cabinet in the PI's office. In addition, audio/video data will be transcribed into text. The public can only access the data associated with the subject ID and transcription data.

4. If you will collect additional documentation such as consent agreements along with the data, describe plans for preserving the documentation and ensuring that its relationship to the collected data is maintained.

We will collect a signed consent form from every subject in this project. The consent form will include the study description, research procedures, potential risks, benefits, and confidentiality statement. Also, we will clearly inform subjects that they can withdraw from the study at any time when they feel uncomfortable during participation. All data will be secured in a locked file cabinet, accessible only to trained research team members.

5. What will you use to collect or generate the data? Provide details about any technical requirements or dependencies that would be necessary for understanding, retrieving, displaying, or processing the dataset(s).

For the user study, we will use Morae Usability Software (http://www.techsmith.com/morae.html) to record user search behavior and think-aloud protocols. The collected data will be in the formats of video, audio, and transaction logs that record subjects' activities while completing given search tasks. We will use identification (ID) numbers, which will be randomly assigned, to protect personal information. Collected data will be aggregated in the process of data analysis. All data, including consent forms, associated demographic data and video records, collected from participants will be stored on separate external storage devices and kept in a locked file cabinet by the PIs at the School of Information Studies, UW-Milwaukee. Only authorized research team members can access the data under the permission of the PIs. UWM Digital Commons (http://dc.uwm.edu/) will serve as the permanent repository to store the collected data. This data will only be associated with the subject ID and audio/video transcription of audio/video data, as well as project products (DL design guidelines, report of current DL status in supporting BVI users, and methodology applicable to creating design guidelines for other underserved user groups) that can be accessed by the public.

6. What documentation (e.g., data documentation, codebooks, etc.) will you capture or create along with the dataset(s)? Where will the documentation be stored, and in what format(s)? How will you permanently associate and manage the documentation with the dataset(s) it describes?

The collected data will be used to generate three products: 1) DL design guidelines, 2) a report of the current status on BVI digital library help needs, and 3) a methodology for developing guidelines for other underserved user groups. The products will be saved in PDF documents. The collected data and products will be stored on separate external storage devices and kept in a locked file cabinet by the PIs at the School of Information Studies, UW-Milwaukee. Only authorized research team members can access the data under the permission of the PIs. UWM Digital Commons (http://dc.uwm.edu/) will serve as the permanent repository to store the collected data. This data will only be associated with the subject ID and audio/video transcription of audio/video data, as well as project products (DL design guidelines, report of current DL status in supporting BVI users, and methodology applicable to creating design guidelines for other underserved user groups) that can be accessed by the public. Any associations between the product documentation and collected data will be indicated in the product documentation notes.

7. What is the plan for archiving, managing, and disseminating data after the completion of the award-funded project?

The collected dataset will be archived in the UWM Digital Commons (http://dc.uwm.edu/), which is an institutional repository at the University of Wisconsin-Milwaukee. DDI (Data Documentation Initiative) metadata will be added when storing the data in the UWM Digital Commons. In addition, this project will produce DL design guidelines, current DL status in supporting BVI users, and the methodology for the creation of the guidelines. These project products will be kept, maintained, and regularly updated after the grant period by the research team. On the project website (See Communication Plan in the Narrative), we will announce every update of the DL guidelines. Moreover, these documents will be stored and can be accessed from UWM Digital Commons.

The team will submit a report to IMLS and disseminate the findings of this project through multiple channels. Most important, the team will work with our advisory board members and partners to recommend the guidelines for integration into the existing guidelines, and disseminate and implement the guidelines in DL design. Through close work with various associations, consortiums, and organizations (e.g., DLF, ALA, DPLA, HathiTrust, IFLA, WAI, ASIST, and Web for All), the team will disseminate and promote guidelines nationally (e.g., news release, panel discussions, publications, workshops). The researchers will present the findings and offer workshops to librarians, developers, and vendors at professional conferences (e.g., ALA; DLF; CHI-ACM, Special Interest Group on Computer-Human Interaction Conference; Code4Lib; and Educause) so that the guidelines can lead to the improvement of existing DL. Results will be presented at research conferences, such as the Joint Conference on Digital Library (JCDL), or the Annual Meeting of ASIST, so that researchers in the field may apply the findings to their own research. Findings will be submitted to respected scholarly and professional journals in the field (e.g., D-Lib, JASIST, and Journal of Human-Computer Interaction)**.** Workshops will be offered at different professional conferences on accessibility, usability and utility to promote DL design guidelines for BVI users (e.g. CSUN International Technology & Persons with Disabilities Conference, Accessing Higher Ground Accessible Media Web and Technology Conference, and the International Conference on Computers Helping People with Special Needs).

8. Identify where you will be publicly depositing dataset(s):

A project website will be created to present findings and products to the public, including DL design guidelines and associated tutorials of this project. The website will also serve as a communication platform for anyone interested in DL design guidelines to share ideas on the topic. Moreover, UWM Digital Commons (http://dc.uwm.edu/) will serve as the repository to store the collected data and design guidelines.

Name of repository: UWM Digital Commons
URL: http://dc.uwm.edu/

9. When and how frequently will you review this data management plan? How will the implementation be monitored?

The data management plan will be submitted to the University of Wisconsin-Milwaukee IRB Board for review of prepared documents and plans for data sharing and re-use after the completion of the project. The research team will regularly check the status of data management for the collected data. Also, the team will consult with the UWM Libraries' data service librarians frequently to assess the data management plan throughout the project. The data management plan will be evaluated in every stage of the project, and the final report to IMLS will include how the team managed and stored the research data during the project.

Original Preliminary Proposal

BUILDING A FRAMEWORK FOR HELP FEATURE DESIGN SUPPORTING BLIND USERS: ACCESSIBILITY, USABILITY AND UTILITY GUIDELINES FOR DIGITAL LIBRARIES

PROJECT NEED AND NATIONAL IMPACT

The project goal is to construct a comprehensive framework for help feature design that addresses barriers that blind users experience in interacting with digital libraries (DLs). Blind users face unique needs, challenges, strategies, and preferences in their interactions with DLs. This framework is comprised of three components: 1) guidelines organized by types of help-seeking situations associated with accessibility, usability and utility, consist of criteria, specification of definitions, intention, benefits, techniques, and common failures for the development and implementation of help features based on Web Content Accessibility Guidelines (WCAG) structure [1]; 2) current status of how DLs satisfy blind users' help needs; and 3) a methodology that can be applied to other underserved users to develop similar guidelines. Based on data collected from 30 blind users by applying multiple data collection methods, the research team has identified 17 unique help-seeking situations blind users face in interacting with DLs, as well as corresponding needs for different types of desired help features [2]. A help-seeking situation is characterized by a user engaged in information seeking within a DL in order to achieve his/her tasks/goals, and needing some form of help in the process. Findings of this study and other previous research indicate that most users who encounter help-seeking situations do not use the help features present in most information retrieval (IR) systems, including DLs, for a very good reason: existing forms of help are simply not helpful [3-8].

The global blind population exceeds 45 million, with 20.6 million adults with significant vision loss residing in the US. [9-10]. Among them, approximately 1.5 million use digital technologies such as computers [11]. Making DLs accessible for blind users is a legal necessity per the Americans with Disabilities Act (ADA). Compliance with accessible Web design guidelines as outlined by WCAG, Section 508 of the U.S. Rehabilitation Act, and newly published guidelines are necessary, but not sufficient, for effective access for the blind [12-17]. DLs are comprised of digital content created by libraries and cultural heritage institutions, and include manuscripts, images, audio, and video. Currently, the design of DLs is sight-centered without a single model, and the structure of DLs is highly complex with content that is by nature heterogeneous in its format and system dimensions [18-23]. These complexities can cause problems in IR, giving rise to help-seeking situations for the user – especially for blind users, who rely on screen readers to access DLs. Although DLs have emerged as one of the IR systems that provide diverse user groups with access to a wide variety of digitized resources via the Web [24], a standard set of help-feature design guidelines has not been created for these systems.

DL research has paid primary attention to accessibility and usability guidelines, with the most commonly used guidelines focusing on Web accessibility [25-26]. The problem is that these guidelines do not address many of the interaction problems and help-seeking situations blind users face in their use of DLs [27-29]. Accessibility of DLs is only the first requirement since blind users need to first access digital libraries and associated pages. Usability of DLs is the second requirement because ease of understanding and ease of use are vital for blind users to interact with DLs. Most important, the ultimate goal for IR is to assist users in achieving their tasks [30-32]. Utility is defined as the usefulness of DLs in helping users to accomplish their information needs and tasks. Utility is the third requirement, the most difficult one to fulfill, as various disabilities may lead to complicated physical and cognitive help-seeking situations. There is a need to create guidelines for developing help-features for DLs that holistically address problems related to accessibility, usability, and utility. The great promise of DLs becoming the gateway to the universal access to information will go unrealized for blind users if they cannot effectively use DLs to meet their information needs.

While accessibility, usability and utility problems in DLs are exacerbated for blind users, they create difficulties for other types of users as well, including the sighted, elderly, users with other disabilities, and members of other underserved communities. For this purpose, this research is at the forefront of the national digital platform movement to provide access to engaging and meaningful digital content, and services, to all Americans. The framework will impact digital libraries across the country by filling gaps in existing guidelines that are not addressed in the current DL infrastructure; new guidelines will ensure that DLs are meeting the needs of diverse communities. The project aligns with several IMLS strategic goals by striving to remove barriers that prevent blind users' from effective interaction with DLs; providing rich opportunities for blind users' to discover knowledge and cultural heritage; and improving help features to enable access to meaningful content for all users. The project has received the support of national, regional, and local organizations presented below that will leverage this structure to register a transformative impact to a diverse and stratified collection of beneficiaries. The framework will be useful as a theoretical basis for DL research by helping to understand the nature of blind users' help-seeking situations and behaviors, but also a practical contribution by offering guidelines on how to develop DL help features for blind users. The DL help feature guidelines will provide a holistic approach to accessibility, usability, and utility problems, directly addressing the information needs and help-seeking situations of blind users across diverse DL content and interface platforms. Additionally, methods employed in this project can be applied to generate guidelines for other types of users and can be extended to other types of IR systems. The significance of this research is its universality, practical implications, and methodological approaches.

PROJECT DESIGN, TASK GOALS, OUTCOMES AND BUDGET

Table 1 presents the project design, which specifies the research questions, project objectives, methods, outcomes, and deliverables within the designated tentative timeline. Ongoing evaluation will ensure that objectives are met during the course of the project. User study, document analyses, Delphi surveys, and consultation with multiple stakeholders will empirically validate the importance of guidelines and appropriateness of measures. Comparison analyses and statistical analyses will confirm similarities and differences among the stakeholders. 20 DLs will be assessed according to measures stated in the new guidelines. Multiple channels will be used to disseminate the findings, including practitioners' and academic conferences, workshops, tutorials, publications, and social media

venues. Success indicators include incorporation of guidelines by the Web Accessibility Initiative (WAI), promotion by national library associations, and the rate of digital libraries' adoption of guidelines. Dr. Xie will manage the project and has been actively involved in the research of DL for about 15 years and help-seeking for sighted users for more than 10 years. Dr. Rakesh Babu is blind and has a strong motivation to promote research to empower the blind in the information society. To ensure the success and sustainability of the project, we will work with consultants and partners representing different stakeholders to develop, promote, and implement guidelines. Consultants include: Dr. Jim Allen (Web Accessibility Initiative-Web Content-WCAG Working Group), and Dr. Krystyna Matusiak (ASIST standard committee and digital librarian for 10 years). The team represents leading experts in a variety of cross-disciplinary fields, such as DLs, help mechanisms, blind users, interface design, usability, web accessibility, as well as partners representing multiple stakeholders. GoToMeeting will be used as the communication tool. The project has received support from and will be in partnership with the Association for the Blind and Visually Impaired (ABVI), Library of Congress, the National Federation of the Blind, Wisconsin Library Services (WiLS), Milwaukee Public Libraries, Milwaukee Public Museum, and Wisconsin Center for the Blind and Visually Impaired. For the full proposal, we are in contact with the following organizations to establish partnerships: American Library Association, Digital Library Federation, and International Federation of Library Associations and Institutions.

TABLE 1. Project Design

Stage	Research Questions	Objectives	Methods	Outcomes and Deliverables	Timeline
Stage 1	What are the limitations of existing DL guidelines on accessibility, usability and utility in meeting the information needs and help-seeking situations of blind users of DLs? What are the help-seeking situations that users encounter when interacting with digital libraries?	Analyze existing accessibility and usability guidelines for DL design. Identify blind users' unique help-seeking situations in relation to DL accessibility, usability, and utility.	Document analysis Qualitative Data Analysis	Existing guidelines related to accessibility, usability, and utility for the development of DL help features Help-situations that are associated with accessibility, usability, and utility	Month 0 through Month 6
Stage 2		Conduct blind user study to identify blind users' unique accessibility, usability, and utility problems and help-seeking situations. Identify the gap between help-seeking situations generated from user study and existing guidelines. Develop new draft of guidelines for the design of help features.	Recruit 60 blind subjects through National Blind Association Questionnaires, Interviews, Concurrent and Retrospective Verbal Protocol Analysis Qualitative and Quantitative Data Analysis	Types of help-seeking situations in relation to accessibility, usability, and utility Problems identified from the user study but are not reflected in the existing guidelines New draft guidelines that integrate the user study and document analysis at Stage 1	Month 7 through Month 18
Stage 3	What are the limitations of existing DL guidelines on accessibility, usability and utility in meeting the information needs and help-seeking situations of blind users of DLs? What guidelines for help features are needed to assist blind users in successfully interacting with DLs in terms of accessibility, usability and utility?	Gather feedback from accessibility/usability experts, designers/developers, and blind users. Create guidelines for the development of DL help features. Assess existing DLs based on new guidelines.	150 subjects with 50 from each group Delphi survey, Focus groups Content analysis Qualitative and Quantitative Data Analysis	Modified guidelines on accessibility, usability, and utility for design of DL help features based on different stakeholders' input	Month 19 through Month 28
Stage 4		Build Framework for DL help feature design for blind users. Disseminate results and work with different partners and organizations to promote the guidelines. Work with different partners and organizations to implement the guidelines.	Assess 20 DLs representing different types of DLs and developed by different types of organizations Focus groups Design Science Methodologies Document analysis	Problems in existing DL help feature design for blind users Framework for DL help feature design for blind users: 1) Guidelines for DL help feature design to satisfy blind users' needs in relation to accessibility, usability and utility 2) Current status of existing DLs and their design problems 3) Methodology that can be applied to other underserved groups to generate similar guidelines Dissemination of the framework through multiple channels	Month 29 through Month 36

The total project budget is $[redacted]. This total includes $[redacted] in match from the University of Wisconsin-Milwaukee. The total amount requested from IMLS is $[redacted] The budget for IMLS funded portion of the project breaks down as follows: $[redacted] is allocated to salary support for the research team. $[redacted] of the budget is allocated for fringe benefits associated with research team salaries. Fringe benefits are calculated using UWM's federally negotiated rates. $[redacted] is requested for materials and supplies, including computers and specialized software that will be devoted to the project. $[redacted] is requested for other costs, including project related travel, consultant fees, payments to research subjects, and non-resident tuition remission. $[redacted] is requested for indirect costs, which have been calculated using the University's federally negotiated rates (49.5%).

References can be found at https://pantherfile.uwm.edu/hiris/www/imlsreferences.html.