Chowdhury, G. (2004) Access and usability issues of scholarly electronic publications. In: Scholarly publishing in an electronic era. International Yearbook of Library and Information Management, 5. Facet Publishing, UK, pp. 77-98. ISBN 1-85604-536-6

http://eprints.cdlr.strath.ac.uk/2606/

Chapter 6

Access and Usability Issues of Scholarly Electronic Publications

Gobinda G. Chowdhury

Introduction

Scholarly communications can take place via a number of documentary forms including seminar and conference papers, technical reports, theses and dissertations, journal articles and review papers, monographs, edited books, and so on. Users in today's digital library world can get access to these scholarly publications through a variety of channels ranging from the websites of the producers or publishers of the information resources to a number of intermediaries and service providers, search tools and services, and so on. Having all the various alternatives available to them, users often find it difficult to choose the best option to get access to the required scholarly information. Each of the alternative channels has its own policies and techniques for the identification, organization and retrieval of information resources, and these not only influence the usability of these services, but also the resultant output that the users are likely to get at the end of a search session. Usability and user friendliness of information access systems depend on a number of factors. Traditionally access to scholarly electronic publications was provided by specialized agencies that included database producers/publishers and online search service providers like Dialog. In the past a number of researchers have studied the usability and user friendliness of electronic information services. However, these issues have become more critical in today's digital information world for a number of reasons, mainly because access to scholarly information is no longer controlled by the specialized agencies. In fact, in theory anyone can be an information producer and information service provider in today's world of web and digital libraries. While this phenomenon increases the opportunities for the users, it also creates a number of problems and confusion.

This chapter looks at the various access and usability issues related to scholarly information resources. It first looks at the various channels through which a user can get access to scholarly electronic publications. It then discusses the issues and studies surrounding usability. Some important parameters for measuring the usability of information access systems have been identified. Finally the chapter looks at the major problems facing the users in getting access to scholarly information through today's hybrid libraries, and mentions some possible measures to resolve these problems.

Channels for Access to Scholarly Information

Users in today's Internet and digital library world can get access to scholarly information resources through a number of documentary forms and channels, such as:

- Full texts of journals – printed as well as electronic: through the publisher, such as Emerald; through service providers, such as, Ingenta

- Born e-journals and e-books: usually through the publisher's website or through services like the subject gateways (see below)

- Digital libraries – general or institutional: websites of specific digital libraries like the California Digital Library, ACM (American Computing Machinery) digital library, New Zealand Digital Library (NZDL), National Science Digital Library (NSDL), etc.

- Digital libraries of special collections, e.g. NDLTD (Networked Digital Library of Theses and Dissertation), Alexandria digital library (a digital library of spatial information resources), etc.

- CD-ROM and traditional online databases: through publishers and/or service providers like Dialog, Ovid, etc.

- Subject Gateways: SOSIG (Social Science Information Gateway), OMNI (health information gateway), Biz/ed (business information gateway), EEVL (subject gateway for engineering, mathematics and computing), etc.

- Web Search tools: directories (like Yahoo), search engines including meta and specialized search engines (like Google, Askjeeves, Kartoo, Vivisimo), etc.

- Special initiatives: like JSTOR, EDINA

- Publicly available scholarly information archives, e.g., arxiv.org (commonly known as the the Los Alamos E-Print Archives), Cognitive Sciences Eprint Archive (CogPrints), NCSTRL (Networked Computer Science Technical Reference Library) etc.

- Hybrid libraries: library webpage, e.g. the Strathclyde University library webpage

- Specific websites of institutions, professional bodies, funding agencies, etc. on specific subjects, e.g. IFLANET, TREC (Text Retrieval Conferences), DLI (Digital Library Initiatives), etc.

- Personal websites – those of specific persons providing access to some or all of their own publications; and so on.

While some of these services are available for free, others offer controlled access – through registration and payments, etc. Nevertheless, the Internet and digital libraries have brought a significant change to the information access and use mechanisms. In most cases users no longer need to pay for browsing or searching an information collection, while in others even the access to the full text of the scholarly publication is available for free. This has of course brought many challenges, the most prominent ones are related to the usability issues.

Impact of the web on information access systems
Internet computing has made a tremendous impact on information access – both on the technology and the economic front. For example, Internet has made it possible to get access to virtually any type of information located anywhere in the world. A number of web search tools have been built over the past few years that are not only robust but are quite sophisticated too. In fact, some of the improvements in information access that have taken place in the past few years surpass the developments in this field for over three decades. Improvements in the web information retrieval are taking place very fast, and the most interesting point is that end-users do not have to pay for these developments. Before the Internet era information retrieval experiments and evaluation used to take place on small test collections that were tiny in comparison with the size of the web. In fact, this was one of the major criticisms of information retrieval experiments before the Internet era.

Web search tools have also brought major changes in the economics that prevailed in the information industry for several decades. Before the Internet era, users had to pay for the search engine as well as the content. Web search tools are free at the point of use, and yet they are constantly improving their performance through research and innovations. Many information search services now offer free browse and search options for their collections.

Web has facilitated the creation and/or redesign of many information access channels including the online journals and service providers,   e-books, digital libraries and online databases and search services. Sophisticated web search interfaces to e-journals, databases and digital libraries are now commonplace, but this was unthinkable even a decade ago. However, having all these sophisticated information access systems all round, the fundamental question still remains: is it now very easy to get access to the right information at the right time with minimum resources and efforts? Borgman (2000) comments that despite the technological advances, information systems continue to be difficult to use. This chapter revisits this issue in the context of access to electronic scholarly information resources.

Usability
'Usability' and 'user friendliness' are two very closely related concepts and are often used interchangeably in the information science literature. Many researchers, especially those who are from the HCI community define usability in relation to the user interface. For example, Hansen (1998) comments that the concept of usability is related to the effectiveness and efficiency of the user interface, and also to the user's reactions to that interface. Nielsen (1994) defines user friendliness as a mixed concept, consisting of several factors such as simplicity of learning, efficiency of use, simplicity of memorising, etc.

Usability of a system refers to its capabilities that enable the user to use it easily and effectively to perform a set of specified tasks within a specified environment. So, by usability of an information service (more precisely a channel providing access to one or more variety of information resources) we generally mean how easily it can be used to get access to the required information. As soon as we accept this simple definition, we come across some major issues concerning information services. First, the service should be such that it can be used easily by the users. A number of technical issues are involved here including the issues of interface design, retrieval mechanisms, interoperability where multiple channels and/or databases are involved, etc. The other issue, often an ignored one, is related to the user; it is highly impractical to design a service that can be used with equal ease by all kinds of users around the world, and yet this is what most of today's digital information services aim to accomplish. This in turn brings other issues that relate to the objectives and functionality of the concerned information service. There is one more issue that in turn brings up a number of related problems and issues. In our definition above we have assumed that an information service should be such that it can be used easily to get access to the required information. This last bit, i.e., 'the required information' brings up a number of critical issues that in turn influence the usability. Most information services in today's world assume that the users are able to correctly specify the information that they require. In fact this is often the major difficulty, since research in human information behaviour shows that often users find it difficult to clearly specify what they need, and moreover the information need often keeps changing in course of an information search session (Borgman, 2000; Chowdhury, 2004). In other words, we assess the usability of information services using a parameter which itself is difficult to define. Moreover, in today's digital world, the user can be anyone virtually anywhere in the world, and this poses more problems for the designers of the information services, because

ideally one should try to design a service that can satisfy every possible user's information requirements despite their linguistic, cultural and various other socio-economic differences.

Usability Studies and Guidelines

Perspectives on usability shifted substantially over the past few decades – initially the purpose of ergonomics was to shape human beings to adapt to the technology, and this slowly moved towards the other end and now the objective is to shape the technology to suit the human capabilities and needs (Borgman, 2000). Many studies have taken place in the recent past on the usability of electronic information services. Some of these studies were designed to assess the performance of a specific system, while others aimed to develop evaluation metrices and guidelines.

Many guidelines for the usability of websites and website design have appeared in the past (see for example, Brinck, Gergle and Wood (2001); Palmer (2002); White (2002); Hert, Jacob,and Dawson (2000). Byerley and Chambers (2002), while studying on the usability of information services for users with special needs, comment that commercial databases should conduct usability testing with users who rely on screen readers for access to the web. A number of studies have also taken place in an area that is closely related to the usability of electronic information services, viz. the user interfaces. A number of recent studies have focused on the usability of digital libraries. Some such studies are discussed in the following sections.

Usability and User Interfaces

User interfaces to information retrieval systems that support information-seeking processes have been widely discussed in the literature. Interface design encompasses what appears on the users' screen, how they view it, and how they manipulate it. Interface design thus has a tremendous impact on the usability. Marchionini (1992) provides a description of the essential features of interfaces to support end-user information seeking and suggests five information seeking functions: problem definition, source selection, problem articulation, result examination and information extraction. He argues that much of the interface work has focused on problem articulation (including query formulation) and that other functions need to be investigated in designing information-seeking interfaces. Marchionini and Komlodi (1998) discuss the evolution of interfaces and trace research and development in three areas: information seeking, interface design and computer technology. Savage-Knepshield and Belkin (1999) discuss the interface design challenges within the context of information retrieval interaction over the last three decades. They note that the degree of interaction between the searcher and the IR system has dramatically increased and much research is still required to meet the challenges in interface design for IR interaction. Hearst (1999) discusses user interface support for the information-seeking process and describes the features of these interfaces that aid such processes as query formulation and specification, viewing results and interactive relevance feedback. She points out that there is an increasing interest in taking the behaviour of individuals into account when designing interfaces.

Hilbert and Redmiles (2002) report on a survey that examines computer-aided techniques used by HCI practitioners and researchers to extract usability-related information from user interfaces. Researchers in the HCI lab in the University of Maryland (HCIL (n.d.)) have developed the following generic guidelines for the design of user interfaces to information systems:

- consistency with respect to the use of word(s), object, and standards;

4

- proper positioning of objects for task performance, comprehensibility, information density, and aesthetics;
- an appropriate mix of GUI (graphical user interface) objects; and
- user interaction logging for analysis of usage patterns.

Shneiderman and his associates propose a number of guiding principles for design of user interfaces that will help improve the usability of the underlying information access systems (Shneiderman, Byrd and Croft, 1997,1998; Shneiderman,1998):

1. Strive for consistency in terminology, layout, instructions, fonts and colour.
2. Provide shortcuts for skilled users.
3. Provide appropriate and informative feedback about the sources and what is being searched for.
4. Design for closure so that users know when they have completed searching the entire collection or have viewed every item in a browse list.
5. Permit reversal of actions so that users can undo or modify actions; for example, they should be able to modify their queries or go back to the previous state in a search session.
6. Support user control, allowing users to monitor the progress of a search and be able to specify the parameters to control a search.
7. Reduce short-term memory load; the system should keep track of some important actions performed by the users and allow them to jump easily to a formerly performed action, for example, to a former query or to a specific result set.
8. Simple error-handling facilities to allow users to rectify errors easily; all error messages should be clear and specific.
9. Provide plenty of space for entering text in search boxes.
10. Provide alternative interfaces for expert and novice users.

Usability of digital libraries

Digital libaries can be evaluated on three key components, viz. contents, functionality and user interface (Van House et al, 1996). A number of studies have taken place in the recent past on the usability of digital libraries. The HCI community always emphasizes on the usability of the user interfaces. For them usability testing involves assessing the effectiveness, efficiency and/or satisfaction of the user with a particular interface (Choudhury, Hobbs and Lorie, 2002; Nielsen, 1993; Norlin, 2000). Bollen and Luce (2002) comment that some usability factors such as user preferences and satisfaction tend to be highly transient and specific, and therefore research on these issues need to focus on more stable characteristics of a given user community, such as 'the community's perspective on general document impact and the realtionships between documents in a collection.'

Park (2000) comments that most earlier studies on the usability of multiple online databases have focussed on technical and performance issues rather than interaction issues. Park's study shows that users prefer to interact with multiple databases through a common interfaces rather than an integrated interface because the former provides more control for the users on the selection of databases. Cultural issues have significant influence on the usability of digital libraries. Emphasizing the importance of cultural issues on the usability of information services, Duncker, Theng and Mohd-Nasir (2000) comment that misinterpretation of the importance of colours, forms, symbols, metaphors, language and use for users coming from different cultural backgrounds can significantly affect the usability and user friendliness of digital libraries.

Bishop et al (2000) comments that 'users don't know what they don't know, don't understand what they don't understand, and in any case, don't want to talk about it in a survey.' Hence researchers should be careful in choosing the method for studying the usability of digital librries involving end users. Recent studies on usability testing with specific references to digital libraries include those of Blanford and Buchanan (2003), Allen (2002), Dickstein and Mills (2000), and Mitchell (1999). Usability issues of e-books have been widely studied and reported on by Landoni and her associates (see for example, Wilson and Landoni,2003; Wilson, Landoni and Gibb, 2003; and Wilson, Shortreed and Landoni, 2004).

Usability Testing: Methods and Criteria
Several methods and guidelines have been proposed for conducting usability tests (see for example, Rubin,1994; Dumas and Redish,1993; Kling and Elliott, 1994). Blandford and Buchanan (2003) list the various usability factors that are applicable to the digital libraries:

- Achieving goals: How effectively and efficiently can the user achieve their goals with a system

- Learnability: The question is how easily can the user learn to use the system

- Help and error recovery: How well the system helps the user avoid making errors, or recover from errors

- User experience: How much the user enjoy working with the system

- Context: How well the system fits within the context in which it is used.

A closer look at the above usability factors reveals that while some of the parameters are related to the technical and systems design issues, others are related to the users. The following is a set of general guidelines and list of parameters that may be used to measure the usability of information services providing access to scholarly information sources.

Interface Features
User interface is the point of contact between an information service and the user. Hence this has a significant impact on the usability of the entire system. Every feature of the interface ranging from the look and feel to the design, colour, fonts, and facilities will have impact on the usability. More specifically one needs to check:
- The types of interface, e.g. simple or novice vs. expert or advanced search interface
- The language of the interface including options for using more than one language for display of the options, query formulation, etc.
- Options for navigation, shortcuts, and easy movement among the various options/screens
- Screen features including the use of colours, typography, layout and graphics
- Options for personalization, e.g. choice of a particular design, choice for the selection of channels of information, number of records per page, sort options, display options, etc.

Search Process
Broadly speaking, three major processes are involved in an information search session, viz. database selection, query formulation, and result manipulation. Each information service provides

different options for each of these processes. However, each option influences the usability of the system.

Database selection

This function is relevant to the systems that provide access to more than one database. It is important to note whether the system allows the users to choose one or more database for searching. It is also important to note how easy it is to select a database, and also how quickly one can revert to another database.

Query formulation

This is the most difficult and yet important stage in an information search process. Each information service provider uses a specific set of options for the formulation and modification of queries. A number of parameters may be noted including:

- The search options – basic and advanced search options
- The mode of query formulation: form, natural language search, command mode, etc.
- Options for formulating complex queries involving more than one search term or phrase and search operators
- Search fields: it is important to note:
  - Fields that can be searched
  - Formulation of queries including the use of search operators, truncation, using multiple values in a single search field, etc.
  - Options for marking a multi-word term as a phrase
  - Options for searching in text and other databases (images, multimedia, etc.)
  - Tools are available to support search term selection, e.g. indexes, thesauri (especially for subject search), etc., and guidelines for their use
- Multiple database/resource search
  - Can multiple databases/resources be searched using a single search query?
  - Is there a common search interface for searching various channels?
- Query modification and saving
  - Options for modifying a query
  - Creation of search sets and conducting search on a previously retrieved set of results
  - Options for saving one or more query for future reference.

Results manipulation

It is important to note the various options available for display and manipulation of search results, including the following:
- Formats available for the display of search results and for the display of individual record
- Limit on the number of records that can be displayed – default vs. user options
- Options for navigation in the list of records
- Marking of the records for display and saving
- Options for sorting results
- Separate display for the output from each chosen channel/database
- Options for printing, exporting and emailing of records
- Options for filtering duplicate records.

Help
Different kinds of help may be available for the various stages of an information search process, and in each case it is important to note its:
  - o Appropriateness for the target users
  - o Usability including the language, style, context, etc.
  - o Consistency of terminology, design and layout
  - o Correctness.

It is also important to note whether error messages are displayed, and if so, whether the system also displays the measures for corrections, if necessary.

Usability of hybrid libraries: user problems and possible solutions
Academic users are probably the largest and the most frequent users of digital library services. Most university libraries today are hybrid libraries in the sense that they provide access to a range of printed as well as digital information resources. University students, staff and researchers can now access a variety of digital resources ranging from e-journals and e-books to electronic databases, local and remote digital libraries and the world wide web. However, it is important to know how easily a user can get access to all the information resources relevant to their query. A simple usability study was conducted towards the end of 2003 with a typical hybrid library website of a university in Scotland. Fifty five students from the MSc. Information and Library Studies class were chosen for this study. Each student was asked to choose a topic of research, and was asked to use the university library website to find information resources relevant to the topic. There were altogether 55 topics. The following examples show the kind of research topics chosen by the users:
  - Marketing of public library services
  - Intellectual property laws in Britain
  - Harry Potter book series: its impact on library readership and protests from religious groups
  - e-government: implementing electronic elections and democracy
  - Digital libraries and their use
  - Managing digital libraries
  - Influence of the horror genre on modern cinema
  - Privacy and ethics in an electronic age

In order to make the searches realistic, no restrictions were imposed on the users in respect of search time, and the choice of the type of information resources and/or services available through the library webpages. The users were asked to find all the possible resources ranging from book materials (which could be found through the library OPAC) to journal and conference papers which could be found through a number of e-journals and electronic databases, theses and dissertations that could be searched through the university thesis collection, and all other types of resources that could be accessed through the websites or search tools pointed to by the library webpage. Users were asked to stop when they considered that a reasonable number of resources of all the different types were found. While searching for information using a specific system e.g., e-journals or electronic databases, users could stop when they had thought that enough time was spent on it, even if the desired results were not obtained. Thus, the objective was not to compare the performance of the users or of one or more specific channels providing access to electronic information resources, but to measure the overall usability of the digital (strictly speaking hybrid) libraries of today. The users were asked to note down their experience, especially the level of

difficulties faced while conducting the searches, and were asked to comment on each search system and the overall digital library.

User Problems and Related issues

Overall, a qualitative approach was adopted for this research, in that the users were given freedom to note their difficulties and comments. Each user noted a number of difficulties faced in course of the search process. While the points were not always the same, and the wordings of comments were at times different, some common issues and problems influencing the usability were identified. The following are some of the most important findings of this study which were obtained as the users' comments:

1. Users felt that a search for electronic information resources calls for some basic ICT and information literacy skills without which a search may never be fruitful.
2. Users experienced that sometimes initial searches may not produce any good hits, yet there may be a wealth of information resources that are relevant to a search topic.
3. A particular search may produce too many or too few hits. Therefore users should be prepared to spend time and try out the various alternative search options.
4. Different systems – online search service providers, e-journals and aggregators, web search tools, and digital libraries – have different search interfaces and often use different search syntax; this makes the learning curve very steep.
5. Familiarity with the search topic and the structure of the digital library as well as the organisation and content of the various systems – e-journals, online databases, digital libraries, etc., helps the user produce better search results with relatively less time and efforts.
6. There may be a number of e-journals and databases covering a given subject/topic. It is often difficult for the user to decide which journal or database to select, and yet this is the first step and it determines the choice of the appropriate search service provider (for electronic databases) or aggregator (for e-journals).
7. Searches through online databases, e-journals, etc., often produce only abstracts, and the user has to go through another course of action to get access to the full text of the retrieved items.
8. Some search options, e.g., 'keyword', 'subject', 'title keyword', and 'subject keyword', are often confusing; users generally found it difficult to differentiate among them.
9. Off-campus searching is often very time consuming and frustrating, because due to the low bandwidth connection from the home computer, a search and download may take a long time, and in the meantime the connection may be broken. On many occasions, the user is prompted to enter the password to re-establish the connection. All these add to the frustration of the user.
10. Sometimes a search produces too many hits and the user has to spend a lot of time (for example for full text journal articles) to decide whether or not an item is relevant.
11. A significant amount of useful information is available on the departmental and faculty intranet sites in the form of lecture notes and handouts, useful reading materials and pre-prints, suggested web sites and digital resources, etc., and it would be useful if they could be linked to the library webpages.
12. Organization of information on the main library page has an impact on the user's selection of a specific digital library service; sometimes the specific services are hidden under several layers, and the user may have to explore the library webpage to discover the various resources and services available.

13. Given the multiple variety of information resources obtained as output, it is often difficult to decide which one to use, and to decide the most relevant items retrieved through all the various systems is a challenging task.

14. Once the user chooses to search on a specific service, e.g. e-journals, or electronic databases, it is difficult to come back to the library web page and start another search; results from one particular search need to be saved, and then the user has to come back to the library webpage, and choose another system to search; often the user has to go through the whole process again, e.g., logging-in with the user id and password, etc.

15. Selection of appropriate search terms is a big challenge, especially for a complex or an unknown topic, and yet this is the first step in any search.

Possible Solutions

The above findings highlight some of the most common problems faced by today's digital library users. Several design and user issues are involved here. Possible design measures are suggested below in respect of the various problems mentioned in the earlier section. It may be noted that in order to resolve some problems, more than one measures may be taken. Overall, these measures may improve the access and usability of digital information resources.

1. *Point 1:* This has direct implications on digital and information literacy training; indeed regular digital and information literacy training are not adequate in most cases, and yet the complexities of the digital information world call for regular and rigorous training.

2. *Points 2,3 and 4*: These mean that users should be prepared to spend more time to search for information, and this is in contrast with the typical web search behaviour of users where a typical search takes only 2-3 minutes (Chowdhury, 2004). This has to be stressed in any user education or information literacy training; this is also an important design consideration.

3. *Point 4*: A one-stop window approach where the user can see and use only one search interface to search information from a variety of systems may resolve this problem.

4. *Point 4*: A task-based information access system may resolve this problem; alternatively there should be enough online help to guide the user.

5. Point 5, 6, 7 and 8: These have implications on information literacy, user education and online help facilities.

6. Point 9: This is directly related to the digital divide. Most recent statistics show only whether a household has an Internet connection or not. However, in order to make it worthwhile for access to and use of digital libraries, it is important to have a high bandwidth connection.

7. Point 10: This is an important point since from web search studies (reported earlier in this paper) it is noted that the user does not spend much time on looking at the search output. Automatic filtration mechanisms based on user characteristics, user tasks and user choices, may be useful.

8. Point 11 and 12: A task-based information access system may be designed to provide access to the library as well as the institutional intranet and internet resources.

9. Point 12, 13 and 14: Cross-database searching facilities with options for discarding duplicates and ranking the results (based on user-driven criteria) may resolve the problem.

10. Point 15: Facilities for using search term dictionary or vocabulary control tools are essential for good digital library search interfaces.

Interoperability of various information access systems

One of the major problems facing today's digital information world relates to the issue of interoperability, an attribute which ensures that a wide variety of computing systems can work together and/or talk to one another. There are different types of interoperability, such as systems interoperability, software interoperability or portability, semantic interoperability, linguistic interoperability, and so on. Since the introduction of computers in creating catalogues, libraries have faced the problems of interoperability, and several tools and standards have been produced to ensure interoperability, including the standardization of cataloguing (by using Anglo-American Cataloguing Rules, say), bibliographic formats (by using standard formats such as MARC21, UNIMARC, CCF, etc.), data exchange formats (by following international standards like the ISO 2709) and information retrieval (by using standards such as ANSI Z39.50). Interoperability among various information access systems can be achieved in a number of ways, for example by adopting (Arms, 2000, 70-72; HyLife, 2002):

- Common user interfaces
- Uniform naming and identification systems
- Standard formats for information resources
- Standard metadata formats
- Standard network protocols
- Standard information retrieval protocols
- Standard measures for authentication and security, and so on.

The open archives initiative (n.d.) supported by the Digital Library Federation, develops and promotes interoperability standards that aim to facilitate the efficient dissemination of the content of publicly available e-print archives. The Open Archives Initiative Protocol for Metadata Harvesting (referred to as the OAI-PMH) provides an application-independent interoperability framework that provides a mechanism for harvesting XML-formatted metadata from repositories.

Conclusion

While the web and digital libraries have opened up many new opportunities for the end users for getting access to scholarly information resources, they have brought many new concerns related to the access and usability of the services. As discussed in this chapter, the HCI community have taken a narrower view of the issue of usability, viz. those that are related to the user interfaces to the information system. Information science researchers however have a taken a wider view. The general parameters for assessing the usability of information services, proposed in this chapter, take into consideration the various stages in an information search process.

Despite many technological developments and growth in the variety and number information access channels, users still find it difficult to use information services. The small survey reported in this chapter provides a list of at least some of the major problems facing the users in today's digital library world. Many of these problems may be resolved by taking some design measures as suggested here. Nevertheless, parallel to the developments in the web and digital libraries, continuous research on the use and usability of electronic information resources and services need to be carried out in order to meet the overall objective of all this research, i.e., to make the information usable at the least possible costs and efforts, or to put it in the form of the good old guiding principle of information services: to facilitate access to the right information at the right time at the least cost.

References

Allen, M. *(*2002). A case study of the usability testing of the University of South Florida's virtual library interface design. *Online Information Review*, 26(1), 40-53.

Arms, W. (2000). Digital libraries. Cambridge, MA, The MIT Press.

Byerley, S. and Chambers, M. B. (2002). Accessibility and usability of web-based library databases for non-visual users. *Library Hi Tech*, 20(2), 169-178.

Bishop, A.P, Neumann, L.J. Star, S. L., Merkel, C. , Ignacio, E. and Sandusky, R. J. (2000). Digital libraries: situating use in changing information infrastructure. *Journal of the American Society for Information Science,* 51(4): 394-413

Blandford, A. and Buchanan, G. (2003).Usability of digital libraries: A source of creative tensions with technical developments, *TCDL Bulletin*. Online. Available: http://www.ieee-tcdl.org/Bulletin/current/blandford/blandford.html (Last accessed 20/4/2004).

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

Borgman, C. (2000). *From Gutenberg to the global information infrastructure: access to information in the networked world*. New York, ACM Press.

Brinck, T., Gergle, D. and Wood, S. *Usability for the Web: Designing Web Sites that Work*. San Francisco, Morgan Kaufman, 2001.

Choudhury, S., Hobbs, B. and Lorie, M. (2002). A framework for evaluating digital library services. *D-Lib Magazine*, 8(7/8). Online, Available: http://www.dlib.org/dlib/july02/choudhury/07choudhury.html

Chowdhury, G.G. (2004). *Introduction to modern information retrieval*, 2nd ed. London, facet Publishing.

Dickstein, R. and Mills, V. (2000). Usability testing at the University of Arizona Library: How to let the users in on the design, *Information Technology and Libraries*. 19(3), 144-51.

Dumas, J.S. and Redish, J.C. (1993), *A Practical Guide to Usability Testing*, Ablex, Norwood, NJ.

Duncker, E., Theng,Y.L. and Mohd-Nasir, N. (2000). Cultural usability in digital libraries. *Bulletin of the American Society for Information Science*, 26(4), 21-22.

Hansen, P. (1998). Evaluations of IR user interface: implications for user interface design. *Human IT: Tildskrift för studier av IT ur ett humanvetenskapligt perspektiv*. Nummer 2. Online. Available http://www.hb.se/bhs/ith/2-98/ph.htm, (last accessed 29.5.2004)

HCIL (n.d.). Improving Usability in Information Services: User Interface Evaluation Metrics and New Widgets. Online. http://www.cs.umd.edu/hcil/pubs/UMDWLib.shtml (Last accessed 25/5/2004).

Hearst, M. (1999), 'User interfaces and visualization'. In: Baeza-Yates, R. and Ribeiro-Neto, B., *Modern information retrieval*, New York, ACM Press, 1999, 257–323.

Hert, C. A. , Jacob, E.K. and Dawson, P. (2000) A usability assessment of online indexing structures in the networked environment, Journal *of the American Society for Information Science*, 2000. 51 (11), 971-88.

Hilbert, D. M and Redmiles, D. F. (2000). Extracting usability information from user interface events, *ACM Computing Surveys*. 32 (4), 384-421.

HyLife (2002). The hybrid library toolkit. Interoperability. Available Http://hylife.unn.ac.uk/toolkit/Interoperability.html

Kling, R. and Elliott, M. (1994). Digital library design for usability. Online. Available: http://www.csdl.tamu.edu/DL94/paper/kling.html (last accessed: 20/4/2004)

Marchionini, G. (1992). Interfaces for end-user information seeking, *Journal of the American Society for Information Science*, 43 (2), 1992, 156–63.

Marchionini, G. and Komlodi, A. (1998), 'Design of interfaces for information seeking'. In: Williams, M. E. (ed.), *Annual review of information science and technology*, Medford, NJ, Learned Information, 33, 1998, 89–130.

Mitchell, S. (1999), 'Interface design considerations in libraries'. In: Stern, D. (ed.), *Digital libraries: philosophies, technical design considerations, and example scenarios*, New York, The Haworth Press, 1999, 131–81.

Nielsen, J. (1993). *Usability Engineering.* Boston: Academic Press.

Norlin, E. (2000). Reference evaluation: A three-step approach-surveys, unobtrusive observations, and focus groups. *College & Research Libraries,* 61(6): 546-553.

Open Archives Initiative. Online. Available http://www.openarchives.org/documents/index.html (Last accessed 26.5.2004)

The Open Archives Initiative Protocol for Metadata Harvesting. Protocol Version 2.0 of 2002-06-14. Document Version 2003/02/21T00:00:00Z. Online. Available http://www.openarchives.org/OAI/2.0/openarchivesprotocol.htm (Last accessed 26.5.2004)

Palmer, J. W. (2002). Web site usability, design, and performance metrics.. *Information Systems Research*. 13 (2), 151-168.

Park, S (2000). Usability, user preferences, effectiveness, and user behaviors when searching individual and integrated full-text databases: Implications for digital libraries. *Journal of the American Society for Information Science*, 51(5), 456-68.

Rubin, J. (1994), Handbook of Usability Testing: How to Plan, Design and Conduct Effective Tests, John Wiley & Sons, New York.

Savage-Knepshield, P. A. and Belkin, N. J. (1999) Interaction in information retrieval: trends over time, *Journal of the American Society for Information Science*, 50 (12), 1999, 1067–82.

Shneiderman, B., Byrd, D. and Croft, W. B. (1998), Sorting out searching: a user-interface framework for text searches, *Communications of the ACM*, 41 (4), 95–8.

Shneiderman, B., Byrd, D. and Croft, W. B. (1997). Clarifying search: a user-interface framework for text searches, *D-lib magazine*, 3 (1), Available at http://www.dlib.org/dlib/january97/retrieval/01shneiderman.html.

Shneiderman, B (1998). *Designing the user interface: strategies for effective human-computer interaction*, 3rd ed., Reading, MA, Addison-Wesley.

Van House, N., Butler, M.H., Ogle, V. and Schiff, L. (1996). User-centred iterative design for digital libraries: the Cypress experience. *D-Lib Magazine.* Online. Available: http://www.dlib.org/dlib/february96/02vanhouse.html

White, M. (2002). Information architecture and usability, *EContent.* 2002. 25 (4), 46-47.

Wilson, R. and Landoni, M. (2003). Evaluating the Usability of Portable Electronic Books. Proceedings of the 2003 ACM Symposium on Applied Computing (SAC), March 9-12, 2003, Melbourne, FL, USA. ACM: pp. 564-568

Wilson, R., Landoni, M. and Gibb, F. (2003). The WEB Book experiments in electronic textbook design. *Journal of Documentation*, 59 (4), 454-477.

Wilson, R., Shortreed, J. and Landoni, M. (2004). A study into the usability of e-encyclopaedias. In: Haddad, H.., Omicini, A., Wainwright,R. L. and Liebrock, L. M. (Eds.): Proceedings of the 2004 ACM Symposium on Applied Computing (SAC), Nicosia, Cyprus, March 14-17, 2004, 1688-1692.