

DIGITAL LIBRARIES – A CHALLENGE FOR MEDICAL RESEARCH AND EDUCATION

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Summary

Since the early 1990s Digital Libraries have become a major factor for collecting, organising and distributing scientific research. This is especially true in the biomedical sciences. In **this article, different definitions** of the term Digital Libraries are discussed. Two major definitions are dwelled upon: one emerging from the library world and the other from the world of scientific research.

Librarians tend to speak for a broader definition of the term “Library”. They see a library as **an organisation that secures** the selection, conservation, organisation, preservation and the access to information that is vital for the members of the specific organisation.

Researchers most often favour a narrower definition of the library concept. For them a library could be any room containing a smaller or bigger amount of books or data discs or tape cassettes. Researchers seldom care for the social and institutional context of the term “Library”. Their emphasis is tilted towards databases and how to collect, retrieve, organise and access the information.

Future use, development and problems of Digital Libraries, their content, users and their staffing are discussed. For example, the technical issues which include the problem with standards and protocols. To bring the distributed variety of digital resources and services together in a way that allow for integration and unified search, retrieval and presentation is a great challenge for the future. So is the problem of transferring personalised service and support from standard library and information services to the digital library. A user interface can hardly replace person to person service but better user interfaces must be developed and researched in order to help users. The future digital library will go beyond helping the user with searching and browsing only. They must be able to expect support for taking correct actions and getting help for problem solving where the digital library system confirm or deny existing hypotheses.

Content management technologies will be the big thing of the future. The increasing amount of digital content will see to that. Semantic web technologies will probably add important features to digital libraries like semantic interoperability, better browsing, searching and filtering capabilities and delegating routine tasks of cataloguing, metadata annotation etc to automated agents. Simple algorithms and brute computing power will make your local librarian rarer and rarer. Another fact that also point in that direction is that one of the major costs for classic libraries are staff, facilities and materials, in that order. The future digital library more or less depend on materials only.

Now and in the future computers can rank and find documents, they can evaluate, make citation analysis, they can extract references from a document and link them to the full text source (SFX). Better ways of extracting and inserting meta data are under development. The low cost of these operations are bringing medical research to new audiences.

The challenge for medical research and digital libraries of the future is to handle the increasing automisation of the research sources in a way that makes these resources manageable and available to a broader audience. This certainly can not be done without the specialist librarian working as an **interface** between the machine and the customer.

Digital libraries and resources in the Medical field comes in many shapes. A few good examples of what is available today as Open Access on the Internet is presented like Bioline International, BioMed Central, Public Library of Science (PLOS) etc.

Keywords: Digital libraries, Information services, Librarians, Open Access, Future

Research aim and research question

The aim of this article is to find out if there is a standard definition for the concept “Digital Libraries”. The term is new and included in our vocabulary during the last decade only. I also try, by using the literature, to find out what sort of digital collections, resources and services that qualify for the definition/s.

What problems are facing the digital libraries of today and what are the solutions for tomorrow? Questions like this are discussed. In the process my aim has been to contribute some answer to what librarians, researchers and teachers can expect of Digital library services to come.

Digital Libraries

Definitions and circumscriptions

The term “Digital Library” is used in articles for the first time in the early 1990s. Since then research and practice in digital libraries has become standard. Plenty research funding, especially in the United States and United Kingdom, have made sure that both researchers and librarians been actively involved in digital libraries projects. Conferences and journals in the topic are thriving. A search in Google on the exact phrase “Digital Libraries” returns almost 2 million hits in early 2006. But what have happened, in these 15 years since the term first was used, that forced this explosive activity? And what does the concept “Digital Library” really mean?

Well, to answer the first question, what happened was that the flow of information got even worse as the Internet established itself as the number one channel for exchanging data. The World Wide Web (WWW) and the HyperText Transfer Protocol (HTTP) became the communication tool of choice and made producing and disseminating data so much easier. In the early 1990s the first web-browser appeared pioneered by Tim Berners-Lee at CERN. With the web-browser came the capability to use hyperlinks. In the middle of the 1990s Netscape made browsing a possibility for everyone and when we start entering the new millennium we have, at least in the developed countries, enough bandwidth and connection possibilities, for sending and exchanging very heavy loads of data. We also have new and pretty stable standards for structuring and exchanging data such as the Z39.50 communications protocol designed to support searching and retrieval of full-text documents, bibliographic data, images, multimedia etc in a distributed network environment, plus we have the Open Archive Initiative – Protocol for Metadata Harvesting. We also can use proven standards for metadata handling such as Dublin Core (DC), Encoded Archival Description (EAD), Metadata and Encoding Transmission Standard (METS). We got better authoring tools and software solutions that made life on the web so much easier.

So, to answer shortly, what happened during the last 15 years was that the tools for realising the full potential of the web started to present themselves one by one.

But of course there are many interpretations of what a digital library really is. There is no definitive definition of the term. It is widely used and there is no certainty that when discussing digital libraries two people will mean exactly the same thing. For example the term “Hybrid libraries” is sometimes used to define a library where digital and printed information co-exists. The forms and shapes of the digital library is manifold. It can provide access to digital content only but also be a hybrid that delivers non-digital content parallel to digital content [Chowdhury G., Chowdhury, S. 1999]. The digital library term has during the last decade become some sort of

umbrella term for a diverse array of information projects. So there **is** no way we can say exactly what the term really mean but we can try to sort out some sort of pattern of and circumscription around the phenomena.

There have been an abundance of attempts to define the term during its short life term. After consulting literature [Borgman 1999] and reflecting on applied practices I think it is safe to say that the concept of digital libraries can be divided into two main domains – the researcher’s domain and the librarians domain. The main difference is that while librarians focus on service and sees the digital library as an institution the researcher focus on the content collected on behalf of and served to special user communities. Both these domains have their own definitions of the phenomena. And neither of these definitions care to deal with the abundance of services on the world wide web that identify themselves as digital libraries and **I am** refereeing to everything from booksellers catalogues, library Online Public Access Catalogs (OPACs) to Proprietary electronic databases such as Dialog, Inspec, ISI, Springer Link etc. These services and any others can very well partly connect to certain aspects of the two major definitions but most often fail to comply to the full definition of either one.

Research and praxis

The massive interest and upswing for telecommunication- and computer studies in the late 1990s and the availability of funds for such hot topics as digital libraries studies across scientific fields lay the foundation for a variety of research into the digital library topic, may it be applications, protocols and standards, social aspects, user behaviour, preservation studies etc. It is by nature a interdisciplinary topic and because of that there are problems of definition. The main problem with defining it is the second part of the term - “Library”. We can pretty much agree on the definition of the term “Digital” as in “using digits (...) spec. applied to a computer which operates on data in the form of digits or similar discrete elements” [Oxford English Dictionary 060315]. It is when we come to the “library” part where all the trouble begins.

Librarians tend to speak for a broader definition of the term “Library”. They see a library as an organisation that secure the selection, conservation, organisation, preservation and the access to information that is vital for the members of the specific organisation. Librarians and Libraries carry a long history and tradition that has been somewhat cemented during the centuries and with the coming of the Internet and digital media, for librarians this is only yet another delivery channel for yet another media.

Researchers most often favour a narrower definition of the library concept. For them a library could be any room containing a smaller or bigger amount of books or data discs or tape cassettes. Researchers seldom care for the social and institutional context of the term “Library”. Their emphasis is tilted towards databases and how to collect, retrieve, organise and access the information.

But through the 1990s definitions of digital libraries have broadened in scope even if there are no definitive one. Trying to summarise definitions given by Research initiatives, Science foundations and digital library researches 3 elements seems to be necessary: 1. There must be some sort of organised collection. 2. It can be partly bibliographical but full-text files of the data, if it is an article or manuscript etc. is now frequently added and required in various formats. 3. The collection is organised for a group or community of users.

Much of digital library research is focused on database structure, data mining, retrieval algorithms, filtering and network architecture. That sort of research is based on the assumption that certain users need certain enabling technologies to successfully manipulate certain content. The notion of a certain community is problematic because the definition in itself does not contain the criteria for defining what a user community is. Another definition, that is seldom mentioned, is the assumption that digital libraries only operate in distributed environments. But then other definitions would include a CD-ROM with digitised books in a certain subject area as an example of a digital library [Witten, Bainbridge 2003].

In 1998 Donald J. Waters [Waters 1998] presented a first, short and workable librarians definition of digital libraries which also was adopted by the Digital Library Federation (DLF) which members are major American universities as well as Library of Congress and British Library. It reads:

“Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities.”

There is quite a distinction here compared with the research oriented definition. Here the focus is on the digital library as an organisation providing information services in digital form and also takes responsibility for preservation and integrity of the collection. The definition is much broader. But the fact that a library is calling itself for a digital library does not usually mean that all its services are digital. It usually means that some parts of the information services are digital. Very few libraries are digital libraries in the sense that their services are digital only.

In an article from 1996 Ross Atkinson [Atkinson 1996] predicts the new role of academic libraries that partly is realised today. He says that technology will provide libraries with the ability to distribute and make scholarly publications accessible more effectively and that mediation of scholarly information will be taken over from the the large commercial publishers by the academic library community. This is important he argues, because information technology does not promote access. It promotes control. And this control have and will be used by commercial information proprietors to increase revenue as much as possible if not the control is used to promote access.

Academic libraries and organisations can and should assume scientific publishing responsibilities in order to promote access. And this is what have happened in the 21st century with the paradigm shift in scholarly publishing towards Open Archiving. We now have two major providers of scientific information – The Commercial Publishers databases and the Digital Libraries and Archives based on the Open Access Principles and run by Academic libraries and scientific societies.

Apart from the World Wide Web at large the digital library must be a controlled zone with a carefully selected subset of information objects which are made searchable and retrievable for the customers/users. The continuing responsibility that comes with a digital library is the control of the subset over time and to ensure that it remains stable and accessible. In order to do so you add value to the items moved from outside into the digital library. Added value in the form of increased accessibility; in the form of metadata that today is mostly bibliographical but in the future can be used for statistical and rating purposes; Added value in the form of maintaining the object for a longer period of time, making sure it is stable, original and can be found at a particular address; Added value in the form of peer-review, making sure that the object been subject to editorial scrutiny and finally adding value to the object by presenting it in a standardised format that can be viewed, retrieved and preserved and shared according to international standards.

Future Developments

Problem solving

As we have seen digital libraries are thriving and expanding their services worldwide not caring too much if they fit into one definition of some sort or the other. Many have been sponsored and funded by government bodies such as the eLib Programme in the UK [eLib 060401] and the Digital Library Initiatives phase 1 and 2 in the United States [Digital Libraries Initiative phase 2 060401].

What is being done at university libraries, at commercial publishers, scientific societies, museums or any other organisation producing and managing information for a community of users, is much more than converting analog

data into digital form. New material is created and served in new forms. Take for example how resources from different collection are put together into new entities of information in making great use of pictures and sound and all kind of different search facilities which is just impossible, for economical or technological reasons, to bring about in the analogue world. These resources go side by side with full-text journals, books, references etc. available at your desktop in seconds. Just click on the link! But there are several stumbling blocks that still irritate the everyday user and the visionary when using the digital libraries of today.

We have, for example, the technical issues which include the problem with standards and protocols. To bring the distributed variety of digital resources and services together in a way that allow for integration and unified search, retrieval and presentation is a great challenge for the future. So is the problem of transferring personalised service and support from standard library and information services to the digital library. A user interface can hardly replace person to person service but better user interfaces must be developed and researched in order to help users. The future digital library will go beyond helping the user with searching and browsing only. They must be able to expect support for taking correct actions and getting help for problem solving where the digital library system confirm or deny existing hypotheses. In an interesting paper Feng et al.[Feng et al. 2005] distinguishes between traditional searching and browsing which is called “tactical level cognition” and the problem solving act which is called “strategic level cognition”. In the future, the authors argue, digital libraries must become not only a simple storage place but a place where knowledge is acquired, shared and multiplied. To facilitate the browsing function digital libraries must integrate diverse repositories of coherent collections and include navigation, searching and browsing facilities in a network of inter-related concepts and repositories. That takes care of the “tactical level cognition”. The “strategic level cognition” support must provide justifications and evidences by adding value and advocating a closer interaction between users and the content. To do this it is necessary to use some sort of vocabulary. Parallell to classic keyword-based indexes and knowledge-based index must be constructed. The authors outline a framework for a machine centered and extracted knowledge discovery across multiple repositories. This is being done in six steps by setting up knowledge discovery targets; identifying relevant resources; filter out interesting concepts; correlating concepts; extracting knowledge and justifications from correlated concepts and the evaluation of the same. It is one possible road ahead. But before we are there the solution to everyday problems like long term preservation of digital objects; copyright of digital material; good solutions for micro charging and pay per view; how to bridge the digital divide and include and promote digital libraries of developing countries are maybe more imminent and real. They will be solved!

The Semantic Web

More and more digital material is added every day to the web. We are just learning how to deal with it in the best way. We are only in the beginning of a long and winding road. One of several future stops on that road is called the semantic web. It is a vision trying to remedy the Babel problem of today’s web by machine processable language ontologies. Ontologies provide a shared understanding of a topic of interest among humans and computers. The mere mass of information that is added every second to the Webb, calls for machine-processability. How can the future semantic web help digital libraries? The simple answer is that if we had common schemes in form of ontologies helping us naming and cataloguing digital objects this would enable interoperability. The user would think he is navigating one single digital library system but in reality he would be using a multitude of distributed systems.

By creating standard machine processable ontologies, ontology editors, annotation tools and inference engines that deduce new knowledge from already specified knowledge (as outlined above by Feng et al) it will be easier in the future to add semantic markup and metadata to documents making them not only richer in content but also much easier to get hold of [Sure, Studer 2005].

Content management technologies will be the big thing of the future. The increasing amount of digital content will see to that. Semantic web technologies will probably add important features to digital libraries like semantic interoperability, better browsing, searching and filtering capabilities and delegating routine tasks of cataloguing, metadata annotation etc to automated agents [Lytras et al. 2005]. This is not going to be an easy task. The process of creating and administrating quality metadata records based on shared and ever evolving **ontologies** is a heavy one, but the stone has already started rolling and sooner or later it will roll past a library near you.

Maybe it is metadata that describes and find content and relationship between content that will be the infrastructure of the future digital library. Maybe **that is** the sort of stuff that will make a world of information available by your fingertips at your desk in your own office or at home, come true. Who knows? One thing is for certain, though. The digital library in whatever future shape it may take is here to stay. And you better get used to it as a researcher or teacher.

Human Machines?

The changes that are going on in scientific communication will have impact cross research fields. The medical field is very well provided when it comes to the availability of digital research resources.

Some say that automation certainly will increase and **refers** to how computing power is described by Moore's Law, saying the number of transistors on a semiconductor doubles every eighteen **months**. This is the same as saying that computing power increases 100-fold every 18 months. And they also argue that future digital libraries, as **sketched** above, are likely to depend more on hardware than on clever algorithms. Simple algorithms and brute computing power will make your local librarian rarer and rarer [Arms 2000]. Another fact that also point in that direction is that one of the major costs for classic libraries are staff, facilities and materials, in that order. The future digital library more or less depend on materials only.

Now and in the future computers can rank and find documents, they can evaluate, make citation analysis, they can extract references from a document and link them to the full text source (SFX). Better ways of extracting and inserting meta data are under development. The low cost of these operations are bringing medical research to new audiences and it is only big organisations that can afford the better and personal service of real life librarians.

Yet another angle on this is the postmodernist view that knowledge does not exist separate from human construction. It is created for humans by humans and packaged in local narratives that vary widely from place to place. This calls for new methods of dissemination where the academic librarian no longer only hands down information but instead transforms into a co-creator, **facilitator**, teacher and guide. In fact this transformation is already taking place but surely will be more and more acute as **digital libraries become** more and more automated. It will be imperative for libraries and librarians to demonstrate that they play **an important** role in the universities of transmitting more than content to the students and the researchers. The future librarian must be able to guide through the maze of academic research aware of the human construction of local narratives and simultaneously have a upper hand on communication technologies. The librarian has to become a "human machine" – a cyborg librarian [Yoder 2003]. This means that the librarian must be a physical being engaging in meaningful human interactions with students and researchers while on the same time performing machine-like investigations of network resourcers, constantly on the hunt for information archived in databases, websites, reference books etc.; using a mix of human experience and machine memory in order to keep students and researchers happy.

Hopefully becoming half human half machine will not be necessary. But never the less the challenge for medical research and digital libraries of the future is to handle the increasing **automatisation** of the research sources in a way that makes these resources manageable and available to a broader audience. Concentrating on this, it is necessary to redefine the role of the library/librarian from being a keeper of resources to become also a producer of resources and knowledge relying on modern technology instead of being swallowed by it.

Digital libraries in the Medical field

The digital library community is clearly increasing in number and volume as more and more people get access to high speed internet connections, more people get involved in distance learning, more people get used to online communication, governments, institutions and commercial companies realize the potential in digital deliveries. Developments like these have prepared the ground for a large number of different types of digital libraries throughout the world.

Digital resources in the Medical field are plenty and come in many shapes. I will therefore only list a few good examples of what is available today as Open Access for free:

Bioline International

Bioline International is a not-for-profit electronic publishing service committed to providing access to quality research journals from developing countries. The site includes journals on the following subjects: health (tropical medicine, infectious diseases, epidemiology, emerging new diseases), biodiversity, the environment, conservation and international development. Access to individual titles can be free or fee based. The site contains peer-reviewed journals from Brazil, Cuba, India, Indonesia, Kenya, South Africa, Uganda, Zimbabwe and other countries.

<http://www.bioline.org.br/>

BioMed Central

BioMed Central is an independent publishing house committed to provide immediate free access to peer-reviewed biomedical research. BioMed Central publishes more than 50 on-line journals covering the whole of biology and medicine. The service includes support for journal editors in developing countries.

<http://www.biomedcentral.com/>

BIREME

The Latin American and Caribbean Center for Information (or BIREME as it is widely known from its previous name 'Biblioteca Regional de Medicina') is the regional centre for technical co-operation in health sciences information. It coordinates a network of libraries, documentation and information centres on health-related technical and scientific information. It is developing a virtual library that includes full-text electronic journals from the region (SCIELO) and is available in English, Spanish and Portuguese.

<http://www.bireme.br/bvs/l/ihome.htm>

BMJ Journals: Countries with Free Access

The site contains full-text access to 25 journals published by the BMJ Publishing Group. Access is available to 'low income' and 'low middle income' economies as defined by the World Bank. Via IP address, Internet links from eligible countries automatically will have free access.

<http://www.bmjournals.com/subscriptions/countries.shtml/>

Cell Press

Access to the online archive of Cell and the other premier journals of the Cell Press collection is freely available starting January 2005.

<http://www.cellpress.com>

DOAJ - Directory of Open Access Journals

A very useful service administrated from the University of Lund in Sweden. The Directory of Open Access Journals covers free, full text, quality controlled scientific and scholarly journals. The aim is to cover all subjects and languages. There are now almost 700 journals in the directory.

<http://www.doaj.org/>

Ejournals in the field of education

This service lists e-journals in the field of education. The selection consists of freely accessible full text academic journals, accessible with no cost and peer reviewed. Responsible for the collection is AERASIG Communication of Research (American Educational Research Association Special Interest Group), which supports the Budapest Open Access Initiative and urges e-journals to support the initiative. The only option is to search by journal. Obvious advantages with this list are that you can be sure of the quality of the content and that it is restricted to one subject field. Students and researchers in the field of education is the target group.

<http://aera-cr.asu.edu/ejournals/>

eMedicine

With just a quick registration you can get access to an immense amount of medical material both oriented towards patients and doctors. The data presented is in the "evidence based" style and very thorough. The only drawback is the popup ads that they use to finance this site so be sure to have your popup blocker on.

<http://www.emedicine.com/>

European Database on AIDS and HIV infection

a bibliographic database focused on grey literature and educational material produced by a group of European documentation centres specialized in AIDS and HIV infection.

<http://edoa.bdsp.tm.fr/>

FreeBooks4Doctors!

From the same organisation that presents free medical journals

<http://freebooks4doctors.com/fb/special.htm>

Free Medical Journals

Over the next few years, many important medical journals will be available online, free and in full-text. The access to free scientific knowledge will have a major impact on medical practice and attract Internet visitors to these journals. Journals that restrict access to their Web sites will lose popularity.

The Free Medical Journals Site is dedicated to the promotion of these free access medical journals over the Internet. If you wish to be informed about new free journals, you may subscribe to our Journal Alert. The site now lists about 1300 journals.

<http://www.freemedicaljournals.com/>

The Lancet

This site provides search facilities, free access to selected full-text articles, free access to the Electronic Research Archive (ERA), and free full-text global news. Registration is required (free). Other content is currently only available by paid subscription or 'pay-per-view'.

<http://www.thelancet.com/registration>

NCBI Bookshelf

The Bookshelf is a growing collection of biomedical books that can be searched directly by typing a concept into the textbox above and selecting "Go".

<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&db=Books>

Public Library of Science (PLOS)

PLOS is a non-profit organization of scientists and physicians. Its aim is to make the world's scientific publications and medical literature a public resource, freely available to all. This endeavour is planning to be a repository of 'open access' e-journals and began publication with the October 2003 PLOS Biology. The program is based in San Francisco, U.S.

<http://www.plos.org/>

WHO Statistics

World Health Organization (UN) offers probably the largest statistical archive of mortality rates and general health figures for a large part of the world. Completely free and good for making comparisons between countries.

<http://www.who.int/research/en/>

This brief expose of Open Access medical resources on the Internet hopefully have made clear how varied and heterogeneous the flora of digital libraries are today. Some work with very simple technology like DOAJ but others are more sophisticated like BioMed Central PLoS. Some give access to only specific document types while others work across subject areas. But they all have one thing in common: they are available for free and their numbers are increasing and ultimately they will make medical research available to a broader community than today!

Conclusions

Two main definitions of the term Digital Libraries have been found. They both descend from the two main professional communities that create and use digital libraries – researchers and librarians. The main difference between these definitions are that while librarians focus on service and sees the digital library as an institution the researcher focus on the content collected on behalf of and served to special user communities. Both these definitions complement each other since they focus on different but important aspects of digital libraries. Aspects that need further research.

Research about and development of digital libraries will continue to be a important field as the scientific information flow continues to increase. But, apart from the World Wide Web at large, the digital library must be a controlled zone with a carefully selected subset of information objects which are made searchable and retrievable for the customers/users. The continuing responsibility that comes with a digital library is the control of this subset over time and to ensure that it remains stable and accessible. In order to do so added value to the items moved from outside into the digital library must be included. Added value in the form of increased accessibility; in the form of metadata; preservation; quality control; standardised formats etc.

This can only happen if we find ways to automate the implementation of these added values. The challenge for medical research and digital libraries of the future is to handle the increasing automatization of the research sources in a way that makes these resources manageable and available to a broader audience. This certainly can not be done without the specialist librarian working as an interface between the machine and the customer. Even

though the future library and the future digital library will require less staff, it will not be complete without the human interpreter/analyzer/guide of the digital information universe we traditionally call Librarians.

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