An Incremental Usability and Accessibility Evaluation Framework for Digital Libraries

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Abstract: This paper presents an incremental usability and accessibility framework for evaluating digital libraries. The results obtained from a case study, where four Joint Information Systems Committee (JISC) services were evaluated, are also presented. The applicability of the framework to similar evaluations is identified.

1. Introduction

Information and Communication Technologies (ICT's) are enabling a global audience to share knowledge and ideas with one another by the click of a button. One of the key tools of this revolution is the Internet, which is replacing CD ROM's with online databases, traditional hard copy books and journals with digital libraries and atlases with interactive geo-spatial data. The success of these services is maximised if end users are well supported to easily accomplish their desired tasks.

2. Nature of digital libraries

In recent years, the information superhighway, the Internet, has become a global gateway for information dissemination. With the ability to share worldwide collections of information, Digital Libraries (DLs) have become one of the common mediums to store and disseminate information by individuals or groups that select, organise and catalogue large numbers of documents.

DL's, generally referred to as 'collections of information that are both digitised and organised', (Lesk, 1997) give us opportunities we never had with traditional libraries or even with the web. Current design of DLs contains complex facilities including text search, functionality relating to hypertext, multimedia, the Internet and highly interactive interfaces.

According to Theng (1997), we have problems producing good web-sites (as evidenced by much research done in addressing problems on the web), then due to the fact that DLs are more than

just web-sites, it is anticipated that we might have problems creating good DLs too. Also, Dix et al (1995) suggested that even if the best methodologies and models are adopted in the design of a usable interactive system, it is still necessary to assess the design and test the system to ensure that it behaves as expected and meets the user's requirements. Therefore, there is a need for a usability and accessibility framework that supports the development of effective solutions for DLs in order to produce truly usable and accessible DLs.

A crucial factor for libraries is that the information they preserve and deliver must be effectively organised. With regards to DLs, Arms (2002) notes that a '[d]igital stream of data sent to earth from a satellite is not a library. [However] The same data, when organised systematically, becomes a digital library collection'. This is one of the key dimensions of a DL. Highly effective cataloguing, organisation and structure of information separates DLs from other ad-hoc web services where the information architecture and navigational mechanisms have no particular justification.

Another key dimension is user behaviour. Web-sites are often designed to support browsing activities, whereas DLs need to support task orientated navigation. Vora and Helander (1997) define the difference between these two information-seeking behaviours:

> The main distinction between navigation and browsing is based upon user goals. In browsing, users explore the available hypertext to get a general idea about one or several topics. Whereas, in navigation, user have a specified goal in mind (Vora and Helander, 1997).

Previous evaluations of DLs identified key design flaws that needed improving (Theng et al, 1999). The main issue was to provide better navigation support mechanisms to address the 'lost in hyperspace' problem. Navigation here is used in terms of end-users' confidence in navigating within the DL. From their investigation, navigation of DLs is still not desirable. Users still experienced some degree of 'lostness'.

Soergel (2002) developed a framework for DL research. His research proposed some guiding principles for the development of DL. The principles that related to usability issues were:

- DLs need linked data structures for powerful navigation and search.

- The interface for the DLs should guide users through complex tasks
- Innovative DL design should be informed by studies of user requirements and user behaviour.

3. Usability and accessibility

John and Marks (1997) identify three key factors to assess the usability of an interface:

> Usability is measured by the extent to which the intended goals of use of the overall system are achieved (effectiveness); the resources that have to be expended to achieve the intended goals (efficiency); and the extent to which the user finds the overall system acceptable (satisfaction) (John and Marks, 1997).

The usability of a system is also related to issues surrounding its accessibility. There is a broad range of users to whom web-based services are directed, and the services provided ought to be accessible to them (e.g. visually, hearing, physically or cognitively impaired or even people with different experience of and attitudes towards technology).

The Disability Discrimination Act (DDA) began to come into effect in December 1996 and brought in measures to prevent discrimination against people on the basis of disability. Part III of the Act (to be enforced in Fall 2004) aims to ensure that disabled people have equal access to products and services. Under Part III of the Act, businesses that provide goods, facilities and services to the general public (whether paid for or free) need to make reasonable adjustments for disabled people to ensure they do not discriminate by:

- Refusing to provide a service;
- Providing a service of a lower standard or in a worse manner;
- Providing a service on less favourable terms than they would to users without the disability.

There is a legal obligation on service providers to ensure that disabled people have equal access to web-based products and services. Section 19(1) (c) of the Act makes it unlawful for a service provider to discriminate against a disabled person "in the standard of service which it provides to the disabled person or the manner in which it provides it".

While no web-sites in the UK have so far been pursued under the Act, it does appear that courts will use the W3C WAI guidelines as the accepted standard required for compliance with the DDA (Sloan 2001). Interestingly, in April 2003 the Disabilities Rights Commission (DRC) launched a formal investigation (to be carried out by the Centre for HCI Design at City University) into the accessibility of public and private web-sites (for more information refer to http://www.drc-gb.org/newsroom/newsdetails.asp?id=393&section=1). Additionally, under the eEurope Initiative launched in December 1999, the European Commission has committed the Member States to "make all public web-sites and their content accessible to people with disabilities" through the adoption of WAI Guidelines. Although this is a non-legal requirement and only applies to public sector Web-sites, there is also a commitment to review legislation and standards — which could see the initiative extended outside the public sector.

An important proviso here is that education is not covered by the DDA, but by separate legislation, the Special Educational Needs and Disability Act 2001 (SENDA). This Act introduces the right for disabled students not to be discriminated against in education, training and any services provided wholly or mainly for students, and for those enrolled on courses provided by 'responsible bodies', including further and higher education institutions and sixth form colleges. Student services covered by the Act can include a wide range of educational and non-educational services, such as field trips, examinations and assessments, short courses, arrangements for work placements and libraries and learning resources. In a similar wording to the DDA, SENDA requires responsible bodies to make reasonable adjustments so that people with disabilities are not at a substantial disadvantage.

So if Digital Library services and resources are used by people with disabilities as part of their work or personal development, they will be subject to the DDA (as providers of goods and services to employees of educational or research institutions or members of the public); if they are used by students or prospective students, they will be subject to SENDA.

Interface design should therefore be governed by the requirements of all stakeholders of the system. Thus a variety of issues have to be taken into account throughout by using a highly user-centred design process.

4. Usability and accessibility iterative framework for DLs

Libraries have always tried to remove obstacles to information access. A poorly designed DL is certainly a barrier to the library user; therefore need exists for a specific usability and accessibility framework for DLs, which if adopted can insure quality and enhanced usability of a service.

We regard the most important aspect in evaluating a system to be the identification of real user problems; therefore our framework plays specific attention to evaluation techniques that involve current and perspective users. Expert evaluation methodologies are also conducted to supplement user evaluations and address areas that are not covered by previous evaluation techniques. After each stage the findings must be evaluated, enabling appropriate design and modification of the techniques in the next stage of the framework, thus ensuring maximum effectiveness.
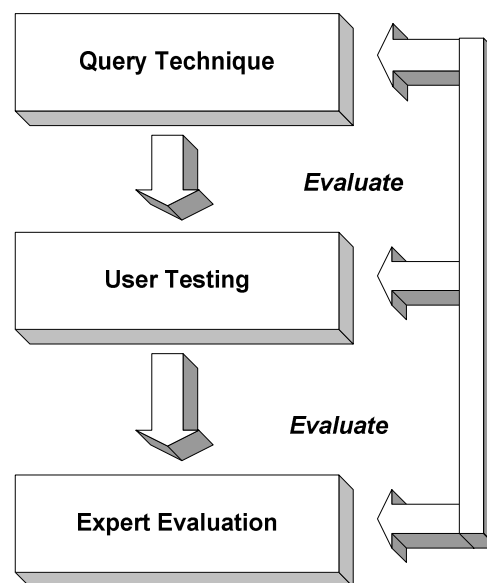
Figure 1: DLs usability/accessibility framework

The framework can be broken down into seven key steps:

1. Conduct Query - Requirement Gathering

Identify satisfaction levels of current users of the system and establish key positive and negative aspects of the interface, what features they would like to see etc.

2. **Analysis**

Evaluate current findings and identify issues not yet addressed

3. **Perform Empirical (user) Evaluations**

We regard user testing as the strongest evaluation technique, allowing us to identify real user problems by observing users interacting with the system. Retrospective focus groups or interviews conducted after the evaluations also provide a volume of qualitative data.

4. **Analysis**

Establish key problems and assess if any areas of the service have not been covered by user evaluations

5. **Expert Evaluations**

Appropriate modification of expert evaluation techniques maybe required so that they supplement previous evaluation findings, and address any areas or issues that have not as yet been covered

6. **Analysis**

Analyse all data identifying key issues that need to be addressed in the redesign of the service. Establish new usability and accessibility goals for the design

7. **Iterative Process**

Re-conduct all stages in the iterative framework to evaluate redesign

The techniques in each stage of the process are:

Query Techniques	**User Testing**	**Expert Evaluations**
Questionnaires	Retrospective	Heuristic evaluation
Interviews	Concurrent	Cognitive Walkthrough
Focus groups		

The evaluation techniques applied to the DLs framework also need to address the highly organised and task based nature of DLs. In our evaluations of four JISC services (a bibliographic service, a portal, a geo-spatial DL and an Image database) the tasks applied to the user testing evaluations and cognitive walkthroughs were designed with these two dimensions in mind, for example.

- **Image Database – User Testing, Task 1**
   Retrieve images of *London Bridge*, ONLY form the collections below:

   Design Council Archive: University of Brighton
   Women's Library: Suffrage Banners Collection

- **Portal Service – Cognitive Walkthrough, Persona 3**
   Find the education materials – *Internet for Education* from the SOSIG site.

These examples are both task orientated, and require a high level of content organisation by the services.

However, not all usability requirement gathering and evaluation techniques are applicable to all of the services in the same manner. In addition, the goals and actions that users wish to achieve vary according to the nature of the service. Therefore, it is imperative that the specific usability issues that apply to each service are clearly identified, along with the corresponding stakeholder requirements for each resource.

For example, the usability issues surrounding virtual map libraries differ in some aspects to those of other DLs due to the specific type of information they preserve and display. The technical nature of the information means that the interface must provide visualisation tools that all users can utilise. Hence the systems usability especially in terms of interface design, must be strongly correlated with the end-users' productivity. Methodologies that gather user requirements and evaluate usability must also be adapted to suit individual services in some instances. Query techniques like questionnaires need to be designed to specifically extract users' requirements in relation to that service.

The requirements of the different types of users also differ between, and within a service. Some users require a service to offer an abundance of advanced tools, thus providing greater versatility when interacting with the application. Other users however want clearly structured and formulated steps to help them accomplish their tasks, although perhaps at the expense of flexibility.

5. Conclusion

Our usability and accessibility framework for digital libraries concentrates on establishing a framework that focuses on the main characteristics of digital libraries. This focus is based on the findings we gathered from the extensive research we did of current usability practices adopted by JISC, the requirements of the stakeholders and additional investigation in the area of digital libraries.

According to our findings, the main characteristics of a truly usable and accessible digital library are:

- Support task-based information seeking behaviour
- Highly organised information content

The framework was constructed in a way that specifically addressed these factors, and met the usability and accessibility needs of digital libraries. Therefore ensuring that by adopting the framework, truly usable and accessible digital libraries can be produced.

The evaluations of the four JISC services were conducted using the usability and accessibility framework established for digital libraries. The methodologies adopted in this study were both analytic and empirical. Query techniques were used to establish the requirements and key problems that users currently experienced. User testing was conducted to further identify major usability and accessibility issues with each of the JISC services. This was followed by analytic evaluations such as heuristics evaluations and cognitive walkthroughs with usability and accessibility experts evaluating the JISC services based on their expert knowledge. Each stage in the process was supported and supplemented where needed by the one that followed in order to clarify the findings, identify further usability and accessibility issues and produce an iterative process.

The evaluation framework specified the stages at which designers should employ such methodologies and techniques in the iterative design process – from requirement elicitation, design generation to the evaluation stages. In the usability and accessibility framework, we regarded that the most important aspect in evaluating a system was the identification of real user issues; therefore our framework focused on the evaluation techniques that involved both the current and perspective users. Expert evaluation methodologies were embedded as part of the evaluation stage within the framework. Expert evaluations act as a supplement to the empirical user testing evaluations and address areas that have not been identified by the previous evaluation stages. The findings gathered from the evaluations at each stage are then analysed, enabling appropriate design and modification of the techniques in the next stage of the framework, thus ensuring effectiveness and efficiency when conducting the evaluations, maximising the benefits resulting from the findings of the evaluations. This workable framework will enable designers and developers of DLs to employ the most suitable methodologies and techniques for each aspect, at each particular stage, in the development of their service.

We believe that by employing the usability and accessibility framework and guidelines established in this study, JISC will be able to produce truly usable and accessible services and resources for the existing and future JISC Information Environment.

6. Suggestions to practitioners

Practitioners could apply the usability and accessibility evaluation framework into the evaluation of existing or future DLs in order to assess the usability and accessibility issues of these services.

In the meantime, the usability and accessibility guidelines established from the findings of the four JISC services we evaluated, could be adopted into the re-design of other services and resources as well as in the design of future DL services. This would ensure that appropriate usability and accessibility practices are adopted into the design lifecycle.

7. Suggestions to researchers

Future research directions could be in investigating how appropriate Human-Computer Interaction (HCI) design principles could best be applied within DL services and resources. Also, how to address current developments in HCI design and synthesise these for use within the context of the Information Environment. In particular, to cover the role of HCI design in the

delivery of learning, teaching and research, and most importantly, to further investigate how DLs could be adopting these principles for HCI design within its practices more formally in the future.

At the same time, an investigation of visualisation techniques for use by DLs and resources could be conducted, establishing sets of visualisation techniques and guidelines for DLs to enhance the delivery of information for learning, teaching and research within the Information Environment.

Finally, future research could be done into specific digital libraries, such as geo-spatial information services and bibliographic database services. An in-depth investigation into these services specifically would help us to refine our framework and guidelines presented in this project and further cater for the needs of different digital library services.

References

Arms, W. (2002) Digital Libraries. [Online]. Available: http://www.cs.cornell.edu/wya/DigLib [04 March 2003]

Dix, A, Finlay, J., Abowd, G. & Beale, R. (1995). *Human-Computer Interaction*. London: Prentice-Hall.

John, B.E., Marks, S.J. (1997). Tracking the effectiveness of usability evaluation methods. Behaviour and Information Technology, 16, 4/5, 188-202.

Lesk, M. (1997). Practical Digital Libraries: Book, bytes and bucks. San Francisco, CA: Morgan Kaufmann.

Sloan M, (2001) Web Accessibility and the DDA, Refereed article, The Journal of Information, Law and Technology (JILT). [Online]. Available: http://elj.warwick.ac.uk/jilt/01-2/sloan.html

Soergel, D. (2002). A Framework for Digital Library Research: Broadening the Vision. D-Lib Magaizne, 8, 12.

Theng, Y.L., Duncker, E., Mohd-Nasir, N., Buchanan, G. & Thimbleby, H. (1999). Design guidelines and user-centred digital libraries. Lecture Notes in Computer Science: Research and Advanced Technology for Digital Libraries (Proceedings of ECDL' 99), pp. 167-183. Springer Verlag, Heidelberg, Germany.

Theng, Y.L. (1997). Addressing the 'lost in hyperspace' problem in hypertext. PhD Thesis, Middlesex University (London).

Vora, P.R. & Helander, M.H. (1997). Hypertext and its Implications for internet. In Helander, M.H., Landauer, T.K., Prabhu, P. (Eds.) Handbook of Human-Computer Interaction (2nd Editions). Amsterdam: Elsevier Science.